AGING
ANALYTICS
AGENCY

Advanced Biomedicine in the Gulf Region Landscape Overview

Prospects for the Development of
A Full-Scope Gulf Longevity Hub

Longevity   **Precision Health**   **Finance**   **Policy**

Advanced Biomedicine in the Gulf Region

Prospects for the Development of a Full-Scope Gulf Longevity Hub

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Prospects for the Development of a Full-Scope Gulf Longevity Hub

"Advanced Biomedicine in the Gulf Region: Prospects for the Development of a Full-Scope Gulf Longevity Hub" re-tunes and reapplies the analytical methodologies and frameworks first applied to Aging Analytics Agency's "**National Longevity Development Plans**" and "**Global Longevity Governance**" to a dedicated analysis of the levels of Longevity-progressiveness in the Gulf regions, analyzing the current levels of Healthy Longevity (Health-Adjusted Life Expectancy), healthcare efficiency, economic burden of ageing economy and degree of development in advanced biomedicine industries to Bahrain, Kuwait, Qatar, Saudi Arabia, the UAE and Oman.

Introduction: Report Scope and Methodology

"Advanced Biomedicine in the Gulf Region Landscape Overview" is a new analytical case study that applies the sophisticated multidimensional and big data analytics first developed for our previous report, "Global Longevity Governance: Big Data Comparative Analysis of Longevity Progressiveness in 50 Countries", to providing intelligible and fact-based benchmarking of Gulf Region countries in relation to their respective levels of Healthy Longevity, as measured by Health-Adjusted Life Expectancy (HALE), their current gaps between HALE and unadjusted life expectancy, their current levels of success in growing and maintaining National Healthy Longevity, and in dealing with the issue of aging. The results of this analysis are then used to provide tangible policy recommendations on how Gulf countries can either maintain or improve their current international standing and optimize their levels of National Healthy Longevity.

This special analytical case study also compares and contrasts a variety of key factors impacting National Healthy Longevity, and utilizes the results of its analysis to identify social policy, healthcare, medical, financial and socioeconomic factors having the greatest effect on the gap between life expectancy at birth and Health-Adjusted Life Expectancy (HALE) for Bahrain, Kuwait, Saudi Arabia, United Arab Emirates, Qatar and Oman. Some governments are putting policies on Longevity at the center of their growth strategies and budget planning, while others lag behind. This report is able to offer tangible and practical recommendations tuned to the specifics of individual countries, providing the necessary set of tools to reduce their HALE gap and improve their comparative global standing, transforming the deficit and challenge of the silver tsunami into the asset and opportunity of Healthy Longevity for the mutual benefit of their citizens and their economy.

The present report identifies the specific factors with the greatest likelihood of enabling governments to develop integrated Longevity strategies and ecosystems to scale, and to reduce as much as possible their national gap between life expectancy and Healthy Longevity with focus not just on quantity of life, but also on quality. 200 analyzed parameters were used per country (1200 parameters in total), divided into 6 layers and grouped in accordance with the nature of the variables being analyzed. Effectiveness ratios are derived from absolute values and ratios, and are used as a measure of how effective Longevity governance has been in utilizing the financial resources of a given country to generate acceptable increases in health-adjusted life expectancy and quality of life.

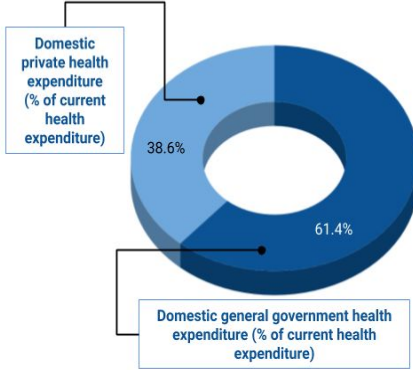# Big Data Comparative Analysis of Healthy Longevity in the Gulf Region
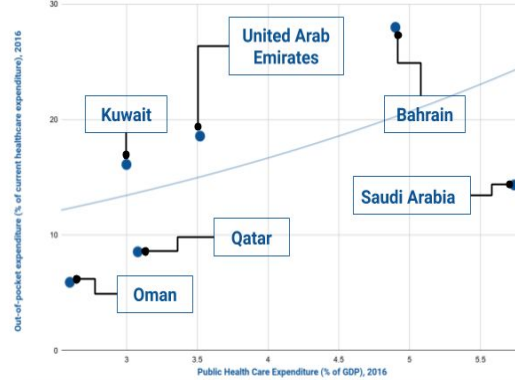
Gulf Cooperation Council

Summary of Healthcare and Longevity Parameters in Bahrain

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

38.6%

61.4%

Domestic general government health expenditure (% of current health expenditure)

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

Public Health Care Expenditure (% of GDP), 2016

The government should undertake affords to create all prerequisites for sustaining population's health through health promotion and prevention and provide access for all to healthcare services for population.

General metrics

Category	Metric	Value
HALE	Both Sexes HALE (2016)	68.1 years
	HALE/Life Expectancy Difference 2016	11.0 years
Economy	GDP per Capita, Current Prices (2016)	22.619 thousand ($)
	Annual GDP Growth (2016)	3.2 %
Healthcare	Current Health Expenditure per Capita (2016)	1.099 thousand ($)
	Public Health Care Expenditure 2016	4.9 % of GDP
Retirement	Age Dependency Ratio 2016	29
	Population over 65, 2016	3.08 %
	Number of WHO Age Friendly Cities and Communities	0
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	2.4
	Annual Cigarette Consumption (Units per Capita) 2016	1101.5
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	65.8 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **73**
- Human Development Index 2016: **0.82**
- E-Government Development Index 2016: **0.77**
- Corruption Perceptions Index 2016: **43**
- Global Gender Gap Index 2016: **0.615**
- Democracy Index 2016: **2.71**

HALE, 2016 / Difference Between HALE and LE, 2016

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / Public Healthcare Expenditure (as % of GDP), 2016

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Summary of Healthcare and Longevity Parameters in Kuwait

Current Healthcare Expenditure
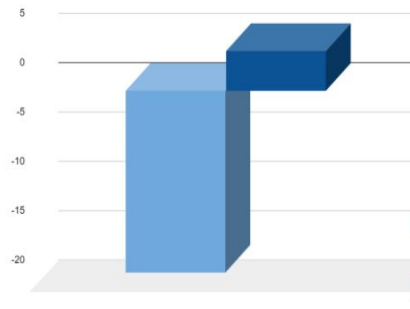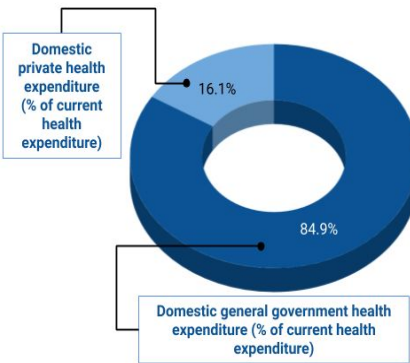
Domestic private health expenditure (% of current health expenditure)

16.1%

84.9%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

Public Health Care Expenditure (% of GDP), 2016

The priority should be focused on reducing ill health and the burden of diseases through programs that secure the health of the whole population. This can be achieved with shifting resources from curative to preventive public health activities.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

General metrics			
HALE	Both Sexes HALE (2016)	66.3 years	
	HALE/Life Expectancy Difference 2016	8.5	
Economy	GDP per Capita, Current Prices (2016)	27.653 thousand ($)	
	Annual GDP Growth (2016)	3.5 %	
Healthcare	Current Health Expenditure per Capita (2016)	1.068 thousand ($)	
	Public Health Care Expenditure 2016	3.0 % of GDP	
Retirement	Age Dependency Ratio 2016	30	
	Population over 65, 2016	2.66 %	
	Number of WHO Age Friendly Cities and Communities	0	
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.0	
	Annual Cigarette Consumption (Units per Capita) 2016	1412.7	
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	73.4 % of adults	

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **81**
- Human Development Index 2016: **0.80**
- E-Government Development Index 2016: **0.71**
- Corruption Perceptions Index 2016: **41**
- Global Gender Gap Index 2016: **0.624**
- Democracy Index 2016: **3.85**

HALE, 2016 / Difference Between HALE and LE, 2016

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / Public Healthcare Expenditure (as % of GDP), 2016

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Summary of Healthcare and Longevity Parameters in Qatar

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

18,4%

81,6%

Domestic general government health expenditure (% of current health expenditure)

Effectiveness ratios

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

Public Health Care Expenditure (% of GDP), 2016

The government should focus on improvement of nutritions and promotion of healthy lifestyle, also pay attention to improvement of healthcare services and their accessibility to all income groups.

General metrics			
HALE	Both Sexes HALE (2016)	68.6 years	
	HALE/Life Expectancy Difference 2016	9.5	
Economy	GDP per Capita, Current Prices (2016)	57.16 thousand ($)	
	Annual GDP Growth (2016)	2.1 %	
Healthcare	Current Health Expenditure per Capita (2016)	1.83 thousand ($)	
	Public Health Care Expenditure 2016	3.08 % of GDP	
Retirement	Age Dependency Ratio 2016	18	
	Population over 65, 2016	1.2 %	
	Number of WHO Age Friendly Cities and Communities	0	
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	2	
	Annual Cigarette Consumption (Units per Capita) 2016	1020	
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	71.7 % of adults	

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **82**
- Human Development Index 2016: **0.86**
- E-Government Development Index 2016: **0.67**
- Corruption Perceptions Index 2016: **61**
- Global Gender Gap Index 2016: **0.64**
- Democracy Index 2016: **3.18**

HALE, 2016 / **Difference Between HALE and LE, 2016**

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / **Public Healthcare Expenditure (as % of GDP), 2016**

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Summary of Healthcare and Longevity Parameters in Saudi Arabia

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

32,2%

67,8%

Domestic general government health expenditure (% of current health expenditure)

Effectiveness ratios

0.05
0.025
0
-0.025
-0.05
-0.075

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

30
20
10
0

United Arab Emirates
Kuwait
Bahrain
Saudi Arabia
Qatar
Oman

3   3.5   4   4.5   5   5.5

Public Health Care Expenditure (% of GDP), 2016

The country need to reduce disparities in health and health care systems between poorer and richer families and underfunded health care systems that in many cases are inefficiently run and underregulated.

General metrics

Category	Metric	Value
HALE	Both Sexes HALE (2016)	65.7 years
	HALE/Life Expectancy Difference 2016	8.86
Economy	GDP per Capita, Current Prices (2016)	19.88 thousand ($)
	Annual GDP Growth (2016)	1.7 %
Healthcare	Current Health Expenditure per Capita (2016)	1.15 thousand ($)
	Public Health Care Expenditure 2016	5.74 % of GDP
Retirement	Age Dependency Ratio 2016	40
	Population over 65, 2016	3.2 %
	Number of WHO Age Friendly Cities and Communities	0
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.2
	Annual Cigarette Consumption (Units per Capita) 2016	1341
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	69.7 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **77**
- Human Development Index 2016: **0.85**
- E-Government Development Index 2016: **0.68**
- Corruption Perceptions Index 2016: **46**
- Global Gender Gap Index 2016: **0.58**
- Democracy Index 2016: **1.93**

HALE, 2016 / Difference Between HALE and LE, 2016

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / Public Healthcare Expenditure (as % of GDP), 2016

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Summary of Healthcare and Longevity Parameters in UAE

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure) — 32,2%

Domestic general government health expenditure (% of current health expenditure) — 67,8%

Effectiveness ratios

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016
Public Health Care Expenditure (% of GDP), 2016

United Arab Emirates, Kuwait, Bahrain, Saudi Arabia, Qatar, Oman

The country need to reduce disparities in health and health care systems between poorer and richer families and underfunded health care systems that in many cases are inefficiently run and underregulated.

General metrics

Category	Metric	Value
HALE	Both Sexes HALE (2016)	66,7 years
	HALE/Life Expectancy Difference 2016	10.55
Economy	GDP per Capita, Current Prices (2016)	38.14 thousand ($)
	Annual GDP Growth (2016)	3 %
Healthcare	Current Health Expenditure per Capita (2016)	1.32 thousand ($)
	Public Health Care Expenditure 2016	3.52 % of GDP
Retirement	Age Dependency Ratio 2016	18
	Population over 65, 2016	1.1 %
	Number of WHO Age Friendly Cities and Communities	1
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	3.8
	Annual Cigarette Consumption (Units per Capita) 2016	748
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	67.8 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **70**
- Human Development Index 2016: **0.86**
- E-Government Development Index 2016: **0.75**
- Corruption Perceptions Index 2016: **66**
- Global Gender Gap Index 2016: **0.64**
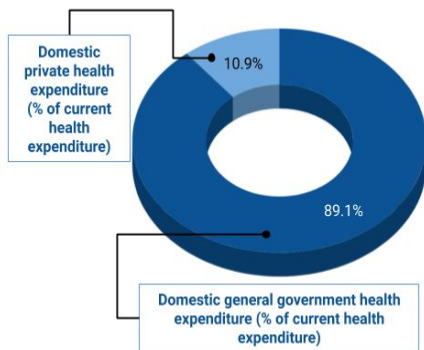- Democracy Index 2016: **2.75**

HALE, 2016 / Difference Between HALE and LE, 2016

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / Public Healthcare Expenditure (as % of GDP), 2016

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Summary of Healthcare and Longevity Parameters in Oman

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

10.9%

89.1%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates
Kuwait
Bahrain
Saudi Arabia
Qatar
Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016
Public Health Care Expenditure (% of GDP), 2016

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

The people of Oman do still suffer from some diseases related to nutritional problems and congenital disorders. It is believed that these are related to certain behavioral aspects of the population, which require to be modified by strong health promotional measures.

General metrics

Category	Metric	Value
HALE	Both Sexes HALE (2016)	65.6 years
	HALE/Life Expectancy Difference 2016	11.4 years
Economy	GDP per Capita, Current Prices (2016)	14.721 thousand ($)
	Annual GDP Growth (2016)	5.4 %
Healthcare	Current Health Expenditure per Capita (2016)	0.648 thousand ($)
	Public Health Care Expenditure 2016	2.6 % of GDP
Retirement	Age Dependency Ratio 2016	32
	Population over 65, 2016	2.33 %
	Number of WHO Age Friendly Cities and Communities	0
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.1
	Annual Cigarette Consumption (Units per Capita) 2016	271.1
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	62.6 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **76**
- Human Development Index 2016: **0.79**
- E-Government Development Index 2016: **0.60**
- Corruption Perceptions Index 2016: **45**
- Global Gender Gap Index 2016: **0.612**
- Democracy Index 2016: **3.04**

HALE, 2016 / Difference Between HALE and LE, 2016

HALE, 2016	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

HALE, 2016 / Public Healthcare Expenditure (as % of GDP), 2016

HALE, 2016	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Key Findings of the Special Case Study

There are a number of factors that affect **Healthy Longevity**, for instance, socioeconomic status, income, demography, wellbeing, the quality of the health system and the ability of people to access it, health behaviours such as tobacco and excessive alcohol consumption, poor nutrition and lack of exercise, social factors, genetic factors and environmental factors including overcrowded housing, lack of clean drinking water and adequate sanitation. This report shows that the biggest threat to human`s health is the prevalence of non-communicable diseases (NCDs). Unplanned urbanization, globalization of unhealthy lifestyles and population aging are main influencers of growing amount of noncommunicable diseases.

Unplanned Urbanization	Globalization of Unhealthy Lifestyles	Population Aging

Growing Amount of NCD

NCDs are known to be a "slow motion disaster." Lack of physical activity and unhealthy diets cause raised blood pressure, increased blood glucose, overweight and obesity. These are called "metabolic risk factors" and can lead to cardiovascular disease, the leading NCD with regard to premature deaths. All risk factors of NCDs lie in non-health sectors, requiring collaboration across all of government and all of society to combat them. One thing to note is that the countries that have the highest life expectancy and HALE indicators are generally the most developed countries. **The greater one's income, the lower one's likelihood of disease and premature death.** The relationship between income and health is a gradient: they are connected step-wise at every level of the economic ladder.

Source: Oman Observer

Health-Adjusted Life Expectancy

Health-Adjusted Life Expectancy (HALE), used here as a measure of Healthy Longevity, is the average number of years an individual can expect to live free of chronic age-related disease. HALE can be estimated at international, national or local levels to:

- Compare population health across communities and over time;
- Provide a full picture of which diseases, injuries, and risk factors contribute the most to poor health in a specific population (this is probably the most common use of summary measures of health);
- Assess which information or sources of information are missing, uncertain, or of low quality;
- Measures of HALE are normally presented by age, sex and geographical region.

The uses of HALE include:

▶ Research on healthy ageing encompasses: the biological processes contributing to ageing per se; the socio-economic and environmental exposures across life which modulate ageing and the risk of age-related frailty, disability and disease; and the development of interventions which may modulate the ageing trajectory;

▶ Such research needs measures of health span which, in addition to chronological age, can characterise and quantify important functions which are subject to decline at faster, or slower, rates during individual human ageing. Furthermore, it is impossible to determine whether biotechnologies for aging have been successful if we cannot tell how advanced the aging process is in any given individual;

▶ The role of government strategy is of immediate importance in advancing the Longevity industry from its present point, and governments must be able to monitor and describe biomedical progress. Metrics for tangible progress are absolutely essential component of any government strategic agenda. It will be impossible to make concrete claims regarding global progress in biotechnology, preventive medicine without an agreed set of metrics.

HALY / QALY / DALY

The metrics known as HALYs (**health-adjusted life-years**) includes HALE, a measure of population health that takes into account mortality and morbidity that are useful for overall estimates of burden of disease, comparisons of the relative impact of specific illnesses and conditions on communities, and in economic analyses. **Quality-adjusted life years** (QALYs) and **disability-adjusted life years** (DALYs), the latter being types of HALY whose original purposes were at variance. Quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) are types of HALYs whose original purposes were at variance.

HALY	QALY	DALY
Health-Adjusted Life Years is a measure of the health of a population, typically used in estimates of the burden of disease. HALYs are used to measure the combined effects of mortality and morbidity in populations; they permit comparisons between illnesses or interventions as well as between populations. They are commonly used to compare the cost-effectiveness of different health interventions.	The generic measure of disease burden, including both the quality and the quantity of life lived. It is used in economic evaluation to assess the value for money of medical interventions. One QALY equates to one year in perfect health. If an individual's health is below this maximum, QALYs are accrued at a rate of less than 1 per year. To be dead is associated with 0 QALYs.	Measure the amount of life lost in a population as a result of premature death or disability. They can be used to estimate the burden of disease on populations. One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

Source: NCBI

HALE and Life Expectancy

▶ **Health-Adjusted Life Expectancy** (**HALE**), used here as a measure of Healthy Longevity, is the average number of years an individual can expect to live free of chronic age-related disease.

▶ **Life Expectancy (LE)** at birth reflects the overall mortality level of a population. It summarizes the mortality pattern that prevails across all age groups in a given year – children and adolescents, adults and the elderly.

Life Expectancy in the Gulf Countries

Country	2016	2010
Qatar	76,9	77,2
United Arab Emirates	76,4	76,3
Bahrain	76,2	77,2
Oman	75	75,6
Kuwait	73,7	74,1
Saudi Arabia	73,2	73,8

● 2016　● 2010
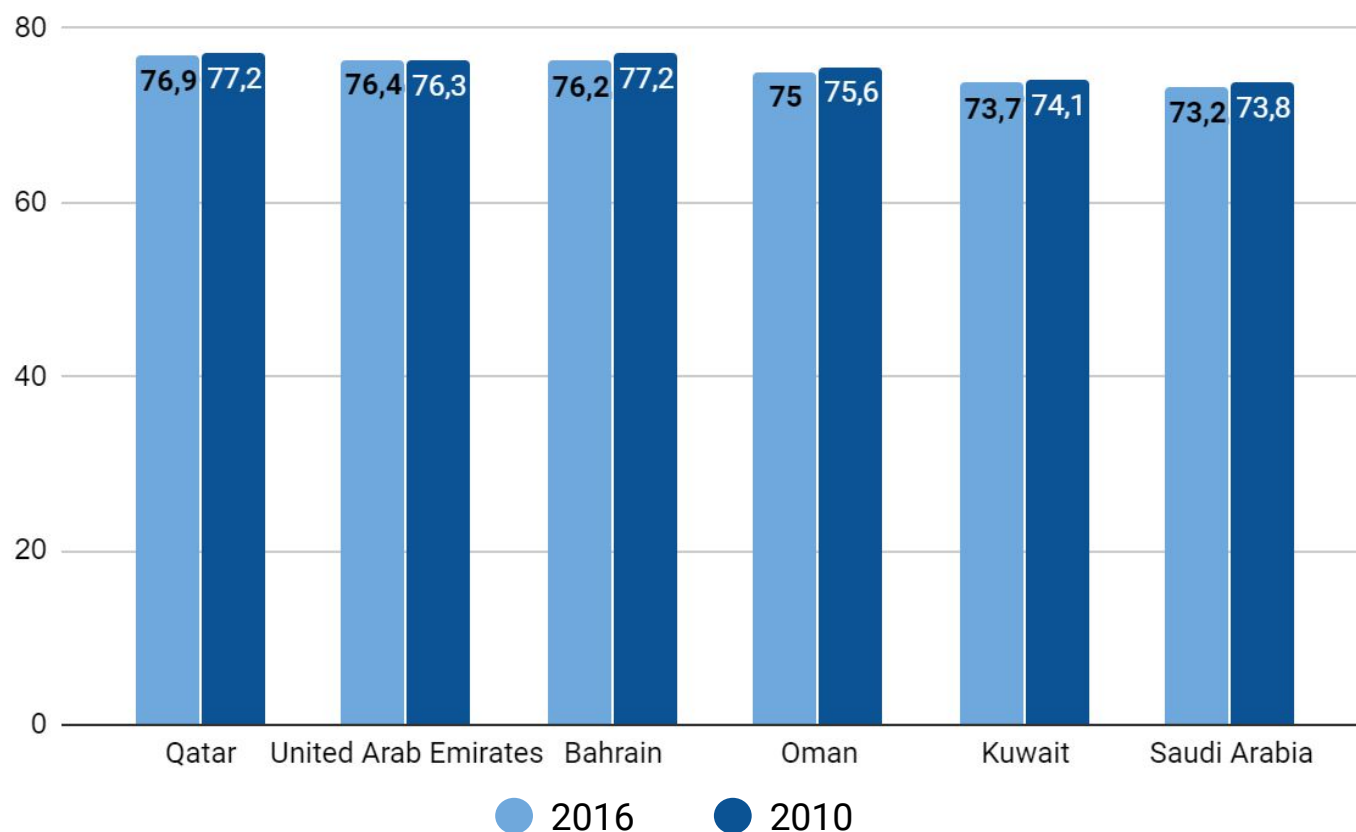
Significant investments in health care infrastructure by GCC governments and the increase in hospitals and clinics raised the quality of healthcare services in the region so led to the rise of **Life Expectancy**.

Source: Wikiwand　WHO

Preventive Medicine and HALE

Healthcare has changed since the decline in mortality caused by infectious diseases as well as chronic and non-contagious diseases, with a direct impact on the cost of public health and individual health care. People must now transition from traditional reactive medicine based on symptoms, diagnosis and treatment to a system that targets the disease before it occurs and, if it cannot be avoided, treats the disease in a personalized manner. Precision Medicine is that new way of thinking about medicine. Precision medicine is poised to have an impact on patients, health care delivery systems and HALE in ways that were only imagined 15 years ago when the human genome was first sequenced.

Deep Diagnostics and Preventive Medicine

20%

2019

80%

Treatment of chronic and Last stage diseases

Preventive Personalized Precision Medicine

50%

50%

2025

Treatment of Chronic and Last Stage Diseases

HALE and Life Expectancy

▶ **Health-Adjusted Life Expectancy** (**HALE**), used here as a measure of Healthy Longevity, is the average number of years an individual can expect to live free of chronic age-related disease.

▶ **Life Expectancy (LE)** at birth reflects the overall mortality level of a population. It summarizes the mortality pattern that prevails across all age groups in a given year – children and adolescents, adults and the elderly.

HALE, 2016

HALE	Country	Difference Between HALE and LE, 2016
76.9	Qatar	9.5
76.4	United Arab Emirates	10.5
76.2	Bahrain	11
75	Oman	11.4
73.7	Kuwait	8.5
73.2	Saudi Arabia	8.6

Source: WHO   Wikiwand

HALE and Life Expectancy

Gulf countries are characterized as those with **Low HALE and Life Expectancy** because of a sign of unhealthy behavior of population. According to the analysis people of the Gulf countries are suffering of diabetes and hypertension due largely to overweight, obesity and sedentary lifestyle, therefore **United Arab Emirates, Oman** and **Bahrain** belong to the group of Low HALE and Life Expectancy with a high gap between these indicators. **Qatar, Kuwait** and **Saudi Arabia** are classified as countries with a medium HALE/LE gap.

Here are a number of factors which mostly affect HALE and Life Expectancy levels in the aforementioned countries:

- prevalence for obesity and diabetes;
- level of healthcare expenditures;
- income disparity across the country;
- living standards.

World life expectancy continues to increase on the whole, but these countries are still lagging behind. In order to increase the longevity and potential of their citizens' lives, they will require targeted aid and a focus on infrastructure and healthcare.

Low HALE and Life Expectancy

High Gap between HALE and Life Expectancy

Medium Gap between HALE and Life Expectancy

United Arab Emirates

Oman

Bahrain

Saudi Arabia

Kuwait

Qatar

Source: WHO
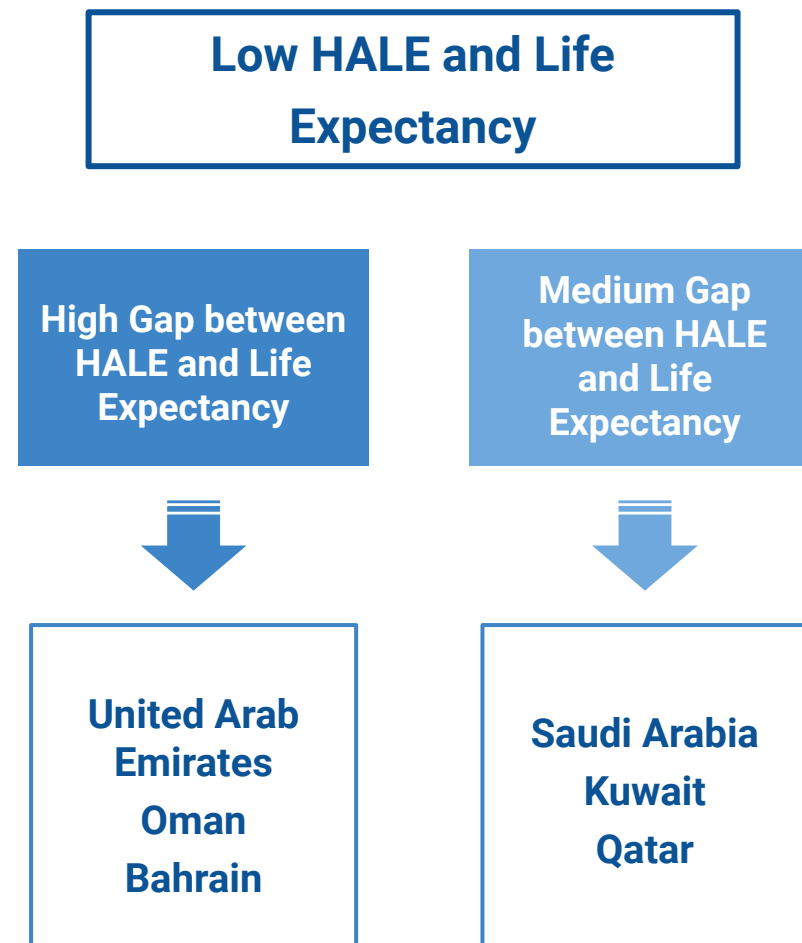
HALE and Public Healthcare Expenditure

> ▶ **Health-Adjusted Life Expectancy** (**HALE**), used here as a measure of Healthy Longevity, is the average number of years an individual can expect to live free of chronic age-related disease.
>
> ▶ **Public Healthcare Expenditure** consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds.

HALE, 2016

HALE	Country	Public Healthcare Expenditure (as % of GDP), 2016
76.9	Qatar	3.08
76.4	United Arab Emirates	3.52
76.2	Bahrain	4.9
75	Oman	2.6
73.7	Kuwait	3
73.2	Saudi Arabia	5.74

Public Healthcare Expenditure (as % of GDP), 2016

Source: WHO

Healthcare Spendings and GDP

> **Public spending** is a factor making a large impact on the healthcare systems of the countries which indirectly affects HALE and LE of population. **Health spending** measures the final consumption of health care goods and services including personal health care and collective services, but excluding spending on investments.
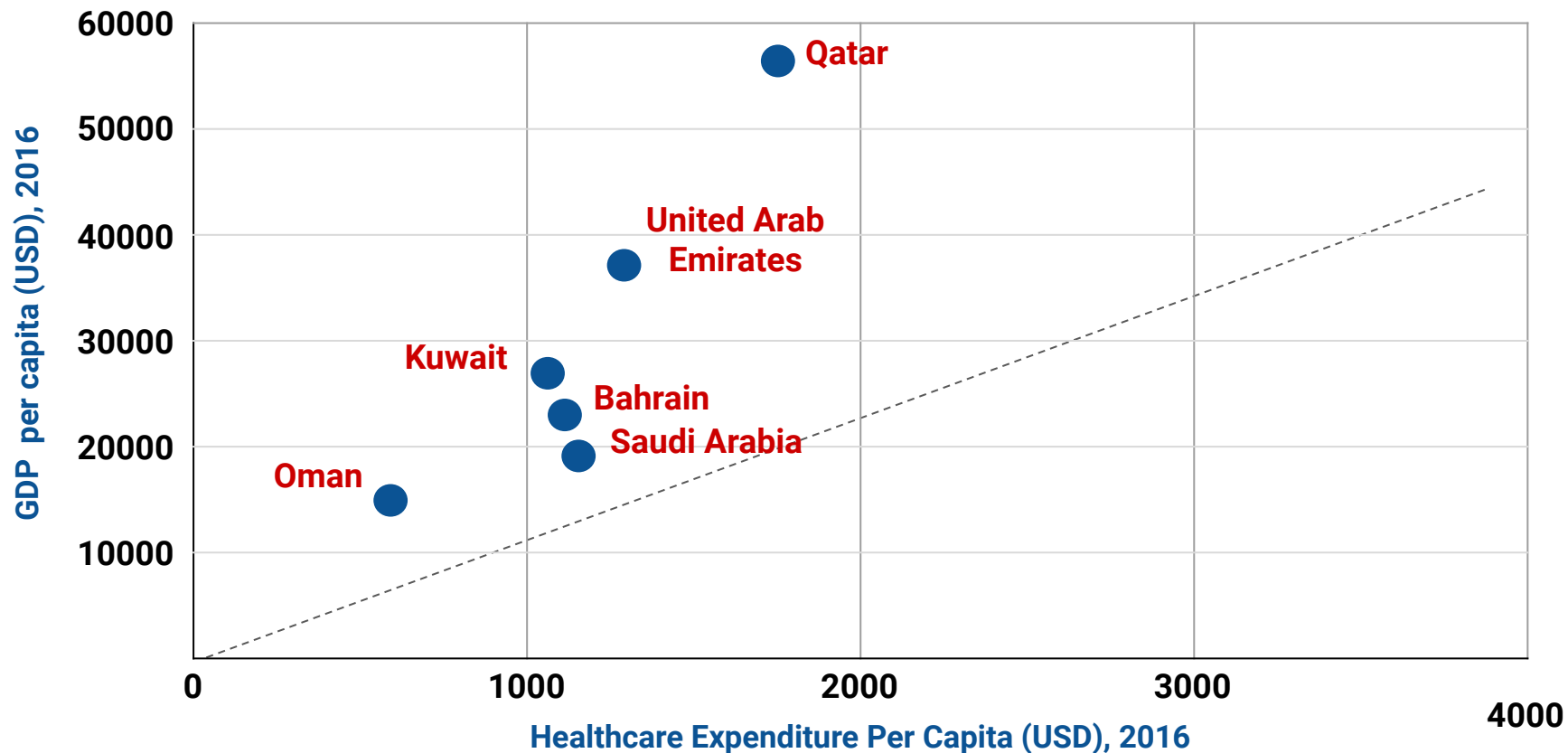
This chart collection takes a look at how spendings on healthcare are correlated with GDP per capita. The analysis looks at 2016 health and economic data from the World Bank and Organization of Economic Cooperation and Development (OECD). **Qatar, United Arab Emirates** tend to spend more per person on healthcare and related expenses than countries with lower income as **Saudi Arabia, Bahrain, Kuwait, and Oman.** Comparing health spending in countries is complicated, as each country has unique political, economic, and social attributes that contribute to its spending.

Healthcare Expenditures per capita by Country

The financial resources that a country devotes to health care and how this changes over time and is a result of a wide array of social and economic factors, as well as financing and organisational structure of country's health system.

Healthcare Expenditure Per Capita (USD), 2016
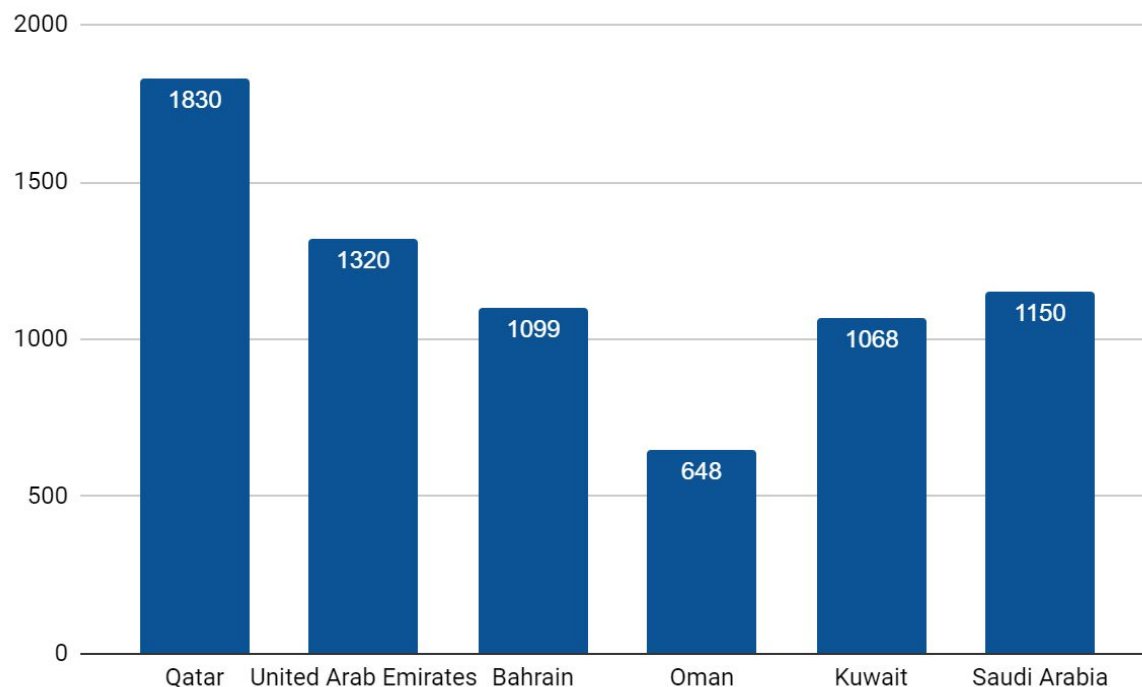
Per capita spending on health across countries continued to grow in 2016 following the trend of recent years. This comes after the slowdown between 2009 and 2011 caused by the global financial crisis.

Efficiency of healthcare system can not be simply measured by the greatest share of healthcare expenditures as percentage of GDP. Health spending includes consumption of health care goods and services including personal health care and collective services. It is a complex indicator that varies across countries. Healthcare spendings in developed countries are affected with higher prices, high administrative and transaction costs. That is why not in all cases higher healthcare spendings contribute to efficiency of healthcare system and better health.

Source: OECD World Bank

Advanced Biomedicine Industry

Pharmaceutical Industry in the GCC Countries began 25 years ago with the idea to decrease cost of the medications which was increasing rapidly. Nevertheless, nowadays Gulf Countries still **import 90% of their drug needs**. The pharmaceutical market has faced substantial growth over the years due to favorable demographic and economic factors, and strong government support for healthcare. Despite the progress and fact that the governments have been trying to increase local drug manufacturing and reduce reliance on imported products by encouraging joint ventures and licensing deals with multinational pharmaceutical companies, but pharma sector in the Gulf is still in an emerging phase, and drug manufacturing is at a relatively nascent stage due to a number of obstacles.

According to the CPhI Pharma Insights report about the development of pharmaceutical sector in MENA region, pharmaceutical market worth **$36bn in 2016**, which represented 2% of the global market. In 2014, the GCC countries came together to establish a drug price harmonisation strategy in order to standardise drug prices within the region.

As Biotechnology is the future of medicine, GCC countries should give it priority and support in the new era development. It is part of the national security for the country as well as it is the new treatment modalities for all diseases.

Population dynamics

Ageing

Factors that drive the growth of the pharmaceutical market

Lifestyle changes

Non-communicable chronic diseases

Source: Researchgate

Current Trends of Pharmaceutical Industry

The trend in consuming medication is changing due to changes in how diseases are spread. Urban development and the increase per capita income in the GCC lead to a more comfortable lifestyle and increased unbalanced diets. This leads to an increase in health problems such as diabetes, heart and cardiovascular diseases, which affects the pharmaceutical industry as well as increases healthcare costs.
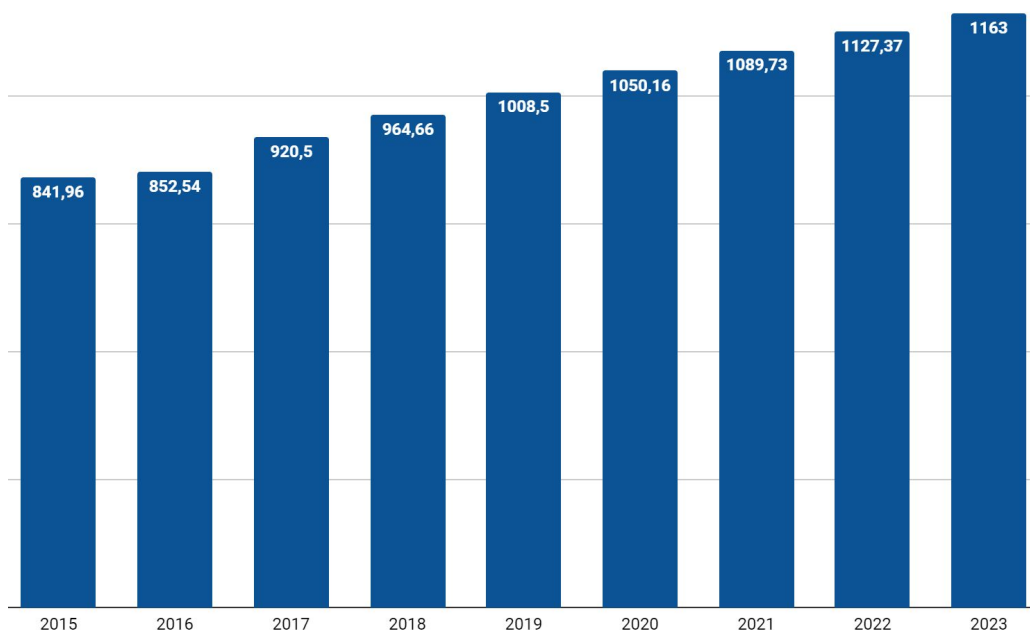
Percent of Total Medicine Producement in the GCC Region

Bahrain 3,1%
Qatar 4,5%
Oman 5,6%
Kuwait 9,2%
United Arab Emirates 18,0%
Saudi Arabia 59,5%
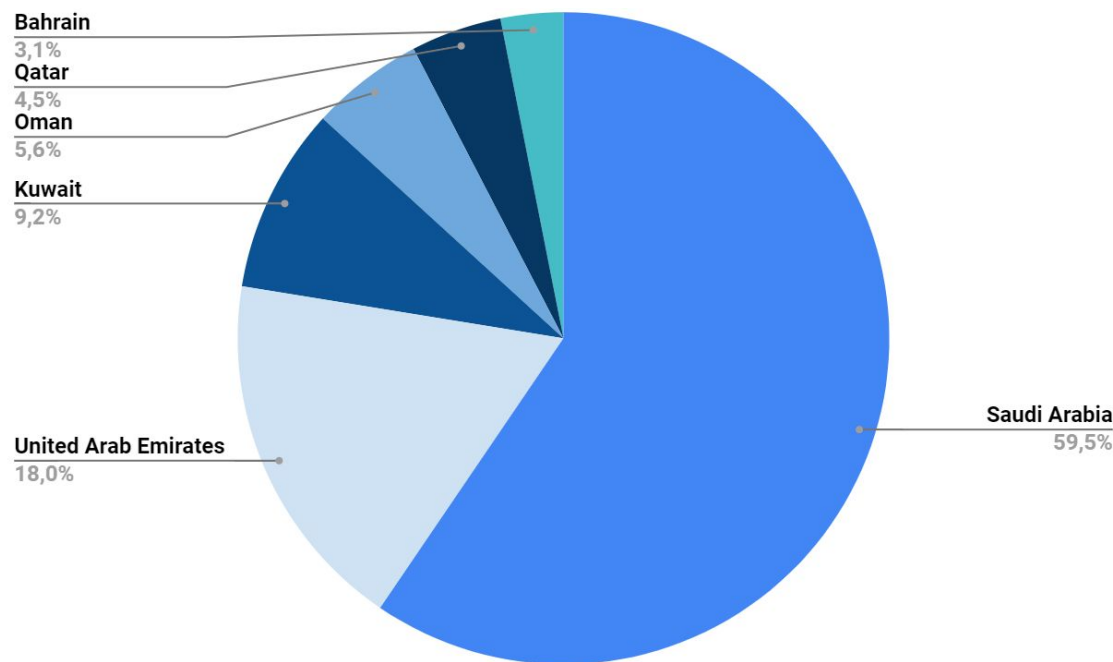
Health care spending in the GCC will increase as the sector grows, which will lead to a decrease in the percentage spent on pharmaceuticals compared to the total health care spending to match those of the developed world, expecting a decrease from 14.3% in 2010 to 12.4% by 2020.

Recently there are efforts to pursue international companies to invest in the GCC countries. There are between 15 to 20 local and foreign pharmaceutical manufacturers in **Saudi Arabia and United Arab Emirates**. By the way, biotechnology sector is not greatly developed in the Gulf countries, as practically most of the companies are looking for Biosimilar. It is believed that high investment in R&D does not produce the expected fast cash and revenues as with Biosimilar.

Source: Researchgate

Prospects of Pharmaceutical Industry

Industry Revenue of Manufacture of Basic Pharmaceutical Products and Preparations in Saudi Arabia, with a forecast to 2023 (in million USD)

Bar chart values:
- 2015: 841,96
- 2016: 852,54
- 2017: 920,5
- 2018: 964,66
- 2019: 1008,5
- 2020: 1050,16
- 2021: 1089,73
- 2022: 1127,37
- 2023: 1163

Saudi Arabia, being the largest market in GCC region, presents better investment opportunities for investors, and this is further augmented with mandatory insurance and corporatization /privatization of the healthcare sector in the country. According to the Future Market Insights report, **Saudi Arabia pharmaceutical market is anticipated to increase at a robust CAGR of 9% over the period 2016-2026**.

Vision 2030 that was recently launched in Saudi Arabia is a great motive to advance Pharmaceutical Industry as it will enforce health insurance, privatize/corporatize the healthcare in Saudi Arabia and invites foreign investors in all aspects of the industry including Pharmaceuticals. This came with great governmental support for the foreign investors.

The pharmaceutical industry in the Gulf is still in the early development stages compared to international standards and most the Pharmaceuticals manufacturers in the GCC countries are producing generics, drug that contains the same chemical substance as a drug that was originally protected by chemical patents. Despite that, **pharma industry is changing through reform and simplifying government regulations, increasing its efficiency and expanding the infrastructure of health care**. Based on that, the pharmaceutical industry in GCC will face many changes in the next few years, which will provide important investment opportunities. The local production is expected to increase. Mainly due to the increase of foreign investment in this sector and extending prevalence of non-communicable diseases.
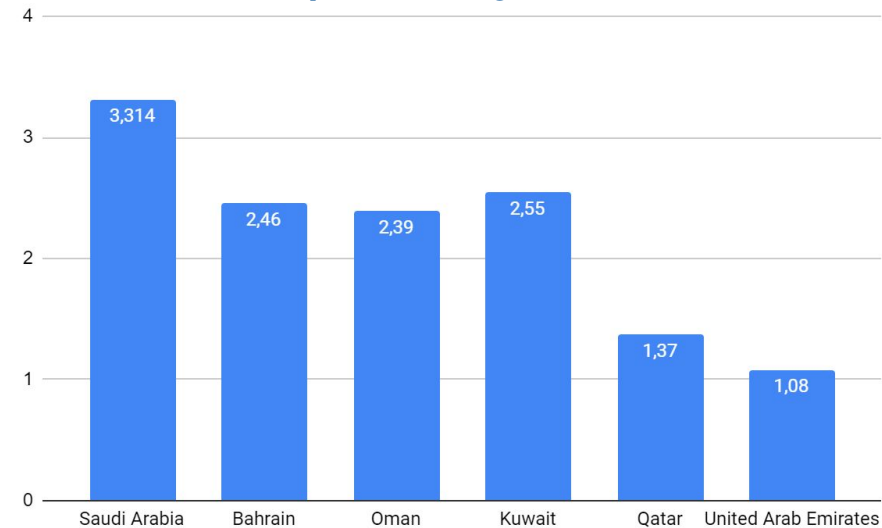
Source: Researchgate   Statista

Aging Population

Populations are expected to age rapidly in the Arab countries during the coming few decades. The tempo, or speed, of the population aging process has been different for some countries in the region, with some identified as having 'fast', others as 'medium' and 'slow' tempos. Within the 'fast' or rapidly ageing group are the **United Arab Emirates, Bahrain and Kuwait**.

The increase in the number of elderly calls for a comprehensive action plan to take care of their health, psychological, physical and social needs.

For instance, almost 25.5 percent of the elderly in Saudi Arabia have diabetes and suffer from high blood pressure. Data related to treatment costs of the elderly Saudi population showed that 79.4 percent of the treatment services were available to them and provided by the state, whereas the proportion of those who receive treatment on their own and have medical insurance is 20.6 percent. As people age their need for care increases. That means aging population creates considerable demands on the national and local economics.

% of Total Population: Aged 65 and Above

Country	Value
Saudi Arabia	3,314
Bahrain	2,46
Oman	2,39
Kuwait	2,55
Qatar	1,37
United Arab Emirates	1,08

Standard & Poor (S&P) has forecast the Saudi Arabian population to expand rapidly to 46 million through 2050, with **the proportion of elderly people rising to 15% of total inhabitants from 3% today**. An S&P analyst has suggested that age-related government expenditure on pensions and healthcare could rise to as much as 14% of GDP by 2050 from 6% today. In Kuwait, the ratio between people aged 65+ and the 15-64 age group was 2.6 in 2015, with this projected to be closer to 20 in 35 years' time.

Source: NCBI   World Bank   Arab Health Online

Old-Age Dependency Ratio by Country

The demographic **old-age dependency ratio** is defined as the number of individuals aged 65 and over per 100 people of working age defined as those aged between 20 and 64. It is an indicator of how many potential retirees a potential worker has to support and also illustrates ageing populations.

The evolution of dependency ratios depends on **mortality rates, fertility rates and migration**. Developed countries have seen prolonged increases in life expectancy, which most analysts project to continue, implying an increasing number of older people and most likely of pensioners too. There have also been substantial declines in fertility, which, of course, will eventually diminish the number of workers entering the labour market. Developing countries opposite trend of increase in birth rate and relatively low old-age dependency ratio.

Old-Age-Dependency Ratio, 2018
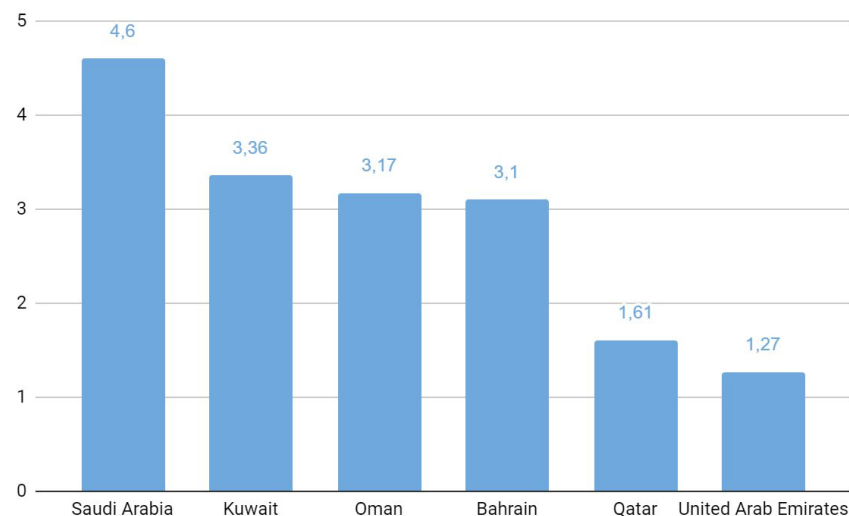
Saudi Arabia has the highest old-age dependency ratio among Gulf countries, it equals 4,6 in 2018. The old-age dependency ratios in **Bahrain, Oman, Kuwait** suggest increases in economic activity at older ages may help to offset the impact of population ageing on the economy in the future.

**Source:** World Bank

Country Healthcare and Longevity Profiles

Bahrain

General metrics			
	HALE	Both Sexes HALE (2016)	68.1 years
		HALE/Life Expectancy Difference 2016	11.0 years
	Economy	GDP per Capita, Current Prices (2016)	22.619 thousand ($)
		Annual GDP Growth (2016)	3.2 %
	Healthcare	Current Health Expenditure per Capita (2016)	1.099 thousand ($)
		Public Health Care Expenditure 2016	4.9 % of GDP
	Retirement	Age Dependency Ratio 2016	29
		Population over 65, 2016	3.08 %
		Number of WHO Age Friendly Cities and Communities	0
	General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	2.4
		Annual Cigarette Consumption (Units per Capita) 2016	1101.5
		Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	65.8 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **73**

- Human Development Index 2016: **0.82**

- E-Government Development Index 2016: **0.77**

- Corruption Perceptions Index 2016: **43**

- Global Gender Gap Index 2016: **0.615**

- Democracy Index 2016: **2.71**

Current Healthcare Expenditure
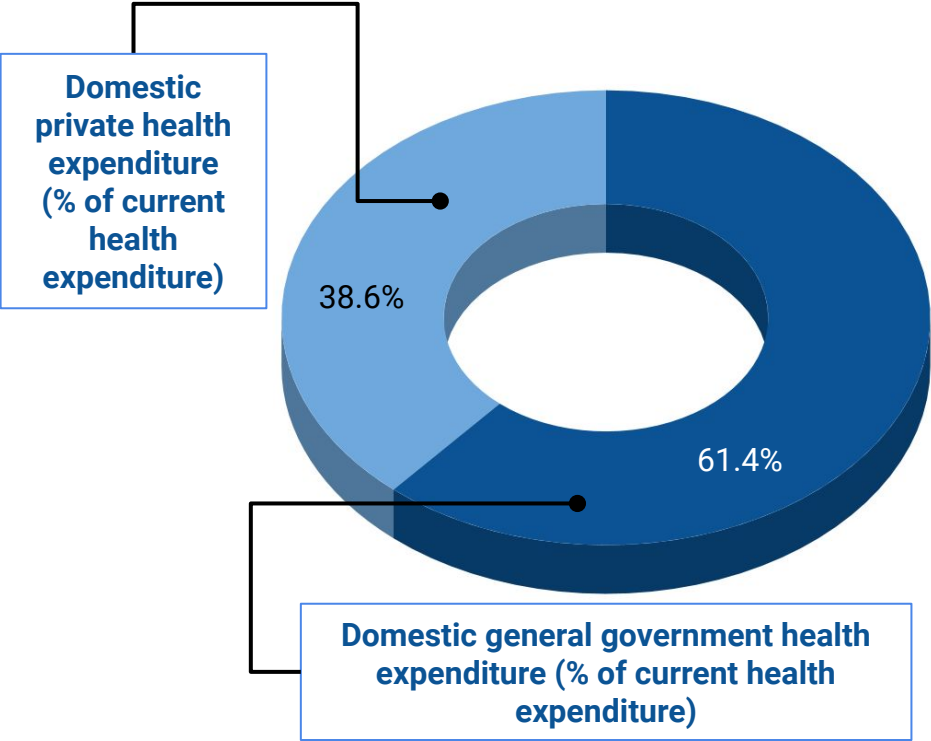
Domestic private health expenditure (% of current health expenditure)

38.6%

61.4%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Public Health Care Expenditure (% of GDP), 2016
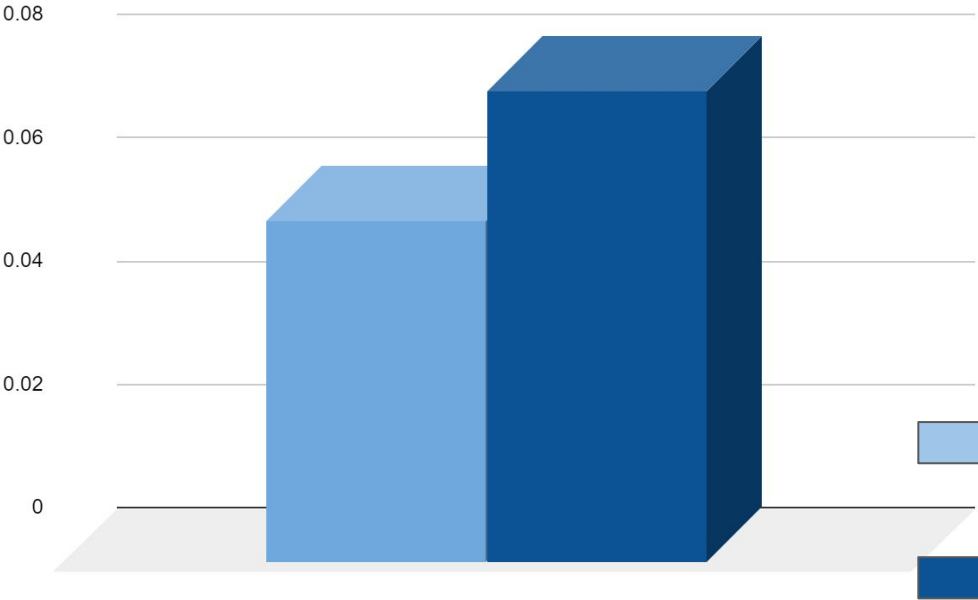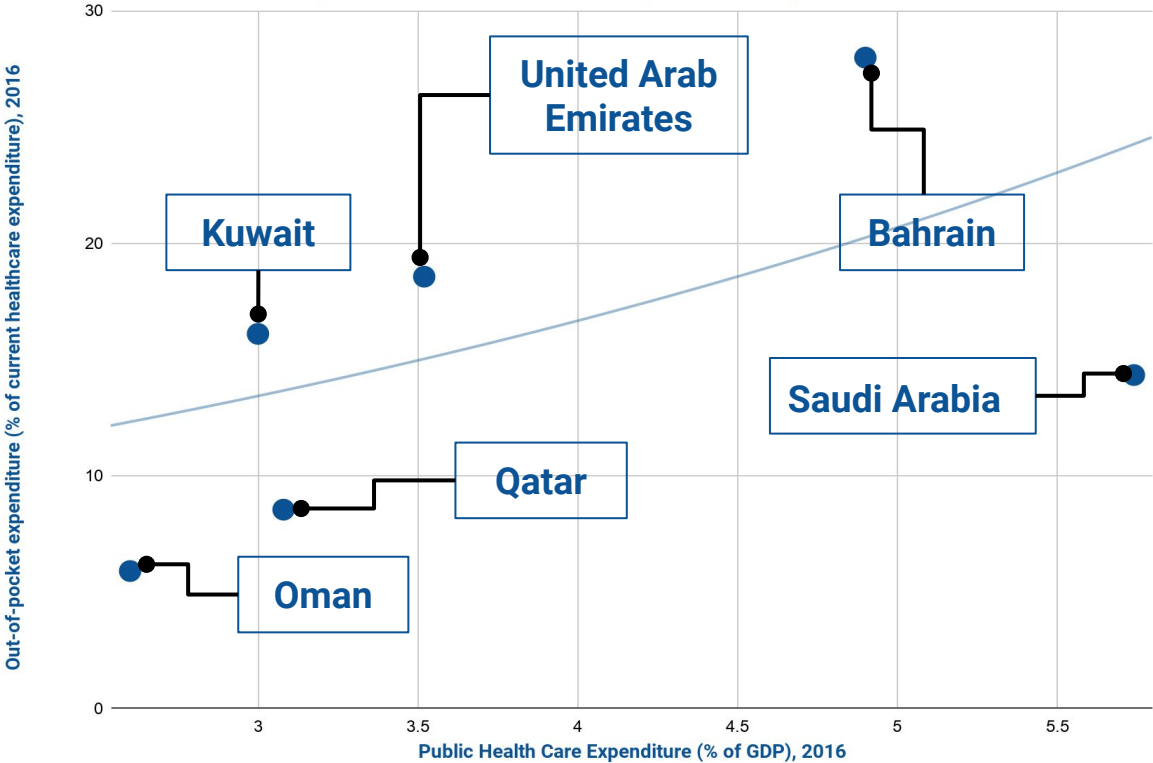
The government should undertake affords to create all prerequisites for sustaining population's health through health promotion and prevention and provide access for all to healthcare services for population.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

SWOT Analysis of Healthcare in Bahrain

➕ STRENGTHS

- Inclusion of preventive strategies for non-communicable diseases and elderly care to reduce the economic burden of its rapidly-growing aged population within its broader "Bahrain Economic Vision 2030" plan, demonstrating top-level government prioritization of the issues of elderly population and high incidence of non-communicable diseases (NCDs).
- Bahrain also appears to be laying the groundwork for developing an edge in preventive medicine over other Gulf countries through the establishment of their National Genome Project, studying the genetic makeup of Bahrain's population to learn more about genetic susceptibility to disease and develop diagnostic methods and medicines tailored to individuals.
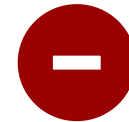
➖ WEAKNESSES

- NCDs account for 63% of all deaths in Bahrain, according to the Ministry of Health, with 92,946 cardiovascular disease patients, 487 cancer patients, 52,806 diabetes patients and 54,029 patients with chronic respiratory diseases.
- The region has a rapidly rising ageing population, which is poised to place significant economic burden upon its recently established Universal Health Insurance framework
- Bahrain has the lowest density of healthcare workers per capita in the Gulf Region, according to research from the World Health Organisation in 2017.
- The region has the second lowest Healthcare Access and Quality index score (74) among all Gulf Countries.

✔ OPPORTUNITIES

- Bahrain has in recent years prioritized the construction of dedicated medical hubs.The Bahrain government announced in February 2018 that it plans to develop an integrated medical city north of Bahrain Muharraq Governorate.
- Work is also ongoing at the $1bn King Abdullah Bin Abdulaziz Medical City. Its second phase is expected to include medical clinics and specialised research centres focusing on NCD prevention and treatment.
- The development and prioritization of dedicated, integrated medical cities is one of the region's strongest edges over its neighbors, and development efforts should continue.

❗ THREATS

- The region's rapidly growing elderly population is set to impose a high economic burden upon state funds due to the recent launch of Bahrain's universal health insurance framework. This represents a serious economic threat to the region if it does not succeed in developing comprehensive, progressive and cost-effective treatment plans for NCDs in the elderly.
- Bahrain has the lowest density of healthcare workers per capita in the Gulf Region, according to research from the World Health Organisation. If the region fails to proactively increase the number of certified healthcare professionals or increase its adoption of telemedicine and preventive medicine, the region's healthcare demands could exceed their carrying capacity.

Analysis of Strengths and Weaknesses of Health Care System in Bahrain

- The Universal Healthcare Coverage law was established in Bahrain in 2018, launching a national health insurance system for the entire population was an important precedent that highlights the government institutions' predisposition to create a universal health coverage scheme, as well as sustainable policies aimed at guaranteeing access to the health system, prevention and health promotion for all ages, in line with Goal #3 of the United Nations' Sustainable Development Goals.
- Ways to improve efficiency in the use of scarce health resources are being explored through legal frameworks and financial reforms, to ensure a good quality-cost ratio in public and private healthcare.
- Accessibility to the health system is maintained by the availability of a well-established network of 27 health centers and specialized clinics staffed with family doctors.
- Dependence on expatriate health workers has been declining as a result of sustainably implemented policies over the years, and is much less than in neighboring countries. Practically 100% of this objective has been achieved in areas such as dentistry, pharmacy and laboratory services, although there is still a substantial gap in the actual workforce needs: there is a noticeable shortage of nurses and doctors in certain specializations and sub-specializations.
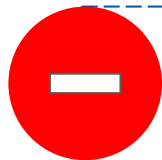
- It is still necessary to effectively comply with the consolidated legal provisions and moving towards Universal Health Coverage (UHC) with a strong focus on service delivery and health care financing.
- Despite the "Bahrainization" process, meaning that health services are provided by nationals, which has been a government policy over the years and has decreased the dependence on health workers from other countries, Bahrain has the lowest density of health professionals in the Gulf Region and a strong unmet demand for professionals in multiple specializations.
- Support and efforts are needed to strengthen health information systems, including Civil Registration and Vital Statistics (CRVS), mortality and morbidity indicators.
- Bahrain's health system requires optimizing the allocation of resources between primary care and hospital care for a more efficient delivery of services. There is a strong need to establish home health care services to avoid poor management of health resources, as well as in response to the needs of an ageing population.
- A substantial increase in noncommunicable diseases and associated risk factors, obesity and tobacco consumption. A comprehensive approach of NCD in primary health care services is necessary.

Recommendations for Bahrain

- **Improve access to healthcare.** Bahrain made substantial efforts in reducing the rising rates of private healthcare expenditure by launching a universal healthcare framework in December 2018, which subsidizes 60% of the costs of private hospitals and facilities. Bahrain should continue these efforts in order to improve its Healthcare Access and Quality index Score (currently second lowest among the countries profiles in this special analytical case study). This can be done by increasing its per-capita healthcare expenditure (currently 1.32 thousand, or 3.52% of their GDP).

- **Prioritize preventive medicine and telemedicine to reduce public and private healthcare expenditure.** The region should attempt to slow the rise in healthcare expenditure (and proactively minimize the future burden on its public healthcare system by its growing elderly population) by prioritizing preventive medicine strategies and proactively developing its available infrastructure for telemedicine and at-home consultations.

- **Continue development of integrated medical cities and hubs.** Bahrain should continue its already strong efforts in developing dedicated, integrated medical cities (one of the region's core strengths), and increase the space, resources and budget within those cities allocated specifically for treating non-communicable diseases and personalized, progressive and technologically-sophisticated elderly care.

- **Prioritize the continued development of telemedicine infrastructure.** The National Health Regulatory Authority (NHRA) gave approval to the region's first telemedicine platform, Doctori, in April of 2020. Telemedicine has the capacity to reduce public healthcare expenditure by cutting physical healthcare infrastructure costs, and the potential to reduce the burden of NCDs (which account for 63% of all deaths in Bahrain) by enabling routine preventive check-ups and consultations, and enhance elderly care by enabling at-home care. These efforts should continue.

- **Leverage results of Bahrain's National Genome Project to enable patient-specific NCD prevention and treatment.** Bahrain should continue funding its National Genome Project to identify demographic-specific predisposition for NCDs and utilize the results in the implementation of more precise preventive care throughout its healthcare system.

Kuwait

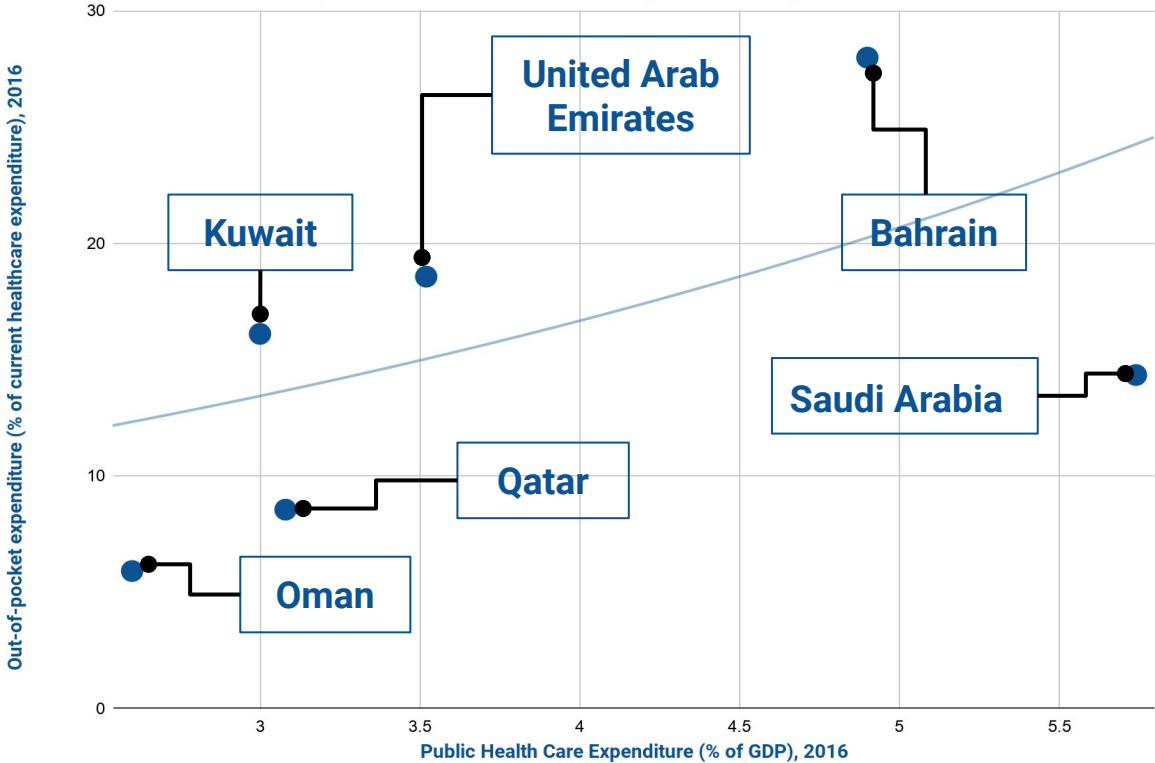| General metrics			
HALE	Both Sexes HALE (2016)	66.3 years
	HALE/Life Expectancy Difference 2016	8.5
Economy	GDP per Capita, Current Prices (2016)	27.653 thousand ($)
	Annual GDP Growth (2016)	3.5 %
Healthcare	Current Health Expenditure per Capita (2016)	1.068 thousand ($)
	Public Health Care Expenditure 2016	3.0 % of GDP
Retirement	Age Dependency Ratio 2016	30
	Population over 65, 2016	2.66 %
	Number of WHO Age Friendly Cities and Communities	0
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.0
	Annual Cigarette Consumption (Units per Capita) 2016	1412.7
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	73.4 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016:
  81

- Human Development Index 2016:
  0.80

- E-Government Development Index 2016:
  0.71

- Corruption Perceptions Index 2016:
  41

- Global Gender Gap Index 2016:
  0.624

- Democracy Index 2016:
  3.85

Current Healthcare Expenditure
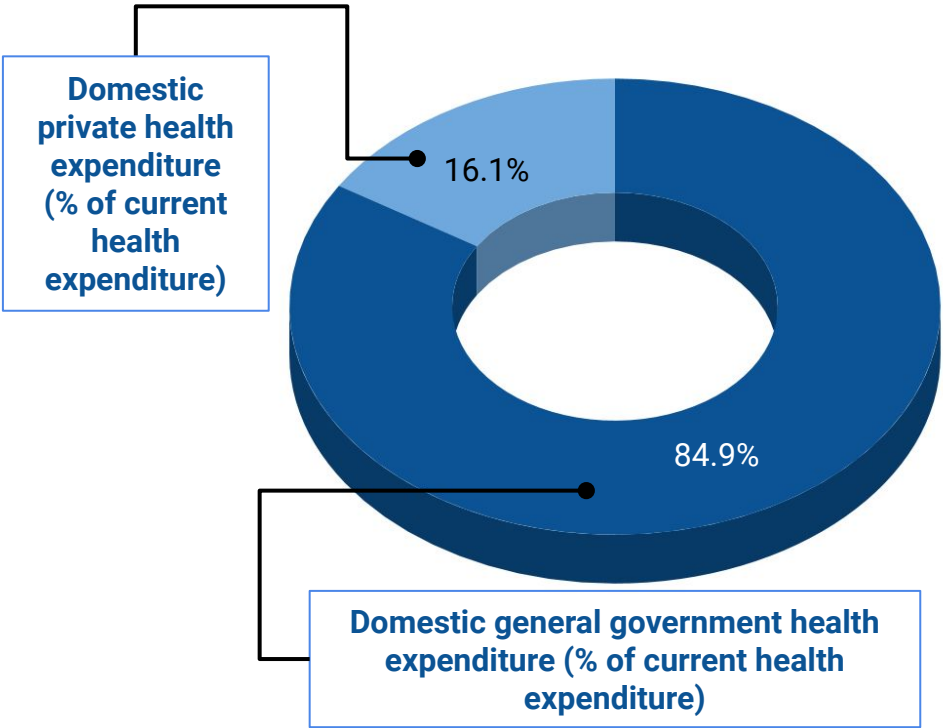
Domestic private health expenditure (% of current health expenditure)

16.1%

84.9%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Public Health Care Expenditure (% of GDP), 2016

The priority should be focused on reducing ill health and the burden of diseases through programs that secure the health of the whole population. This can be achieved with shifting resources from curative to preventive public health activities.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

SWOT Analysis of Healthcare in Kuwait

STRENGTHS

- Extremely wealthy country with extensive healthcare subsidization.
- A recent history of developing medical megaprojects, including state of the art hospitals and integrated medical cities.
- Inclusion of healthcare infrastructure sophistication and accessibility as one of the seven economic pillars of its Kuwait Vision 2030 economic development plan.
- The recent expansion of basic healthcare infrastructure (several new hospitals and medical cities, 7,762 new hospital beds, etc.)
- Extremely low age-dependency ratio (proportion of population above 65 and under 15 years of age).
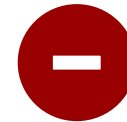
WEAKNESSES

- Comparatively slow growth-rate of the private healthcare sector.
- Lack of nation-wide modern digital infrastructures for storing and management of health data (paper records still predominantly in use).
- A shortage of physicians and healthcare management staff in comparison with healthcare demand and the recent expansions in healthcare infrastructure (e.g. recent addition of 7,762 new hospital beds).
- A comparatively small life sciences private sector (BioTech industry) in particular.

OPPORTUNITIES

- In contrast to many other countries in the region, the high comparative wealth of Kuwait puts it in a unique position to allocate substantial resources to nationwide healthcare development efforts, and the development of technologically sophisticated strategies and technologies for AI-empowered preventive medicine, advanced biomedicine and sophisticated elderly care.
- A currently comparatively low age-dependency ratio and small aged population, which gives it the opportunity to proactively and preventively prepare for the economic burden of an ageing population many years before they start to feel its effects.

THREATS

- The region's currently low age dependency ratio and proportion of citizens over the age of 65 means that the nation has not yet felt the economic burden of an aging population, and has not had a pressing need to prioritize measured to reduce the incidence of age-related disease. This puts the nation at threat of failing to prepare for the effects of the 82.3% increase in its aged population predicted to occur by the year 2050.
- Its comparative lack of a large and very diverse life sciences sector limits its capacities for cross-sector, government-industry-academic collaboration and R&D efforts, which have the capacity to accelerate the rate of progress.

Analysis of Strengths and Weaknesses of Health Care System in Kuwait

- Kuwait is the fifth-richest nation in the world, holding approximately 10% of all crude oil reserves. It is a wealthy nation with the raw monetary resources to enable wide-reaching, comprehensive and relatively expensive government-led programs to develop sophisticated infrastructures and technological ecosystems for preventive medicine, advanced biomedicine and progressive elderly care.
- Kuwait has a comprehensive and extensive state welfare program, established in 1990, which offers its citizens free and subsidized access to healthcare (as well as subsidized education, housing, transportation and utilities) that is funded not through taxes but via oil revenues.
- A 2018 study found that average life expectancy in Kuwait is predicted to rise to 81.4 years by 2040 based on its current growth rates, which at that time would place it higher in terms of overall average life expectancy than all other regions profiled in the present report.
- A currently very low age dependency ratio and small proportion of elderly citizens
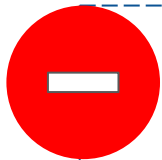
- While Kuwait has an extensive welfare system to cover its population's medical costs without taxation, the benefits of the system are unevenly distributed among its population. Kuwait should seek to enable reforms to broaden and universalize the level of access to the benefits of this system to a larger proportion of its population, specially in terms of access to subsidized healthcare.
- Kuwait currently has lower population ageing than neighboring regions, but it can expect to witness a fivefold increase in the proportion of its population above the age of 65 by the year 2050. In order to reduce the potential future economic burden of this increase, the region should plan and allocate resources for preventive medicine and elderly care in proportion to the future, rather than the present state, of its elderly population.
- Slow growth rate in the number of medical professionals (physicians and managerial staff) in comparison with the high growth rate of increased healthcare infrastructure and facilities.
- A high incidence of non-communicable diseases (NCDs). 73% of deaths in Kuwait are a result of NCDs, and citizens have a 12% chance of dying prematurely from them.
- High levels of NCD risk factors. 77% of Kuwait adults are either overweight or obese, and 50% of young adults (aged 18 - 44) have three or more of five major NCD risk factors (smoking, inadequate fruit and vegetable consumption, physical inactivity, overweight and raised blood pressure).

Recommendations for Kuwait

- **Dedicate substantial monetary resources for the development of a sophisticated preventive medicine ecosystem.** Kuwait has vast monetary resources at its disposal, being the fifth-richest country on the world, and owning 10% of global oil reserves. In comparative contrast to some of its neighbors, it is in a very good position to fund extremely comprehensive projects aimed at developing the technology, personnel and infrastructure for advanced, progressive and sophisticated preventive medicine, advanced biomedicine and elderly care ecosystems. The nation should leverage its unique monetary position to establish a leadership position in the technological sophistication of its healthcare, with a focus on AI-driven preventive precision medicine.

- **Early and proactive planning for an increase in population aging.** While Kuwait's aged demographic is currently comparatively low, it is set to increase to 17.5 % by the year 2025 and by 82.26 % by the year 2050. This means that the country is not currently forced to develop the necessary resources and policies to reduce the economic burden of an ageing population. The nation should proactively allocate resources to preventive medicine (to delay the onset of age-related disease) and sophisticated elderly care (to optimize health outcomes in the elderly), based upon the predicted growth rate of its ageing population, rather than its current status. From a policy point of view, it should take care to avoid underestimating the potential economic burden of a large ageing population.

- **Development of nation-wide electronic medical records infrastructure.** Kuwait still uses paper filing for patient medical records in many regions, which is unusual for such a wealthy country, considering that this is a step that many other countries with less resources have already taken. This is a low-hanging fruit that can deliver significant benefits cost-effectively. Kuwait should dedicate funds to the development of an efficient digital infrastructure for nation-wide electronic medical records, which will deliver immediate increases in efficiency and reduction of errors for comparatively small levels of funding and investment.

- **Continue the development of medical megaprojects.** Kuwait has a recent history of developing very large and well-funded medical megaprojects, including medical cities. The nation should maintain its current momentum, and increase the proportion of funds and facilities dedicated to R&D for NCD prevention and advanced elderly care.
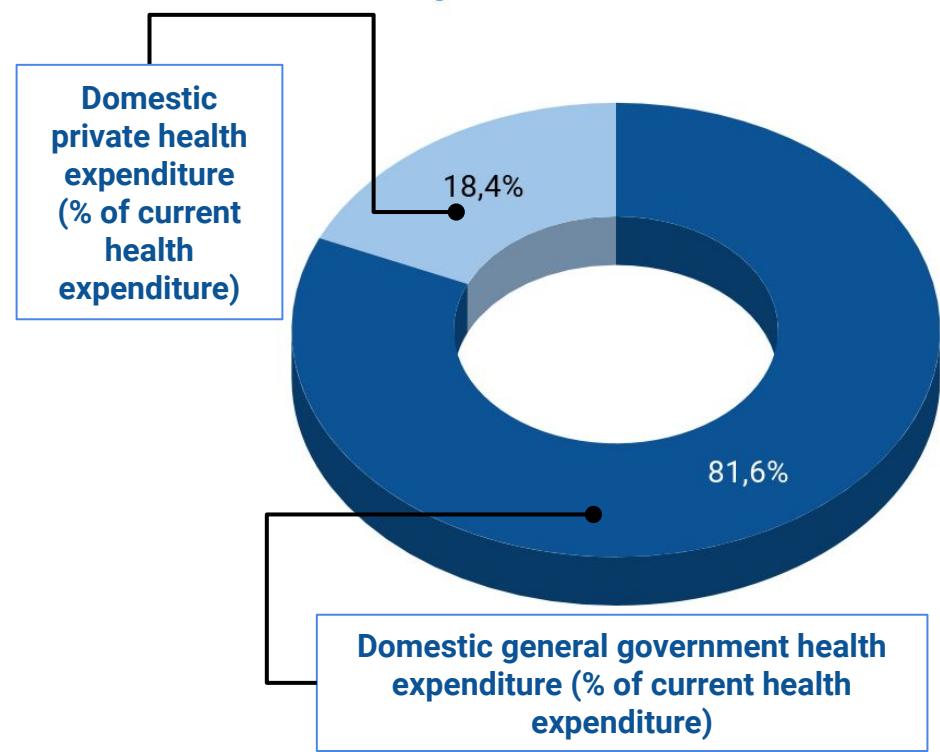
Qatar

General metrics			
HALE	Both Sexes HALE (2016)	68.6 years	
	HALE/Life Expectancy Difference 2016	9.5	
Economy	GDP per Capita, Current Prices (2016)	57.16 thousand ($)	
	Annual GDP Growth (2016)	2.1 %	
Healthcare	Current Health Expenditure per Capita (2016)	1.83 thousand ($)	
	Public Health Care Expenditure 2016	3.08 % of GDP	
Retirement	Age Dependency Ratio 2016	18	
	Population over 65, 2016	1.2 %	
	Number of WHO Age Friendly Cities and Communities	0	
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	2	
	Annual Cigarette Consumption (Units per Capita) 2016	1020	
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	71.7 % of adults	

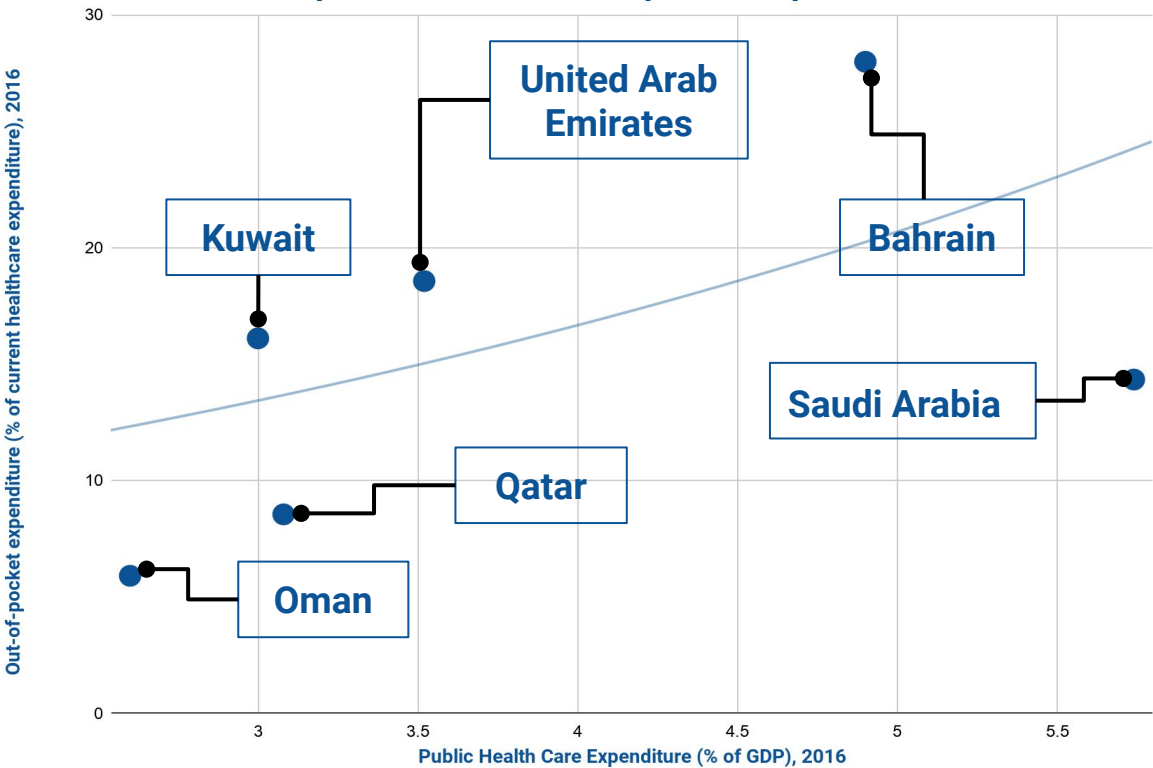## Longevity-Related Indices

- The Healthcare Access and Quality Index -2016:
  82

- Human Development Index 2016:
  0.86

- E-Government Development Index 2016:
  0.67

- Corruption Perceptions Index 2016:
  61

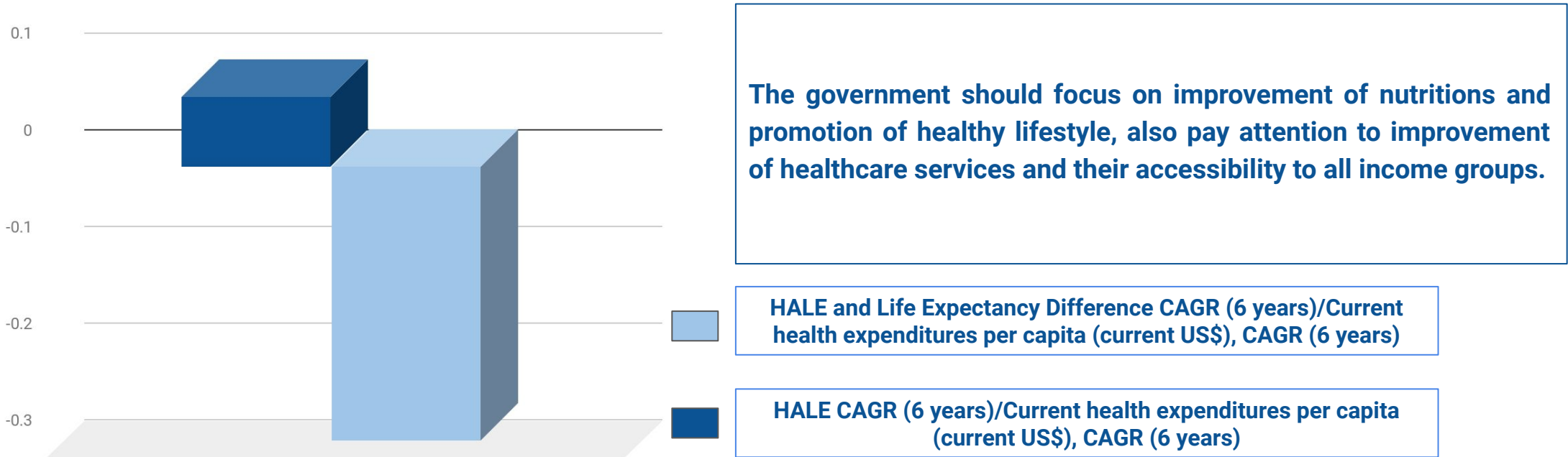- Global Gender Gap Index 2016:
  0.64

- Democracy Index 2016:
  3.18

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

18,4%

81,6%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

Public Health Care Expenditure (% of GDP), 2016

Effectiveness ratios

The government should focus on improvement of nutritions and promotion of healthy lifestyle, also pay attention to improvement of healthcare services and their accessibility to all income groups.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

SWOT Analysis of Healthcare in Qatar

STRENGTHS

- The healthcare system is available to both Qataris and expatriates. Qatar has a public health service that provides free or highly subsidized healthcare.
- 19 million USD has been dedicated to biotechnology research with the creation of Qatar Science and Technology Park (QSTP).
- The World Health Organization (WHO) recently ranked Qatar at the top of the per capita health expenditure list among the Gulf Cooperative Council.
- There are now currently 36 hospitals and numerous clinics in Doha, the capital city. Health centers have also been set-up along the highways for ease of access.
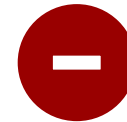
WEAKNESSES

- The proportion of healthcare spending by the private sector has been steadily rising since 2003 from 17% to 22.55% in 2010.
- Medicine is heavily subsidized. For instance, a course of antibiotics for a government pharmacy costs 1.5 US dollar.
- There is need for more medical workers in primary health care.
- 69% of mortalities occur from chronic conditions, particularly cardiovascular diseases (24%), cancer (18%) and diabetes (7%).
- 70.1% of Qatari adults are overweight that is the additional burden of cardiovascular diseases on the health status of the population.

OPPORTUNITIES

- The Qatari government is aimed to improve the healthcare through developing state of the art medical facilities and medical education.
- The Supreme Council is focusing on health reform by the development of medical insurance, electronic record keeping and data collection, and improvements in quality assurance and evidence based medicine at its various hospitals.
- Complex reformation of the healthcare system to receive the outcomes that will allow to meet needs of the existing and future generations.

THREATS

- 43.9% of Qatari adults have low levels of physical activity that creates the challenge for the effective engagement of population in sports.
- 88% of Qatari children have dental caries that is the problem of weak preventive care in this healthcare's sector.
- Air pollution in Qatar vastly exceeds safe limits and is damaging the health of the population. Qatar has the second highest levels of PM2.5 particles in the world, behind Saudi Arabia.

Analysis of Strengths and Weaknesses of Health Care System in Qatar

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- Seventy-seven percent of current healthcare expenditures are in the public sector.
- eHealth is currently widely used by the Qatari healthcare as the government hopes to develop a system that allows good data collection, quik processing and generation useful insight.
- Qatari government uses the healthcare system vision that assumes the building of the patient-centered healthcare system which main figure is population's health and well-being.
- Life expectancy for Qataris is 80.4 years and as of July 2017 less than 2% of the population are 65 years or older.
- At 65 years, women are expected to live a further 20.3 years, 14.3 of which are healthy. At 65 years, men are expected to a live a further 18.7 years, of which 13.5 are healthy.

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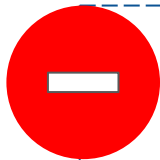
- There are relatively high levels of tobacco use among men that are 31.9% and children that are 13-15 years old (15.7%).
- Approximately 16% of patients with more than one chronic disease were readmitted at the emergency department within 28 days of discharge.
- Approximately 6% of total emergency admissions were patients with more than one chronic condition.
- Cardiovascular disease, diabetes, and cancer are the three top causes of mortality, accounting for 24%, 17%, and 9% respectively.
- Qatar is experiencing trends in aging similar to that of other developed countries and the proportion of older people is expected to grow.
- Qatar's polluted air is harmful for residents' health. Doha had the 12th highest average levels (93 ug/m3) of PM2.5 of all world cities. The town of Al Wakrah to the south ranked 25th on the same list (85 ug/m3).

Recommendations for Qatar

- **Creation of the patient-centered model of service delivery.** Patients health should be the most valuable asset for the government.

- **Utilizing the Artificial intelligence and Machine learning for simplifying the healthcare experience.** Artificial intelligence is the advanced technology that can reduce time and money spent on treatments through the intensive processing of the medication for patients with even more outstanding results. Machine learning is the additional tool for simplifying treatments with the help of progressive equipment supplied to the net of hospitals and clinics throughout Qatar.

- **Modifying the behavioural risk factors that sharpen most common non-communicable diseases.** If to look through the analyses of the health status and medical systems of developed countries the strong correlation between the wrong lifestyles and arising of the CDVs can be pointed out. Practically quarter of burden of chronic conditions is caused by the tobacco and alcohol use, bad dietary habits and low physical activity, so there is a crucial task for government to initiate campaigns aimed to reduce the negative impact of these risks on the health status of the population.

- **Adoption of the P4 clinics for the on time delivery of the preventive care.** Most deaths in Qatar generally can be avoided and are caused by diseases that are treatable in case of early diagnostics and efficient medications. This points out the need in P4 medicine when every person can receive individual healthcare.

- **Reduce socioeconomic inequalities in health at individual and population level.** Behavioural risk factors tend to be more common among people at a disadvantage because of a lesser education or lower income.

- **Tackle environmental problems.** It is known that air pollution has adverse effects on health and human life in general. The most Qatari GHG emissions is caused by energy consumption, it is very important to examine how one can reduce the GHG emissions to better improve the air quality without harming economic growth.
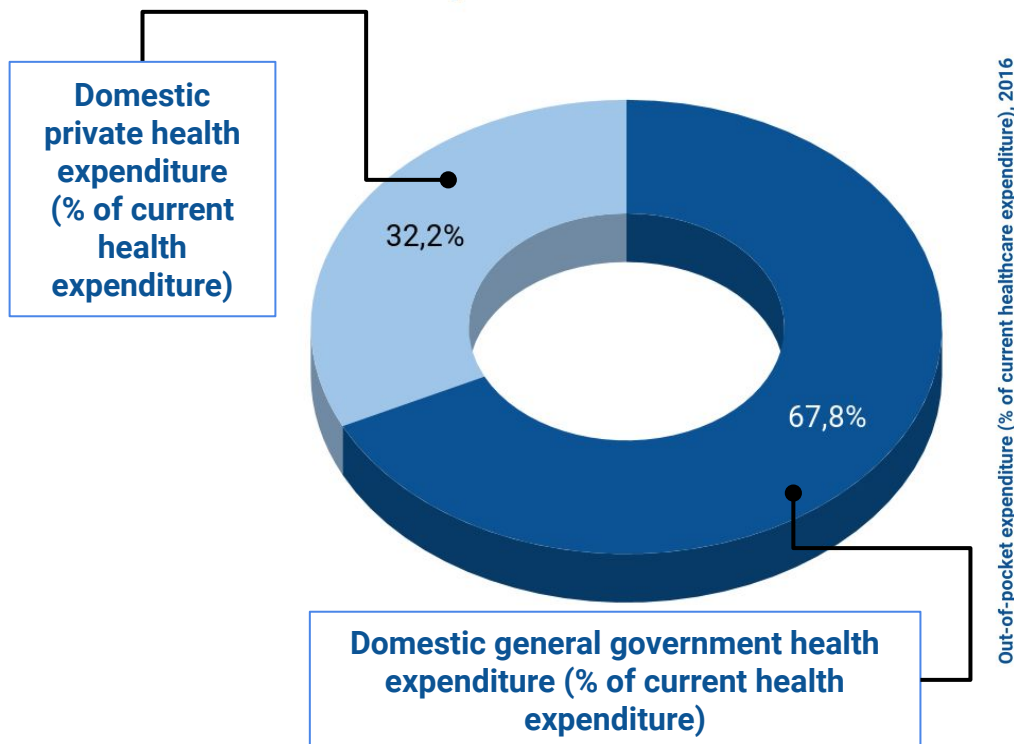
Saudi Arabia

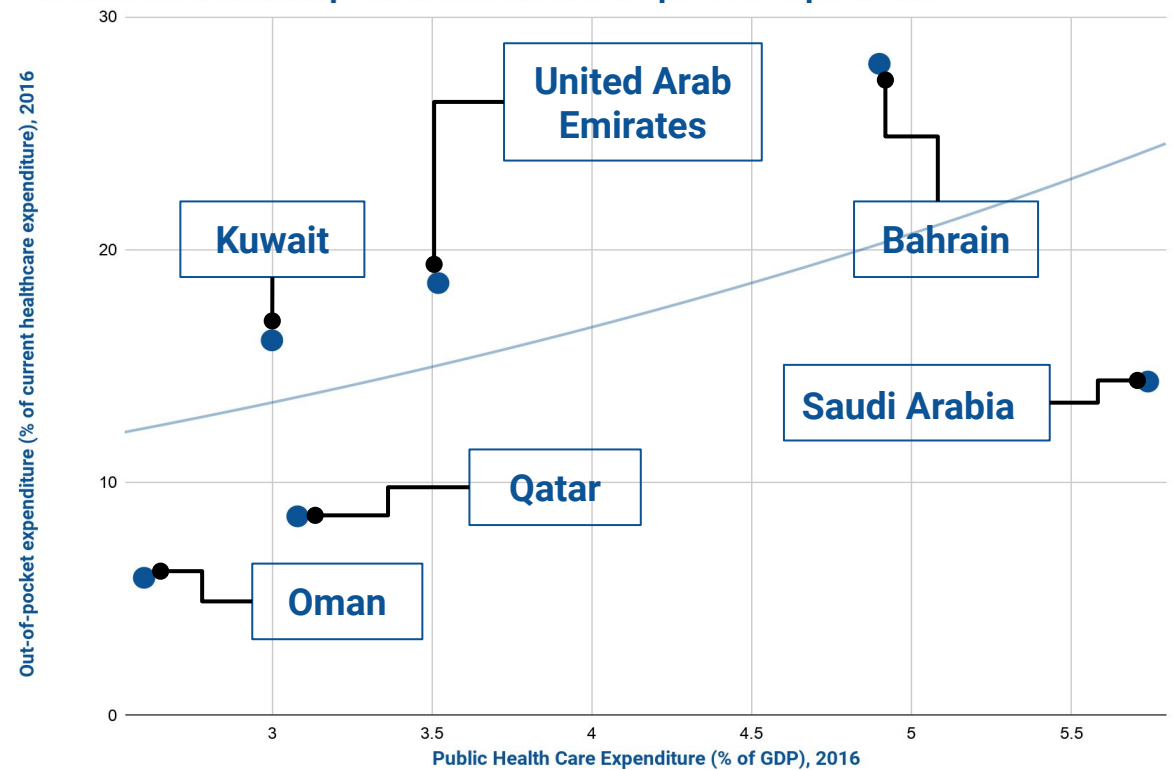| General metrics			
	HALE	Both Sexes HALE (2016)	65.7 years
		HALE/Life Expectancy Difference 2016	8.86
	Economy	GDP per Capita, Current Prices (2016)	19.88 thousand ($)
		Annual GDP Growth (2016)	1.7 %
	Healthcare	Current Health Expenditure per Capita (2016)	1.15 thousand ($)
		Public Health Care Expenditure 2016	5.74 % of GDP
	Retirement	Age Dependency Ratio 2016	40
		Population over 65, 2016	3.2 %
		Number of WHO Age Friendly Cities and Communities	0
	General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.2
		Annual Cigarette Consumption (Units per Capita) 2016	1341
		Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	69.7 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016:
  77

- Human Development Index 2016:
  0.85

- E-Government Development Index 2016:
  0.68

- Corruption Perceptions Index 2016:
  46

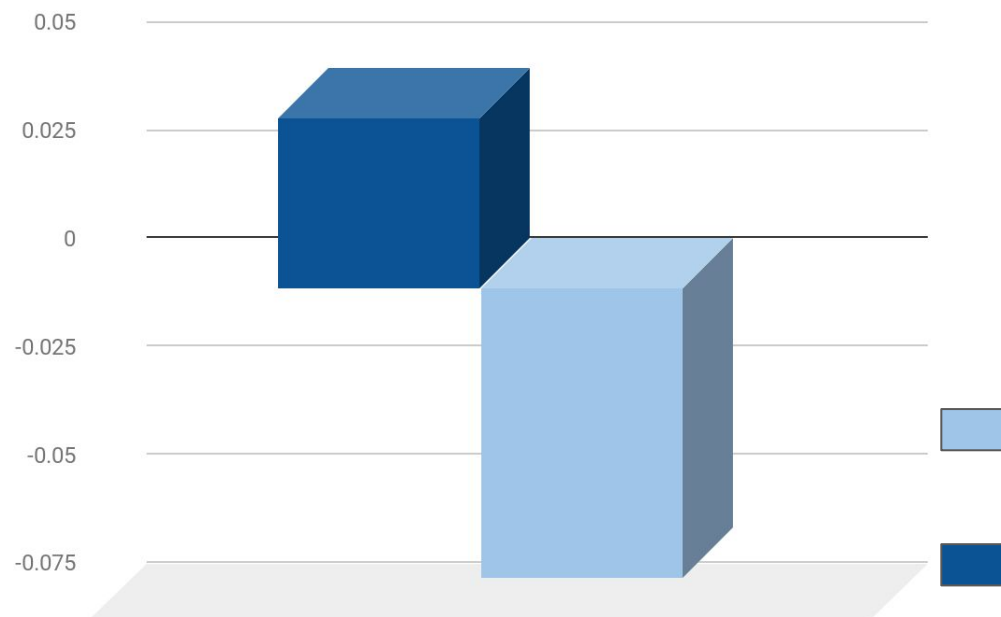- Global Gender Gap Index 2016:
  0.58

- Democracy Index 2016:
  1.93

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

32,2%

67,8%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Public Health Care Expenditure (% of GDP), 2016

Effectiveness ratios

The country need to reduce disparities in health and health care systems between poorer and richer families and underfunded health care systems that in many cases are inefficiently run and underregulated.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

SWOT Analysis of Healthcare in Saudi Arabia

STRENGTHS

- Between 2010 and 2016 the number of doctors per 1,000 population increased from 2.4 in 2010 to 2.8. The ratio of nurses improved from 4.8 to 5.7 and number of beds per 1,000 population increased from 2.1 to 2.2.
- The overall decline in communicable diseases can be explained by the improvement in sanitation systems, nutrition, hygiene awareness and invention of more effective medicine.
- The creation of the Saudi Center for Health Information Exchange.
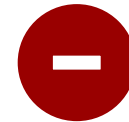
WEAKNESSES

- Overall, the three risk factors that account for the most disease burden in Saudi Arabia are high body-mass index, dietary risks, and high fasting plasma glucose.
- Non-communicable diseases are estimated to account for 73% of all deaths.
- Prevalence of overweight and obesity among adults is on the rise.
- Cardiovascular diseases are the leading causes of death and accounts for 37% of total deaths in 2016.
- Inequality in health outcomes across different socioeconomic groups.

OPPORTUNITIES

- Government continues its efforts in developing various medical cities with the private sector investment using various Public Private Partnership (PPP) models.
- Increasing the availability of a skilled workforce in healthcare is also emerging as a significant focus for country.
- Utilizing information technology to offer management solutions related to cost, quality, access and resources.
- Owing to the large population in the KSA and high occupancy rates of the hospitals, the country requires more primary care clinics and medical centers to meet the demand of the rising population.

THREATS

- Air pollution in Saudi Arabia vastly exceeds safe limits and is damaging the health of the population. Qatar has the first highest levels of PM2.5 particles in the world.
- SEcurity issues relation to patients' information.
- Lack of regional experience and references in the field of eHealth.
- Shortage of Saudi health professionals, effective partnership between patients and their healthcare providers, changing patterns of disease, high demand resulting from free healthcare services for all citizens

Analysis of Strengths and Weaknesses of Health Care System in Saudi Arabia

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- The Saudi Arabian government provides free access to a number of health care services to all community members and also to the emigrants working in the country.
- The government is diverting the funds towards creating a robust healthcare infrastructure by building new hospitals.
- Good access and effective care are for certain services including: immunization, maternal health care, and control of epidemic diseases.
- Creation e-health record.

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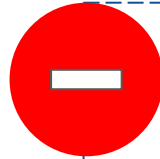
- The health care system still experiences certain challenges in terms of lack of coordination and cohesion among the various health enterprises. These challenges often lead to wastage of resources and duplication of data and effort.
- Because of the enormous changes in the lifestyle of Saudis in the last three decades, the risk factors of coronary heart disease (CHD), including physical inactivity, are increasingly becoming prevalent in the society.
- There is the need for further improvement in the quality of healthcare in university hospitals.
- Poor access and effectiveness are for chronic disease management programs, prescribing patterns, health education, referral patterns, and some aspects of interpersonal care including those caused by language barriers.
- Saudi Arabia is experiencing trends in aging similar to that of other developed countries and the proportion of older people is expected to grow.
- Inequality in health outcomes, and access to health services and their utilisation due to socioeconomic status (SES) is a common theme in health research and policy intervention.
- Social norms and conservative religious beliefs have a powerful effect on women's lives and health in Saudi Arabian society.

Recommendations for Saudi Arabia

- **Prioritise the dealing with a number of healthcare burdens**. Some the same as in many other parts of the world – like rising incidence of heart disease and cancer – and coping with them with innovative use of technology, partnerships and initiatives.

- **Move to a life-course perspective in tackling the rising epidemic of "metabesity."** Saudi Arabia is tackling more unusual challenges, such as a high incidence of congenital diseases due the large number of consanguineous marriages, as well as an explosion in the prevalence of obesity and metabolic syndrome due to a rapidly changing lifestyle to one that is more affluent and sedentary.

- **Consideration of age and sex distribution when planning and implementing health services.** The United Arab Emirates has a rapidly growing population with a unique age and sex distribution. There is an unusually high proportion of young people and expatriates of working age, small numbers of older persons and rapid year on year growth due to high net in-migration.

- **Combat gender inequity.** The traditional Arab family affects women's health in multiple ways. Finances are strictly the man's obligation. Young women are assigned the toughest household tasks. Marriage and motherhood are highly valued, but the pressure to produce sons is strong. Poor relationships with fathers and history of abuse during adolescence can lead to depressive symptoms in girls. There is an inverse relationship between the number of children a woman has and her education, income and age at marriage.

- **Improve the service quality and prevention care.** The paradigm shift from sick care to preventive medicine is focused both on longevity and quality of life. The government should establish an effective referral system to ensure equity and access to the population irrespective of their location of residence, income, education, and social status and age.
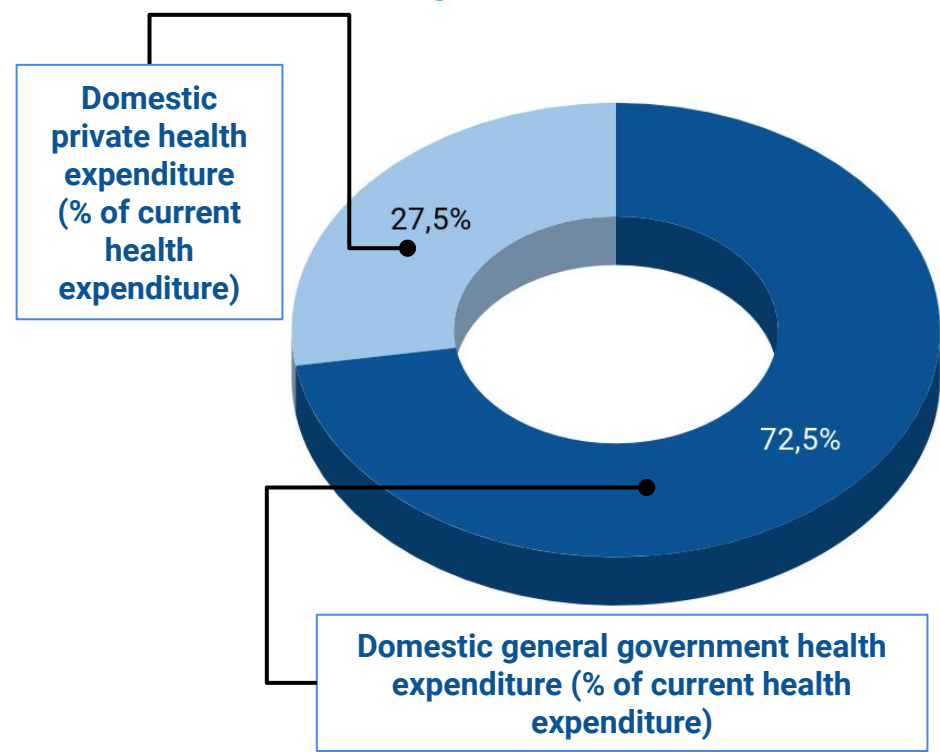
United Arab Emirates

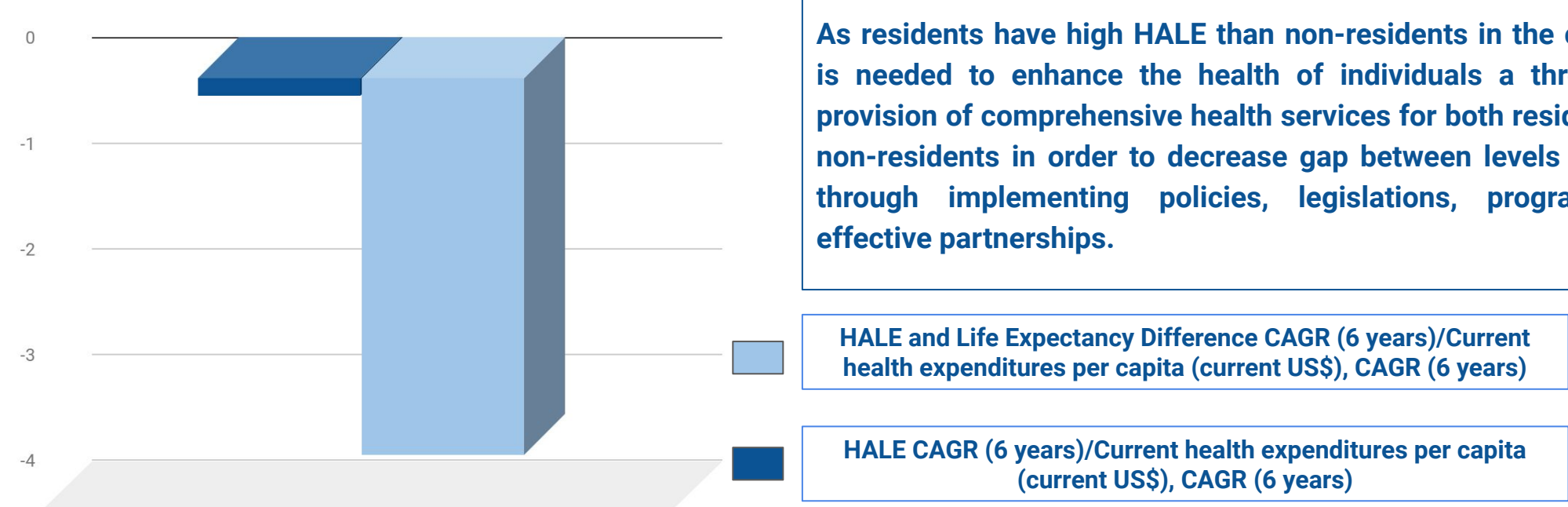| General metrics			
	HALE	Both Sexes HALE (2016)	66,7 years
		HALE/Life Expectancy Difference 2016	10.55
	Economy	GDP per Capita, Current Prices (2016)	38.14 thousand ($)
		Annual GDP Growth (2016)	3 %
	Healthcare	Current Health Expenditure per Capita (2016)	1.32 thousand ($)
		Public Health Care Expenditure 2016	3.52 % of GDP
	Retirement	Age Dependency Ratio 2016	18
		Population over 65, 2016	1.1 %
		Number of WHO Age Friendly Cities and Communities	1
	General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	3.8
		Annual Cigarette Consumption (Units per Capita) 2016	748
		Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	67.8 % of adults

Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **70**

- Human Development Index 2016: **0.86**

- E-Government Development Index 2016: **0.75**

- Corruption Perceptions Index 2016: **66**

- Global Gender Gap Index 2016: **0.64**
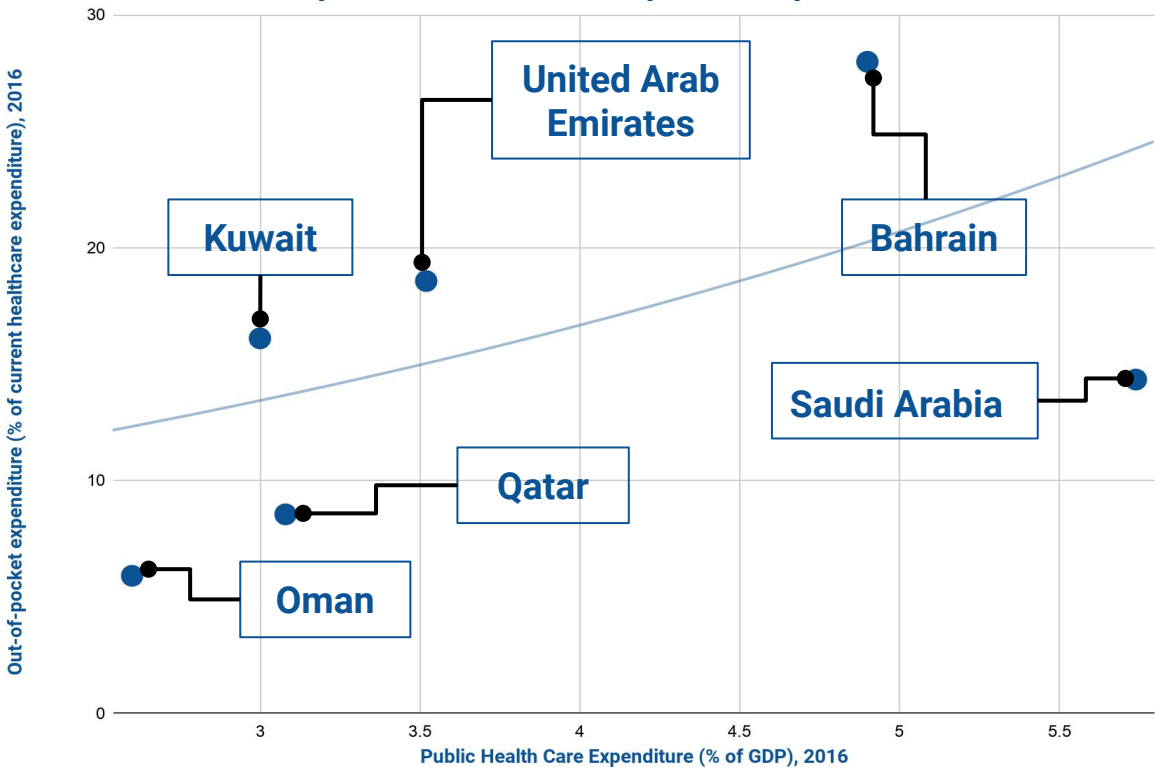
- Democracy Index 2016: **2.75**

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

27,5%

72,5%

Domestic general government health expenditure (% of current health expenditure)

Effectiveness ratios

Public Healthcare Expenditure and Out-of-pocket Expenditure

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

Public Health Care Expenditure (% of GDP), 2016

As residents have high HALE than non-residents in the country it is needed to enhance the health of individuals a through the provision of comprehensive health services for both residents and non-residents in order to decrease gap between levels of HALE, through implementing policies, legislations, programs and effective partnerships.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

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SWOT Analysis of Healthcare in the United Arab Emirates

STRENGTHS

- The UAE has a comprehensive, government-funded health service and a rapidly developing private health sector that delivers a high standard of health care to the population.
- Due to the success of this high standard of care across all stages of the health care system, life expectancy in the UAE is 76.8 years, reaching levels similar to those in Europe and North America.
- The UAE is renowned for its quality healthcare facilities, which has led to a rise in medical tourism over the past decade. Healthcare is so prevalent, there are an estimated 181 doctors per 100,000 residents.
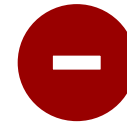
WEAKNESSES

- Health care is expensive. There are more private hospitals and healthcare facilities than public. As of 2018, the UAE had 104 hospitals: 33 government and 71 private.
- Public health facilities are less expensive, but wait times are long.
- The World Health Organization has determined that a third of the adults in the UAE are obese, and one out of five people live with diabetes.

OPPORTUNITIES

- Rapidly growing spa market.
- Private health care services are increasing at a rapid rate everywhere in the UAE through clinics, private hospitals and medical cities.
- Government wants to boost the number of medical tourists coming to the UAE in order to establish Dubai as a center of healthcare excellence in the region.
- Since the population aging, there is a high demand for healthcare.

THREATS

- Rapidly growing population and the concurrent increasing demand on the healthcare sector.
- Higher demand for healthcare will surge healthcare costs.
- Overconsumption of medical services, increasing costs of medical equipment and competition for qualified professionals, and increase of chronic diseases.
- Increasing burden of socioeconomic inequality would contribute to bigger discrepancy in health status and worsening demographic situation in general.

Analysis of Strengths and Weaknesses of Health Care System in the United Arab Emirates

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- According to World Health Organization Ranking: The World Health System, Health care system of the United Arab Emirates is 27.

- United Arab Emirates has a strong healthcare infrastructure.

- Most infectious diseases like malaria, measles and poliomyelitis that were once prevalent in the UAE have been eradicated. New vaccination campaigns are taking place to protect against chicken pox, pertusis and the rotavirus.

- Access to clean water in urban and rural areas is assured for 100% of the population, and close to 100% use modern sanitation facilities. The new-born (neonate) mortality rate has been reduced to 5.54 per 1000 and infant mortality to 7 per 1000. Maternal mortality rates have dropped to 0.01 for every 100,000.

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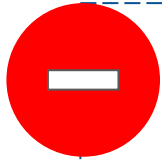
- The UAE's health expenditure reached a value of $13.7 billion in 2018. This includes healthcare expenditure from the seven emirates in addition to their contribution to the federal budget. There is an expectation for this figure to reach $14.4 billion in 2019, a 5.4 percent increase comparing to 2018. The forecast on spending is to rise to $18.3 billion by 2023 (compound annual growth rate of 6%).

- The high number of expatriate workers have limited access to healthcare services, affecting demographics and healthcare situation in general.

- The fragmentation of the healthcare system led by Abu Dhabi and Dubai.

- The shortage of hospital beds in the country, lack of medical professional staff and the rise in the number of people suffering from chronic diseases. The number of people suffering from chronic diseases was especially startling. The UAE is ranked second world-wide in diabetes. Nearly 37 per cent of Emiratis suffer from hypertension that goes on to take a toll on the heart.

- The high cost of prescription medication makes healthcare unaffordable for population with relatively low income.

Recommendations for the United Arab Emirates

- **Consideration of age and sex distribution when planning and implementing health services.** The United Arab Emirates has a rapidly growing population with a unique age and sex distribution. There is an unusually high proportion of young people and expatriates of working age, small numbers of older persons and rapid year on year growth due to high net in-migration.

- **Prioritise the dealing with a number of healthcare burdens** . Some the same as in many other parts of the world – like rising incidence of heart disease and cancer – and coping with them with innovative use of technology, partnerships and initiatives.

- **Move to a life-course perspective in tackling the rising epidemic of "metabesity."** The United Arab Emirates is tackling more unusual challenges, such as a high incidence of congenital diseases due the large number of consanguineous marriages, as well as an explosion in the prevalence of obesity and metabolic syndrome due to a rapidly changing lifestyle to one that is more affluent and sedentary.

- **Move from sick care to preventive health**. Health screening program can enable rapidly extract data from the results of the screening for various whole population epidemiological studies. Providing individuals with opportunities to check their health status and get proper follow-up consultations can minimise the risk of developing cardiovascular disease and diabetes, for example.

- **The important role of implementation of new technology into healthcare systems.** Government should provide opportunities for wider technologically connected healthcare that empowers doctors and patients and reduces growing pressure on the healthcare system.

- **Provide incentives for investments in home care services and private providers.** Due to the increasing population of the elderly and the abundance of chronic diseases, long-term care facilities are being continuously demanded by the market.
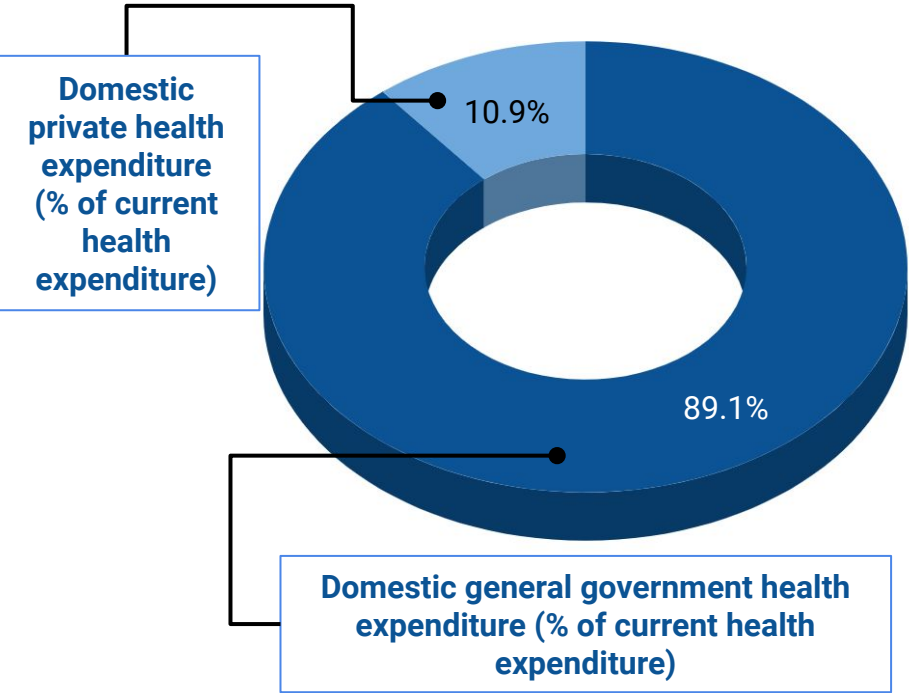
Oman

HALE	Both Sexes HALE (2016)	65.6 years
	HALE/Life Expectancy Difference 2016	11.4 years
Economy	GDP per Capita, Current Prices (2016)	14.721 thousand ($)
	Annual GDP Growth (2016)	5.4 %
Healthcare	Current Health Expenditure per Capita (2016)	0.648 thousand ($)
	Public Health Care Expenditure 2016	2.6 % of GDP
Retirement	Age Dependency Ratio 2016	32
	Population over 65, 2016	2.33 %
	Number of WHO Age Friendly Cities and Communities	0
General Health Status	Alcohol Consumption per Capita (Litres of Pure Alcohol) 2016	0.1
	Annual Cigarette Consumption (Units per Capita) 2016	271.1
	Prevalence of Overweight among Adults 2016 (Age-Standardized Estimate)	62.6 % of adults

General metrics
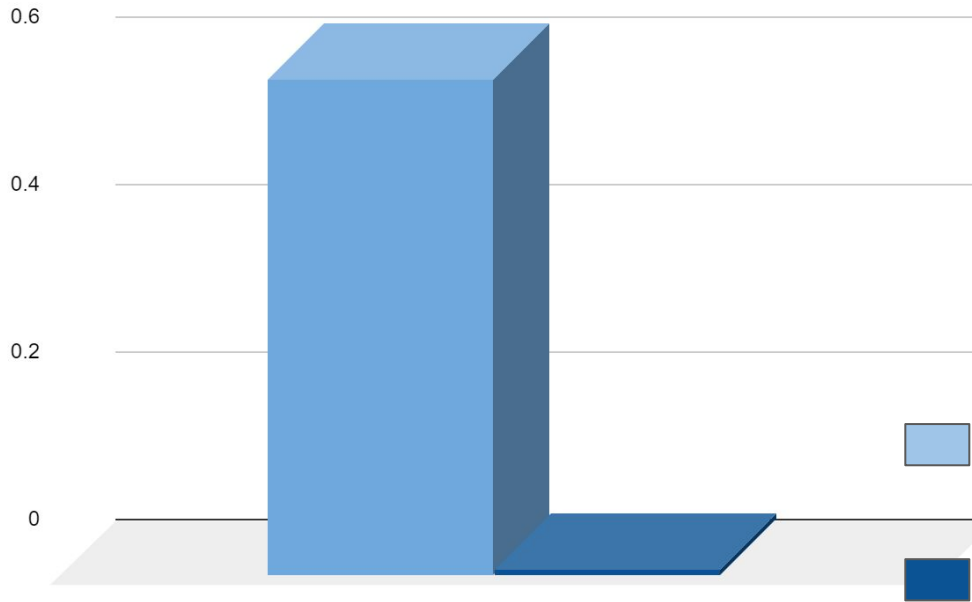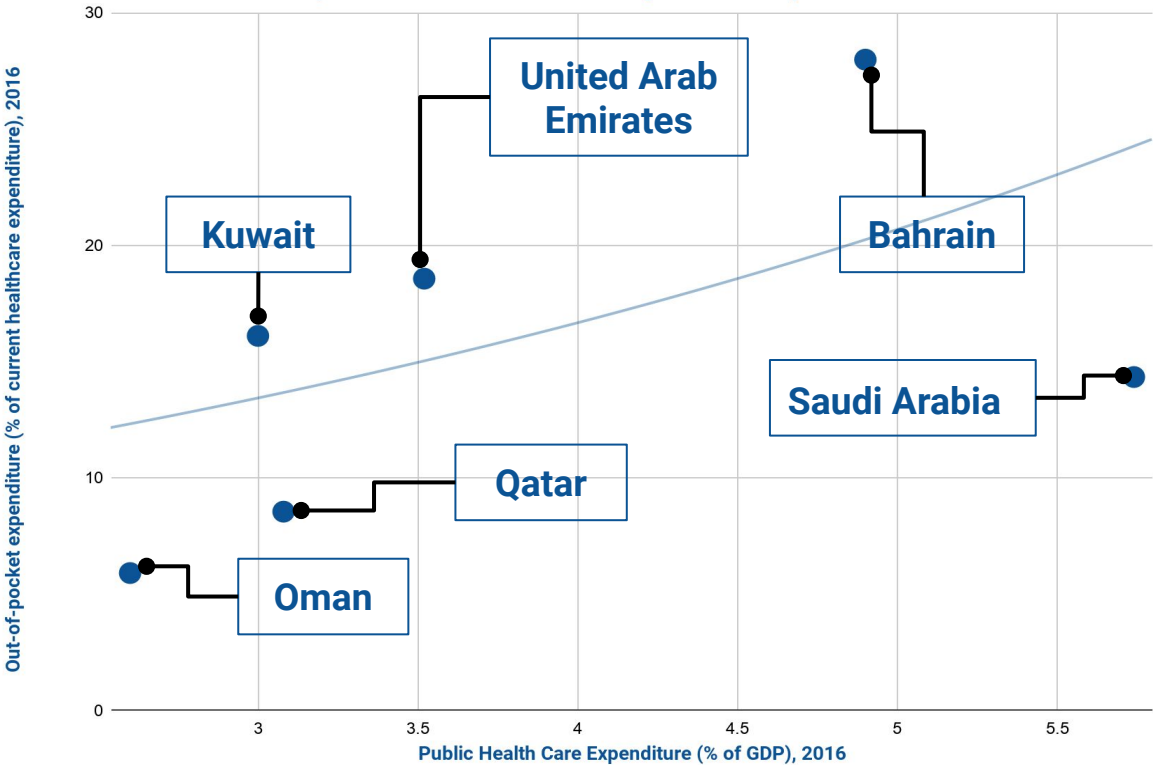
Longevity-Related Indices

- The Healthcare Access and Quality Index -2016: **76**

- Human Development Index 2016: **0.79**

- E-Government Development Index 2016: **0.60**

- Corruption Perceptions Index 2016: **45**

- Global Gender Gap Index 2016: **0.612**

- Democracy Index 2016: **3.04**

Current Healthcare Expenditure

Domestic private health expenditure (% of current health expenditure)

10.9%

89.1%

Domestic general government health expenditure (% of current health expenditure)

Public Healthcare Expenditure and Out-of-pocket Expenditure

Out-of-pocket expenditure (% of current healthcare expenditure), 2016

United Arab Emirates

Kuwait

Bahrain

Saudi Arabia

Qatar

Oman

Public Health Care Expenditure (% of GDP), 2016

The people of Oman do still suffer from some diseases related to nutritional problems and congenital disorders. It is believed that these are related to certain behavioral aspects of the population, which require to be modified by strong health promotional measures.

HALE and Life Expectancy Difference CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

HALE CAGR (6 years)/Current health expenditures per capita (current US$), CAGR (6 years)

SWOT Analysis of Healthcare in Oman

STRENGTHS

- The overall health status of the Omani population has evolved over the past 4 decades from one dominated by infectious disease to one in which chronic disease poses the main challenge.
- Along with a marked reduction in the incidence of infectious diseases, improvements in health care and socioeconomic status have resulted in sharp declines in infant and early childhood mortality and dramatic increases in life expectancy.
- Oman has invested heavily in the health sector and succeeded in creating a relatively modern health care system.
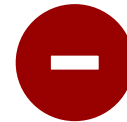
WEAKNESSES

- In Oman, noncommunicable diseases (NCDs) cause 68% of total deaths and 18% of these deaths occur amongst people between the ages of 30 and 70 years. This means that nearly one of every five adult dies from NCDs before they should.
- Cardiovascular disease as the leading cause of death. The distribution of chronic diseases and related risk factors among the general population is similar to that of industrialized nations: 12% of the population has diabetes, 30% is overweight, 20% is obese, 41% has high cholesterol, and 21% has the metabolic syndrome.

OPPORTUNITIES

- The government's determination to provide all its citizens with free, basic health care, along with treating persistent diabetes and cardiovascular disease, means that health-related expenditures are growing.
- Oman has been pushing for the implementation of modern technological solutions to boost efficiency in the health care sector and ultimately keep costs down and cut waiting times.
- The current five-year plan includes spending slated for preliminary and secondary healthcare in addition to women's health issues, infectious and non-infectious diseases, radiology, ophthalmology, mental health, and occupational health.

THREATS

- Oman is now contending with the rise in lifestyle diseases, such as diabetes, obesity, and hypertension.
- The health care sector continues to focus on treatment rather than preventative care, with less priority placed upon wellness education and limited focus on rehabilitative care, including physical, occupational, and developmental therapies.
- Chronic diseases with the ageing of the population will constitute a major drain on Oman's human and financial resources, threatening the advances in health and longevity achieved over the past 4 decades.

Analysis of Strengths and Weaknesses of Health Care System in Oman

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- The overall health status of the Omani population has evolved over the past 4 decades from one dominated by infectious disease to one in which chronic disease poses the main challenge.

- The Ministry of Health (MoH) had 74 hospitals with a total of 6589 beds (equivalent to 14.9 beds per 10,000 people) as well as 266 governmental health centers, clinics, and pharmacies, and 1105 private clinics. Government-run hospitals for the general Omani public accounted for 49 hospitals and 4659 beds, while the private sector accounted for 15 hospitals with 637 beds.

- Over the past few years, the MoH has been reducing the prices in phases of the most commonly used medicines in Oman, which is in line with the 2012 GCC resolution to standardize the import prices of medicines.

- The MoH has expressed interest in U.S. healthcare information management technologies as part of its efforts to standardize operations and establish interconnectivity among Oman's hospitals and regional clinics.

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- Current healthcare expenditures in Oman are expected to grow at a compounded annual growth rate (CAGR) of 9.1 percent from USD 3.2 billion in 2017 to USD 4.9 billion in 2022, according to a report published by Alpen Capital. This growth is due to a rising population and the rising cost of care.

- The insurance market in Oman is small, but will likely grow, particularly the health insurance market.

- During the past two decades the Sultanate of Oman has witnessed, as other parts of the world, an epidemiological transition to non-communicable diseases and other morbidity related to unhealthy life-style behaviors.

- Cardiovascular diseases and neoplasm are the two leading causes of hospital deaths in Oman.

- An increase in the prevalence of diabetes mellitus is expected with advances in health care, as control programs reduce the risk of complications and death from diabetes. Such increase in prevalence is also expected to continue in the future especially that about 29.5% of adult Omanis are overweight and 24.1% are obese.

Recommendations for Oman

- **Move from cure to prevention to combat with non-communicable diseases risk factors.** Prevention faces two main barriers. First, most doctors worldwide are trained to diagnose, treat, and cure diseases, but not to prevent them. Incentive schemes in many health care settings reflect that emphasis. Second, the risk factors for these diseases – tobacco use, the harmful use of alcohol, unhealthy diets, and physical inactivity – lie in non-health sectors and are strongly influenced by the behaviours of powerful economic operators.

- **Enhance eHealth infrastructure.** To achieve higher efficiency of healthcare system and better health outcomes in context of ageing and life expectancy improvements the government should modernise health centres by providing the latest technological equipment. The government also should give particular attention to development of eHealth systems, include the creation of electronic patient records in primary health care, e-prescription services and patient registries.

- **Development of health information systems for better monitoring and evaluation.** A strong health information system has the potential to be the backbone for monitoring and evaluating different aspects of health check-ups and cancer screening and further developing its secondary prevention policies.

- **Support development of AI for preventive medicine.** Artificial intelligence can improve efficiency and outcomes in early disease detection and prevention more than any other technology or tool, and its position in the overall healthcare system of Oman should be prioritized heavily.

- **Establish dedicated AI for Diabetes Prevention Center.** The establishment of a dedicated center for R&D and practical implementation of AI for early diabetes detection and management, in order to leverage the many already-validated tools and technologies for early diabetes detection and personalized treatment, would serve to simultaneously reduce the economic burden of diabetes in Oman, increase its level of National Health-Adjusted Life Expectancy (HALE), and potentially position Oman as the leader of Healthy Longevity in the Gulf region. Specific recommendations on the establishment of such a center are described in detail on pages 65 - 68 of the present report.

Genetic and Region-Specific Issues and Conditions: Conclusions and Implications

Cause-Specific Mortality in the Gulf Region. The Prevalence of Non-Communicable Diseases

In recent years, non-communicable diseases (NCDs) have globally shown increasing impact on health status in populations with disproportionately higher rates in developing countries. NCDs are the leading cause of mortality worldwide and a serious public health threat to developing countries. Nowadays, NCDs, such as cardiovascular diseases (CVD), diabetes, chronic obstructive pulmonary diseases (COPD) and cancers have become an emerging pandemic globally with disproportionately higher rates in the Gulf Region.

The transition from infectious diseases to NCDs has been driven by a number of factors, often indicative of economic development: a move from traditional foods to processed foods high in fat, salt and sugar, a decrease in physical activity with sedentary lifestyles, and changed cultural norms such as increasing numbers of women using tobacco. The impact of globalization and urbanization has also accelerated the growing burden of NCDs.
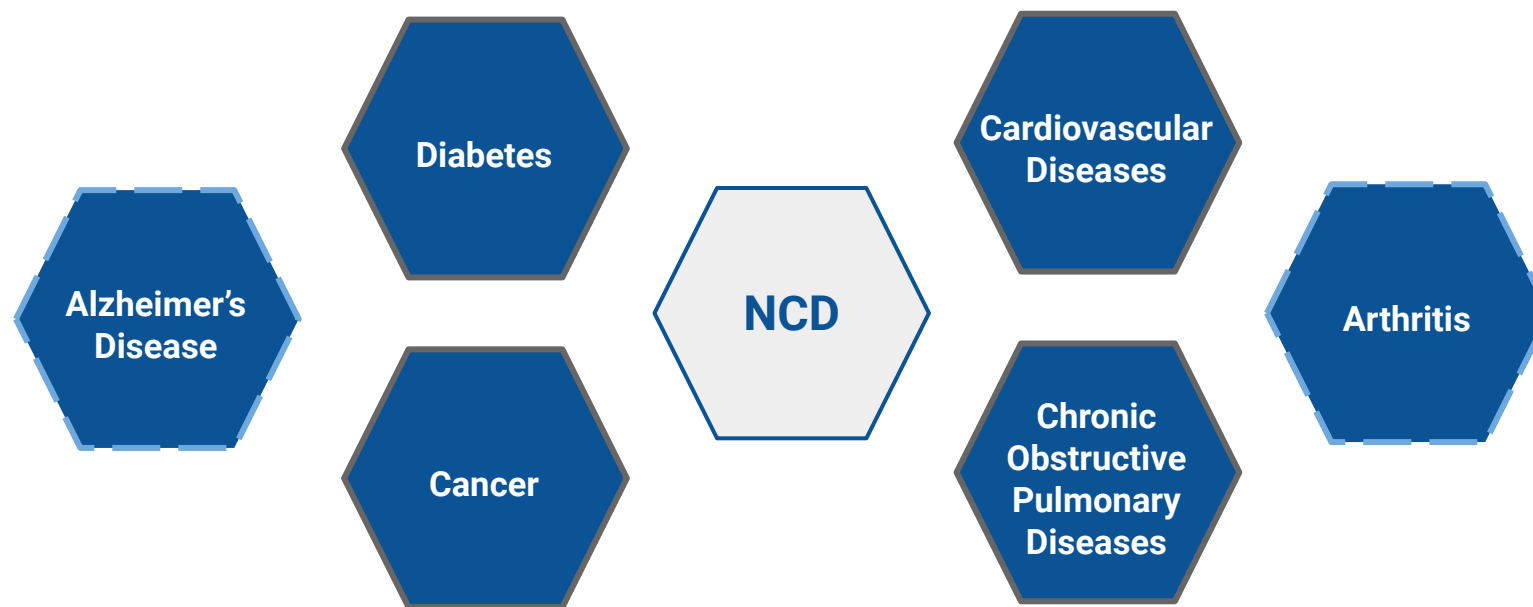
Source: NCBI

Cause-Specific Mortality in Bahrain

Bahrain has undergone the rapid economic development since the 1970s. This development has been paralleled by a changes to a more sedentary lifestyle and westernized diet, by increased cigarette consumption. Several studies has shown that obesity is a public health problem among nationals in Bahrain. The prevalence of cigarette smoking, other types of smoking has grown especially in adult females during past years, that`s why tobacco control is carried out through legislation and health education in this country.

* - NCDs are estimated to account for **83%** of all deaths

Proportional Mortality*, (%)

28	Cardiovascular diseases
16	Cancers
7	Communicable, maternal, perinatal and nutritional conditions
3	Chronic respiratory diseases
10	Injuries
14	Diabetes
21	Other NCDs

Risk Factors

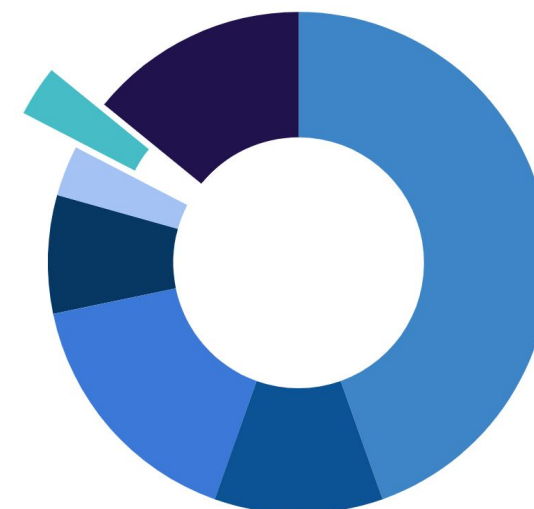|			Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	3	0	2
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	-	-	-
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	14	13	14
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	38	5	27
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	18	14	16
6	Diabetes	Raised blood glucose, adults 18+ (%)	9	8	9
7	Obesity	Obesity, adults 18+ (%)	25	36	29
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	7
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Cause-Specific Mortality in Kuwait

Non-communicable diseases encompass a broad range of conditions that together constitute a large and growing share of the disease burden worldwide. Kuwait is now facing rapid development, with NCDs accounting for the majority of deaths. Despite concerted effort on behalf of the government, prevalence rates of NCD risk factors among nationals exceed those in several developed countries (e.g., 35% for current tobacco smoking among men; 63% for insufficient physical activity; with obesity rates among women exceeding 44%).

* - NCDs are estimated to account for **72%** of all deaths

Proportional Mortality*, (%)

- **41** Cardiovascular diseases
- **15** Cancers
- **7** Communicable, maternal, perinatal and nutritional conditions
- **3** Chronic respiratory diseases
- **13** Injuries
- **3** Diabetes
- **10** Other NCDs

Risk Factors

	Risk Factors		Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	0	0	0
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	60	73	65
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	10	9	10
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	40	3	24
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	20	13	18
6	Diabetes	Raised blood glucose, adults 18+ (%)	15	15	15
7	Obesity	Obesity, adults 18+ (%)	33	44	37
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	6
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Cause-Specific Mortality in Qatar

The top five NCDs that will affect Qatar in terms of economic burden and disability-adjusted life years are cardiovascular diseases, mental health and behavioral disorders, cancer, respiratory diseases, and diabetes. The total direct and indirect costs to the Gulf Cooperation Council calculated for the above five NCDs were $36.2 billion in 2013, which equates to 150% of the officially recorded annual health care expenditure. If this trajectory is maintained, spending per head of population in Qatar will reach $2,778 by 2022.

* - NCDs are estimated to account for **69%** of all deaths

Proportional Mortality*, (%)

- **27** Cardiovascular diseases
- **16** Cancers
- **5** Communicable, maternal, perinatal and nutritional conditions
- **1** Chronic respiratory diseases
- **26** Injuries
- **9** Diabetes
- **16** Other NCDs

Risk Factors

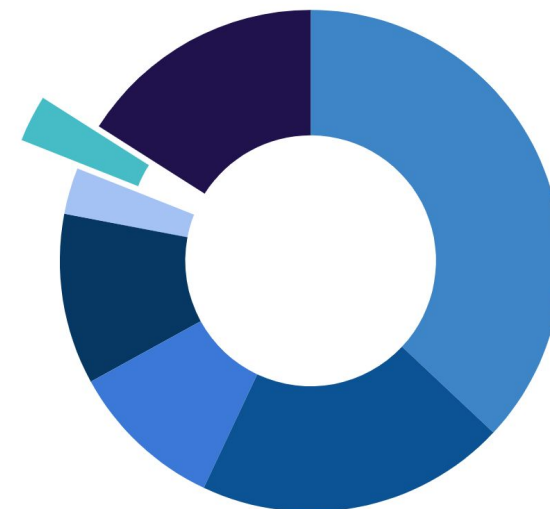| #	Risk Factor	Description	Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	2	0	2
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	30	46	34
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	11	10	11
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	29	1	22
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	16	12	15
6	Diabetes	Raised blood glucose, adults 18+ (%)	13	13	13
7	Obesity	Obesity, adults 18+ (%)	32	42	34
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	9
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Cause-Specific Mortality in Saudi Arabia

This epidemiological transition of chronic disease incidence is driven by different social and environmental factors in Saudi Arabia. The aging population is considered one of the main factors affecting the growth of chronic disease in the country. Improvement in healthcare systems and reduction in deaths related to childbirth and communicable disease allow more Saudis to live longer and become more vulnerable to NCDs. As the population ages and urbanizes, chronic disease burden is expected to be major threat to public health in Saudi Arabia.

*** - NCDs are estimated to account for 73% of all deaths**

Proportional Mortality*, (%)

37	Cardiovascular diseases
10	Cancers
11	Communicable, maternal, perinatal and nutritional conditions
3	Chronic respiratory diseases
16	Injuries
3	Diabetes
20	Other NCDs

Risk Factors

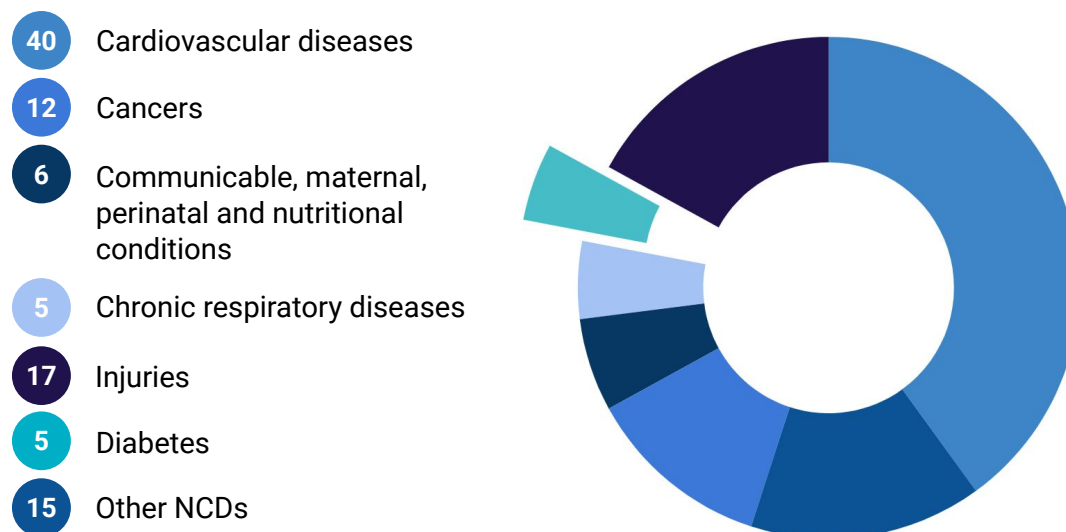|	Risk Factors		Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	0	0	0
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	44	54	52
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	8	8	8
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	26	2	16
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	21	16	19
6	Diabetes	Raised blood glucose, adults 18+ (%)	15	14	14
7	Obesity	Obesity, adults 18+ (%)	31	41	35
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	8
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Cause-Specific Mortality in United Arab Emirates

Noncommunicable diseases constitutes a huge public health challenge, associated with tremendous social, economic, and developmental impact in the UAE. The probability of dying prematurely (before the age of 70) from one of the four main NCDs – principally cardiovascular disease (CVD), cancer, diabetes, and chronic respiratory disease – is 17%. Furthermore, the top five risk factors for NCDs were dietary risks, high body mass index, high systolic blood pressure, high fasting plasma glucose, and high total cholesterol.

* - NCDs are estimated to account for **77%** of all deaths

Proportional Mortality*, (%)

- **40** Cardiovascular diseases
- **12** Cancers
- **6** Communicable, maternal, perinatal and nutritional conditions
- **5** Chronic respiratory diseases
- **17** Injuries
- **5** Diabetes
- **15** Other NCDs

Risk Factors

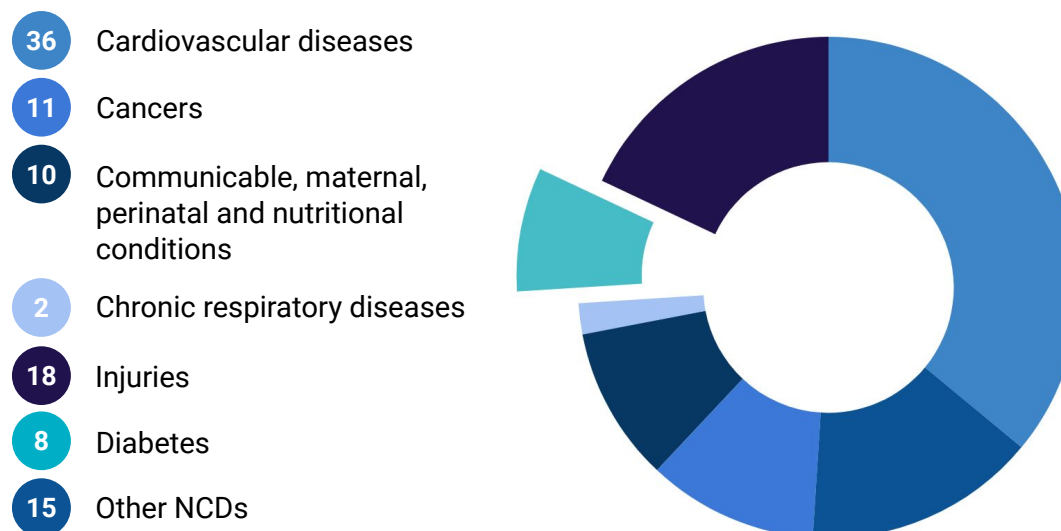|	Risk Factor	Description	Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	5	1	4
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	36	46	38
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	10	9	9
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	38	1	29
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	15	9	13
6	Diabetes	Raised blood glucose, adults 18+ (%)	8	9	8
7	Obesity	Obesity, adults 18+ (%)	27	39	30
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	4
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Cause-Specific Mortality in Oman

NCD is the leading cause of mortality in Oman and other countries of the Gulf Region. The increasing prevalence of NCD has been driven by rapid socio-economic development since the discovery of oil 50 years ago along with urbanization. The recent Oman World Health Survey reported high prevalence of behavioural risks, particularly a high proportion of adults consuming less than five servings of fruits and vegetables (69.8%) and being physically inactive (40%). Experts estimate that high dietary intake of fats, salts and sugar are also a concern.

* - NCDs are estimated to account for **72%** of all deaths

Proportional Mortality*, (%)

- **36** Cardiovascular diseases
- **11** Cancers
- **10** Communicable, maternal, perinatal and nutritional conditions
- **2** Chronic respiratory diseases
- **18** Injuries
- **8** Diabetes
- **15** Other NCDs

Risk Factors

#	Risk Factor		Males	Females	Total
1	Harmful use of Alcohol	Total alcohol per capita consumption, adults 15+ (litres of pure alcohol)	1	0	2
2	Physical Inactivity	Physical inactivity, adults 18+ (%)	27	38	31
3	Salt/Sodium Intake	Mean population salt intake, adults 20+ (g per day)	10	9	10
4	Tobacco Use	Current tobacco smoking, adults 15+ (%)	16	0	12
5	Raised Blood Pressure	Raised blood pressure, adults 18+ (%)	17	15	16
6	Diabetes	Raised blood glucose, adults 18+ (%)	7	8	8
7	Obesity	Obesity, adults 18+ (%)	20	31	23
8	Ambient Air Pollution	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	-	-	4
9	Household Air Pollution	Population with primary reliance on polluting fuels and technologies	-	-	<5

Genetic Disorders Predominance

Rates of Birth Defects in the Gulf Countries

80 babies per 1000

Saudi Arabia

70-79 babies per 1000

UAE
Kuwait
Oman
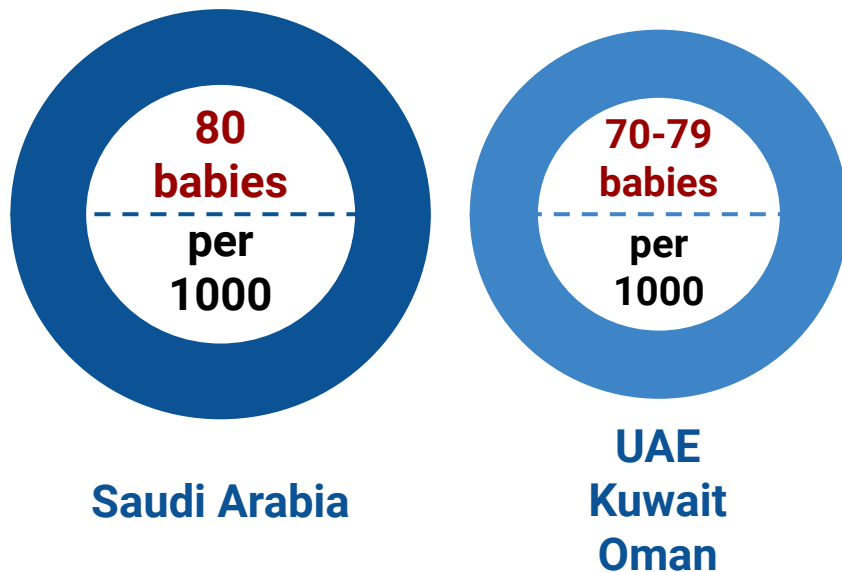
According to the CAGS Database, in the **UAE** there are 240 diseases, but only 28 have a known genetic background. In **Bahrain** were recorded 109 genetic disorders, but only 14 related genes have been identified. In **Oman** there are 271 diseases, but only 58 related genes.

The growing prevalence of genetic disorders throughout the Arab world will place greater financial strain on health systems across the region. Hereditary disorders caused both by environmental and social dynamics, and diagnoses are often made too late.

The Centre for Arab Genomic Studies (CAGS) has collected extensive data from the UAE, Bahrain and Oman, identifying more than **450 genetic disorders** in the population sample. Disorders such as Down's syndrome, sickle cell disease, and thalassaemia are far more common in the region than elsewhere. Many genetic conditions that are considered rare are found more frequently in the region. According to CAGS, 21.4 babies per 100,000 are born with Down's in the UAE, about double the average global rate. The direct cost to treat just one carrier of thalassaemia, a recessive blood disease, is about US$6,000 a year. About one in 10 people in the UAE is a carrier.

There are no national projects aimed at controlling genetic disorders in most Arab countries. Providing **screening programs** soon after birth, or during early childhood, or for current conditions can be used to detect conditions very early in life in circumstances where prompt treatment may be effective. Such screening may also be used to identify symptomatic individuals where the genetic cause of their symptoms has not yet been established.

**Source:** The National | Middle East Health

Diabetes: The Gulf's Major Modern Healthcare Burden

Diabetes: The Modern Burden of Gulf Countries

Apart from genetic disorders there is a tremendous prevalence of diabetes. The economic growth in the Gulf countries since the beginning of the 21 century, stimulated by a boom in hydrocarbons, has brought with it an enormous rise in diabetes rates among local populations. The occurrence of the disease in Kuwait rose from 7% in 2000 to 17.8% in 2013, according to the International Diabetes Federation (IDF). Now, **in Saudi Arabia, 23.9% of the population is affected by the disease; in Kuwait, 23.1%; and in Qatar, 19.8% (global average figure at 8.3%)**. The populations of the Gulf countries are suffering high rates of diabetes due largely to overweight and obesity, among the key risk factors in diabetes. Overweight and obesity, in turn, are down to the growing popularity of Westernised foods in the region that are often laden with salt or sugar, as well as the sedentary lifestyle of many sections of the Arab population.

Type 2 diabetes is affected by multiple genetic factors. Academic research, made by scientists from the Lund University, Sweden, indicates that Arabs may have a genetic predisposition to the disease. In Sweden, immigrants from the Middle East have a 2- to 3-fold increased risk of Type 2 Diabetes compared to native Swedes. In addition, these immigrants seem to have a slightly different form of diabetes with an earlier onset and lower C-peptide concentrations than Swedish patients. It is also more common for patients from the Middle East to have first-degree relatives with Type 2 Diabetes.

Obesity Rates in the Gulf Cooperation Council (GCC) Countries

y-axis: % of population aged 15+ classified as obese

Legend: 2010, 2015
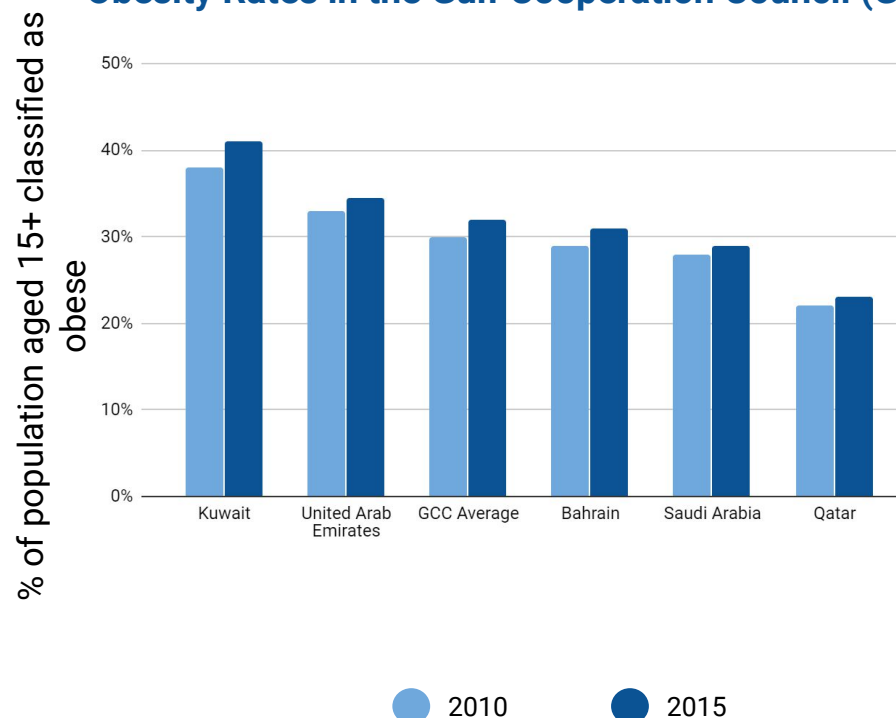
Source: Euromonitor | The Economist
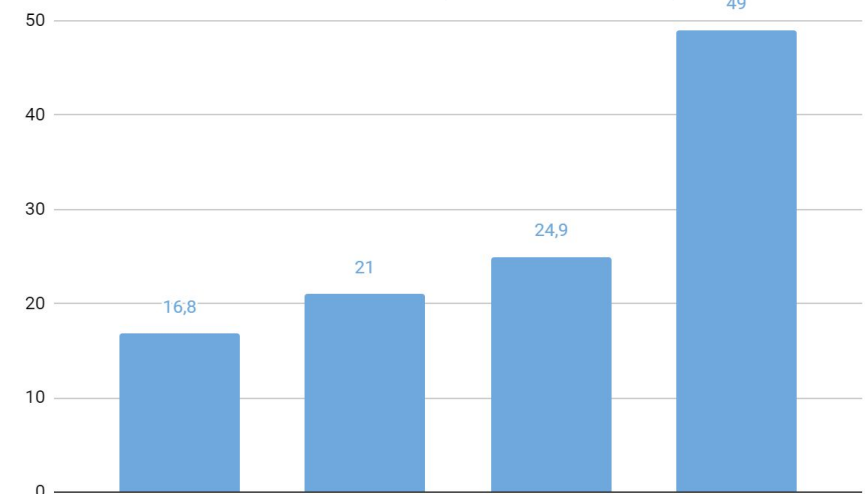
Diabetes: The Modern Burden of Gulf Countries

The impact of diabetes on the economics in the Gulf region is growing as patients with diabetes require at least 2-3 times the health care resources compared to people who do not have diabetes. According to estimates from the IDF, healthcare spending on treating diabetes in the Middle East and North Africa (MENA) region was US$16.8bn in 2014. The direct costs of providing treatment for diabetes could rise even more dramatically in some parts of the region, for example the Health Authority of Abu Dhabi (HAAD) expects the direct cost of providing diabetes treatment to the Emirati population of Abu Dhabi to rise fourfold between 2010 and 2030.

But there is potentially an even bigger price to pay: the development of the region may be at stake, just as the Gulf states push through efforts to diversify their economies away from oil and involve the local workforce in the knowledge economy.

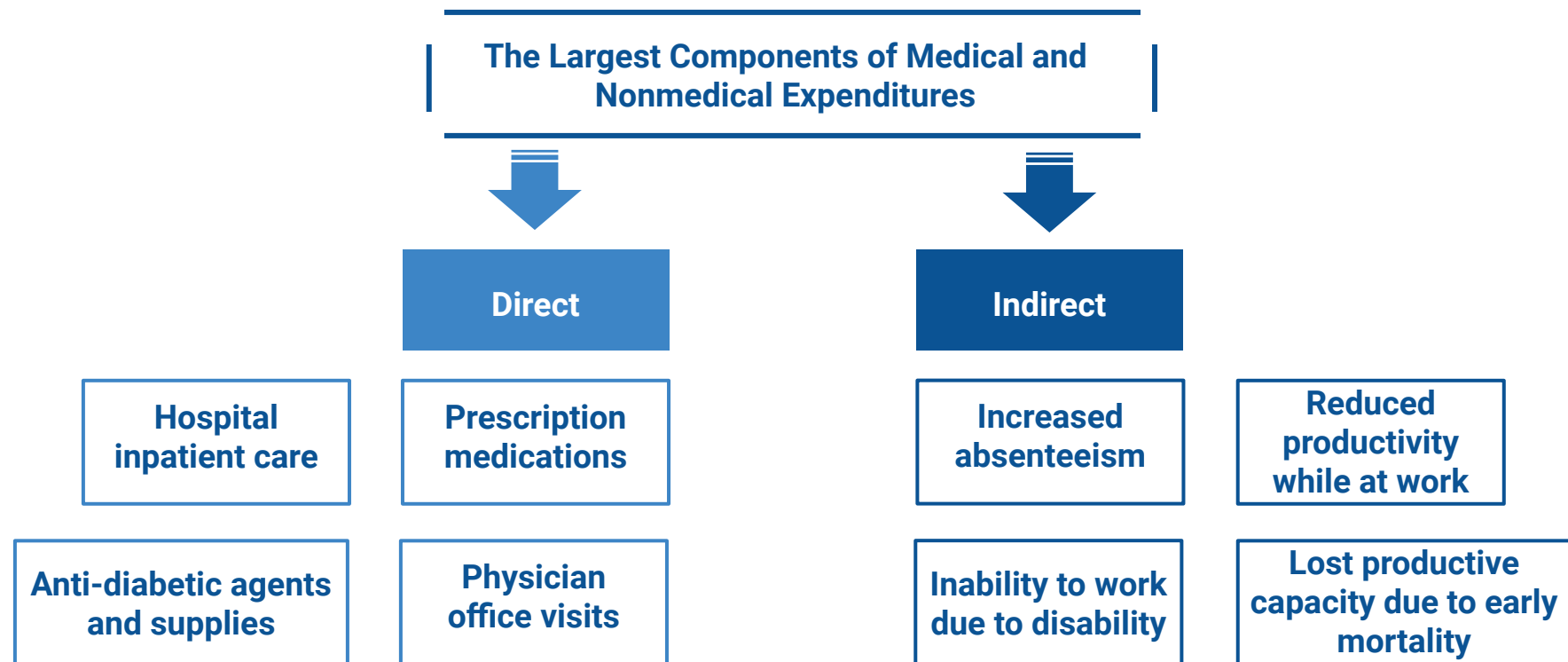## Cost per Patient With Diabetes Worldwide by Region in 2019 (in USD)
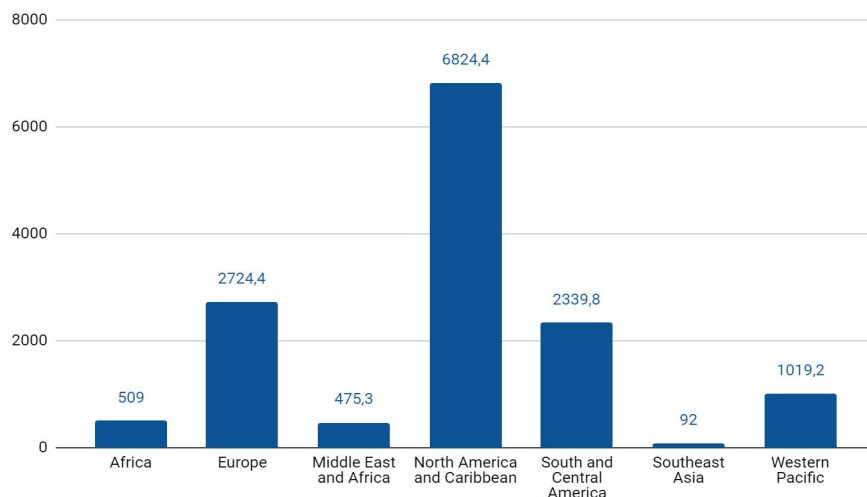
Total Healthcare Expenditure on Diabetes in the MENA region (in billion USD)

Source: Statista   The Economist

Diabetes: The Modern Burden of Gulf Countries

The total economic burden of diabetes is the sum of excess health expenditure (direct costs) and the value of forgone production (indirect costs) due to diabetes and its complications.

The Largest Components of Medical and Nonmedical Expenditures

Direct

Hospital inpatient care	Prescription medications
Anti-diabetic agents and supplies	Physician office visits

Indirect

Increased absenteeism	Reduced productivity while at work
Inability to work due to disability	Lost productive capacity due to early mortality

The baseline scenario projections for the total economic burden in 2030 are more than twice as large as those expressed in 2010 by the World Economic Forum **($1.94 vs $0.75 trillion)**. Even if countries meet international targets, the global economic burden will not decrease. Policy makers need to take urgent and coordinated actions to prepare health and social security systems to mitigate the effects of diabetes.

Source: Diabetes Care   ADA

Special Diabetes Treatment in Gulf Countries

There is an increasing awareness of diabetes in the Gulf countries. The disease rates in the region have expanded so policymakers have responded with a number of policies and initiatives at the regional, national and local level. Many target overweight and obesity with initiatives to improve diet and promote physical activity. At a summit in Qatar in December 2014 the leaders of the GCC states endorsed an updated plan to control noncommunicable diseases in the Gulf region.

The World Health Organisation (WHO) provided the United Nations Political Declaration on the Prevention and Control of Noncommunicable diseases and the WHO's Global strategy on diet, physical activity and health where some approaches presented to combat diabetes. Ibtihal Fadhil, regional adviser to the WHO's Noncommunicable Diseases Programme, confirms that the organisation works closely with the GCC states in the planning and implementation of diabetes programmes in the region. Moreover, WHO is promoting cost-effective interventions in the GCC states that it refers to as "best buys" — for example, reducing salt intake in food and raising taxes on tobacco and alcohol.

The WHO encourages partnerships to promote the prevention and management of noncommunicable diseases, particular diabetes. For instance, there is the Kuwait-Scotland eHealth Innovation Network, a partnership between the Dasman Diabetes Institute in Kuwait, the Ministry of Health in Kuwait, the University of Dundee in the UK, the National Health Service in the UK's Tayside region, and Aridhia Informatics, a clinical informatics firm. This collaboration was established with a view to transforming diabetes care in Kuwait.

Source: WHO   The Economist

Special Diabetes Treatment in Gulf Countries

Particular countries have started new strategies to reduce diabetes. **Oman's Health Vision 2050**, released by the sultanate's Ministry of Health in May 2014, represents a quantum leap in the future health planning process, where the fifth five-year plan directed its strategies through the seven themes on which the vision was based. Health Vision 2050 acts as a basis for shorter-term plans, such as the ninth five-year **Health Development Plan 2016-20**, that includes targeted measures to realise the country's vision, as an example, for building a medical city to provide tertiary care. The construction of a medical city will also facilitate training and education for healthcare professionals.

In Qatar, the Supreme Council of Health, the body responsible for public health in the state, established the **National Diabetes Strategy Committee** in 2013 to agree on measures to tackle the disease. Another fact that should be admitted is that the Ministry of Public Health in Qatar and its partners are developing a national research agenda on diabetes and its complications, which intends to address the risk factors for diabetes and cardiovascular diseases in Qatar through targeted local research. Research is one of the six pillars of Qatar National Diabetes Strategy 2016-2022 in addition to awareness, prevention, patient empowerment, human capability, capacity building and information management pillars.

Some GCC states have brought in screening. The HAAD launched the Weqaya programme in Abu Dhabi in 2008 to better understand noncommunicable diseases in the emirate, in particular diabetes. All adult Emiratis are screened at least annually for cardiovascular risk factors as a requirement for free health insurance coverage. Initial findings suggested that around 45% of adult Emiratis had diabetes or pre-diabetes.

Weqaya Programme Indicators

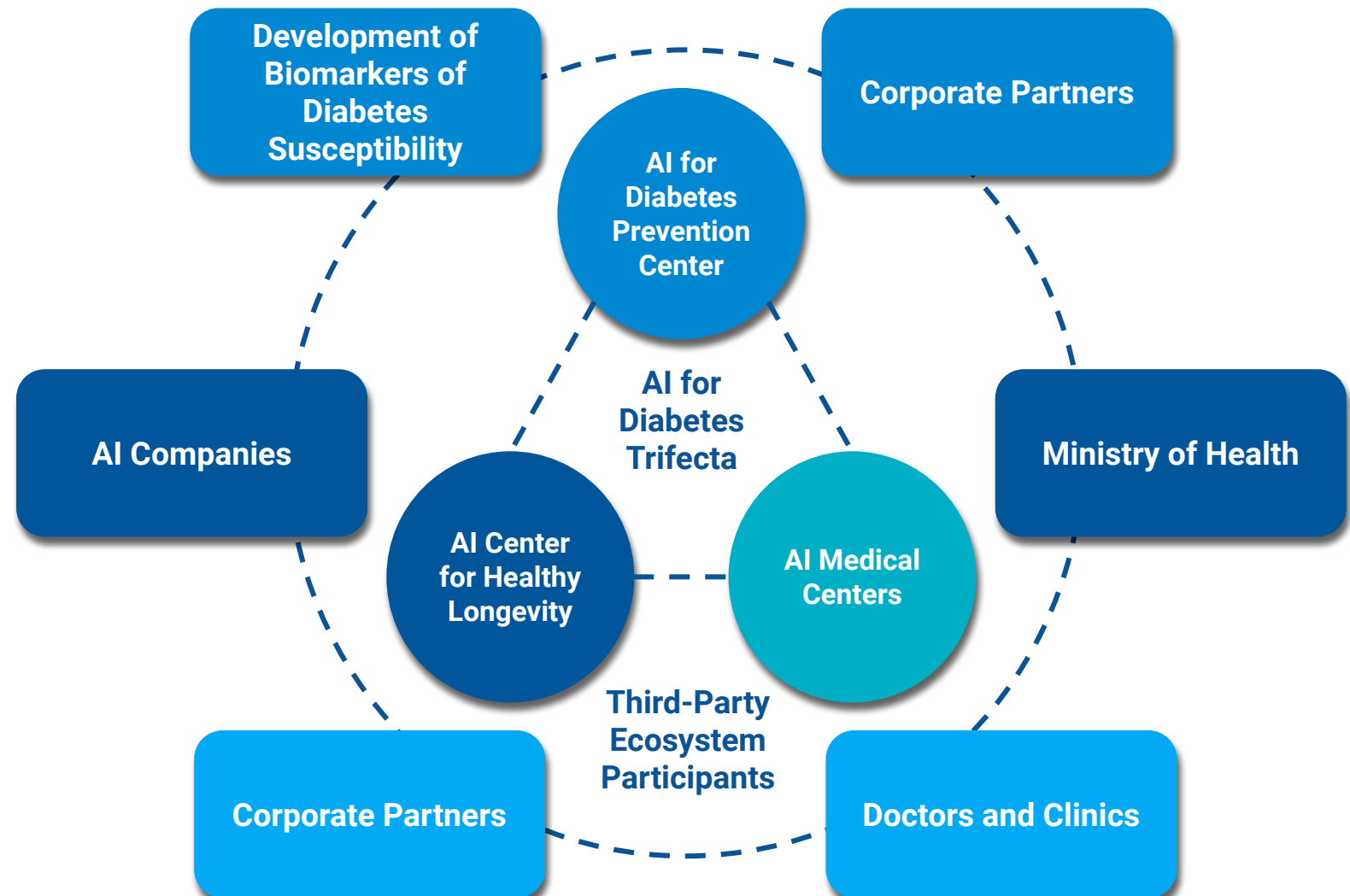|	
Obesity	Population with pre-diabetes
Smoking	Population with diabetes

Source: | Oman Observer | The Economist | IloveQatar |

Recommendations: Using Artificial Intelligence for Diabetes Prevention to Transform Challenge into Opportunity

Artificial Intelligence, deep learning and machine learning have enormous potential to exponentially accelerate progress in the early detection, prevention and treatment of diabetes on a large scale. As the sheer volume of life data on early markers of diabetes, personalized methods of diabetes prevention (including optimized behavioural, lifestyle and diet regimes) and diabetes treatments continue to grow, AI is the only tool capable of handling such large amounts of life data and making sense of it.

The Gulf region has the potential to establish an international Longevity leadership position via the proactive development of a comprehensive cross-sector infrastructure for applying artificial intelligence to the prevention and maintenance of diabetes.

Development of Biomarkers of Diabetes Susceptibility

Corporate Partners

AI for Diabetes Prevention Center

AI for Diabetes Trifecta

AI Companies

Ministry of Health

AI Center for Healthy Longevity

AI Medical Centers

Corporate Partners

Third-Party Ecosystem Participants

Doctors and Clinics

Recommendations: Using AI for the Optimal Assembly of Existing, Validated Early Diabetes Detection and Prevention Technologies

The current level of advancement and development in technologies and solutions available for early diabetes detection and prevention is remarkably high and well-developed, but have not yet received widespread adoption in the gulf region. Artificial Intelligence plays a critical role in the practical implementation of these technologies on a massive, population-wide scale in practice due to the levels of data involved, and the need for sophisticated, data-driven approaches for making sense of that data. The integrated combination of biomarker measurement (in blood, skin, the retina and the microbiome), AI-driven analysis, and routine monitoring of life and health data via digital technologies like smartphones and wearables can create the perfect synergy capable of cost-effectively orchestrating early diabetes detection and prevention, and personalized, optimized diabetes treatment.

This means that if the Gulf region were to make a dedicated effort to aggregate the leading examples of these technologies and solutions, and coordinate their integrated assembly and application using AI, they would put themselves in a very strong position to have immediate, tangible effects on their levels of Healthy-Adjusted Life Expectancy (HALE) (which can be considered as Healthy Longevity in Practice), and position themselves as the leader of Healthy Longevity in the Gulf region as a result. Furthermore, because the total set of technologies and approaches for early diabetes detection and prevention are already quite advanced, we estimate that the Gulf would be capable of implementing such an ecosystem comparatively quickly and without enormous levels of investment.

Early Diabetes Detection and Prevention Technologies

| Diabetes Diagnosis and Prognosis via AI Analysis of Retinal Scans	Microchip Sensors to Detect Blood-Based Diabetes Biomarkers
Fluorescence Detection of Advanced Glycation End-Products in Skin	Detection of Diabetes via AI-Enabled Microbiome Analysis

Recommendations: AI as the Major Game Changer for Oman's Diabetes Burden

AI-Driven Precision Diabetes Diagnostics

- AI-empowered biomarker analysis to detect pre-diabetes and metabolic syndromes early
- Continuous monitoring of pre-diabetes biomarkers

AI-Driven Diabetes Prognostics
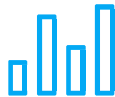
- AI-driven short and long-term diabetes prognostics
- Use of large-scale human data to develop more advanced prognostic tests for diabetes

Personalised Diabetes Treatment Optimization

- AI-driven blood, biomarker and genetic analysis to determine optimal, personalized diabetes drug combinations
- AI-driven analysis of biomarkers of pre-diabetes and metabolic disorders

AI-Driven Personalized Diabetes Prevention

- Using AI and machine learning to detect and monitor pre-diabetes
- AI-driven pharmacogenetic analysis to create personalized lifestyle and diet regimes

Recommendations: The Establishment and Development of a World-Leading Gulf AI for Diabetes Center

The Gulf region has the potential to become an epicenter of diabetes prevention and treatment through the establishment of an AI for Diabetes Prevention Center that will unite the resources of AI companies, corporate partners, hospitals and research labs to developing cutting edge and cost-effective solutions for diabetes prevention and management, effectively transforming the challenge of diabetes into a major opportunity to grow the health and the wealth of its population simultaneously.

PERSONALIZED PRE-DIABETES DIAGNOSIS

EARLY DIAGNOSIS OF METABOLIC DISORDERS

BIOMARKERS OF DIABETES SUSCEPTIBILITY

PHARMACOGENETICS FOR PERSONALIZED TREATMENT

OPTIMIZED, PERSONALIZED EXERCISE AND DIET PLANS

ARTIFICIAL INTELLIGENCE FOR DIABETES PREVENTION CENTER

DEVELOPMENT OF NOVEL DIABETES TREATMENTS

LARGE-SCALE DATA ANALYSIS FOR TREATMENT R&D

DETERMINING OPTIMAL MIX OF TREATMENT AND PREVENTION

MEASURING EFFECT OF DIABETES ON LONGEVITY

DIABETES AND MICROBIOME ANALYSIS

An AI for Diabetes Prevention Center would apply cutting-edge artificial intelligence techniques to early diabetes prevention and treatment optimization

Prospects and Recommendations for the Development of A Full-Scope Gulf Longevity Hub

Prioritization of Preventive Medicine for Gulf-Specific Genetic and Regional Issues

Rising healthcare costs due to a high growth rate of aging population and a high incidence of NCDs make it clear that the current reactive care model is unsustainable, but globally and for the Gulf region in particular.

Gulf countries need to adopt and embrace a new approach that shifts away from "sick care" to a model of empowering overall health and wellness, providing patients with access to proactive care that identifies risk and manages diseases early to prevent escalation and deterioration.

Prevention is the most effective, common-sense way to improve health and reduce healthcare costs for Gulf Region countries by preventing diseases before they require any medical treatment.

With the aging of the population and an increase in the proportion of older persons, the shift in the burden of disease towards chronic conditions has accelerated. And chronic diseases are responsible for 7 out of 10 deaths. These rates are expected to increase significantly over the next two decades, particularly due to the obesity epidemic.

Chronic Diseases in Numbers (for Adults 65+)

80%

adults have **at least 1** Chronic Disease

68%

adults have **2 or more** Chronic Diseases
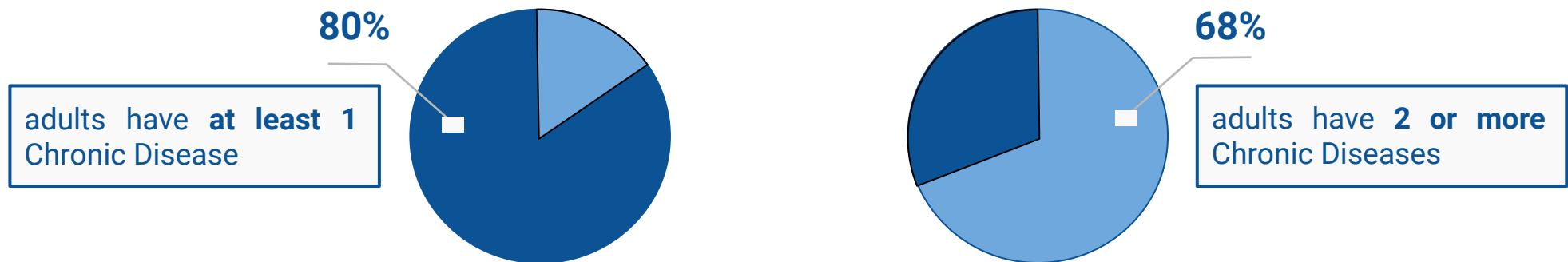
Source:

| Oxford Business Group | Diabetes | NCOA |

The Shift from Sick Care to Preventive Medicine

Steps that Should be Taken to Put Prevention First in Gulf Region Healthcare Systems

Advance and modernize the nation's public health system

Build partnerships within and outside the health field

Partnerships with:

- healthcare payers, including both public and private insurers;
- health care providers, including expanding health care models;
- sectors beyond the healthcare system, including drawing the connection between all facets of society and health.

Due to the IDF the prevalence of diabetes in adults in the sultanate is 10.7%. The healthcare systems of the Gulf are based on the primary health care system and all patients with diabetes are followed up at this level, leaving the complicated cases to secondary or tertiary hospital care. Not all the primary health care facilities have diabetologists so most of these patients are looked after by non-specialised primary health care physicians. People with diagnosed diabetes incur average medical expenditures of $16,752 per year, of which about $9,601 is attributed to diabetes. **On average, people with diagnosed diabetes have medical expenditures approximately 2.3 times higher than what expenditures would be in the absence of diabetes.** In recent years, it is possible to prevent the disease and avoid all of the complexities.

Yet economic and technological factors dating from the early 20th century remain strong barriers to effective disease prevention. A key feature of the system is its use of a piecemeal, task-based system that reimburses for "sick visits" aimed at addressing acute conditions or acute exacerbations of chronic conditions.

Economic incentives encourage overuse of services by favoring procedural over cognitive tasks and specialty over primary care. Incorporating preventive medicine in the Gulf region will provide the benefits of saving lives and improving the quality of humans health.

Source: Huffpost   Diabetes

AI for Preventive Medicine and Precision Health

Today, patients are often diagnosed with a chronic condition, such as cancer or diabetes, when it's too late to reverse the progression of the condition. Treatment plans with late stage diseases are expensive and debilitative. Patients are poorly equipped with insights into their own health conditions, and so are less proactive about making healthy lifestyle choices.
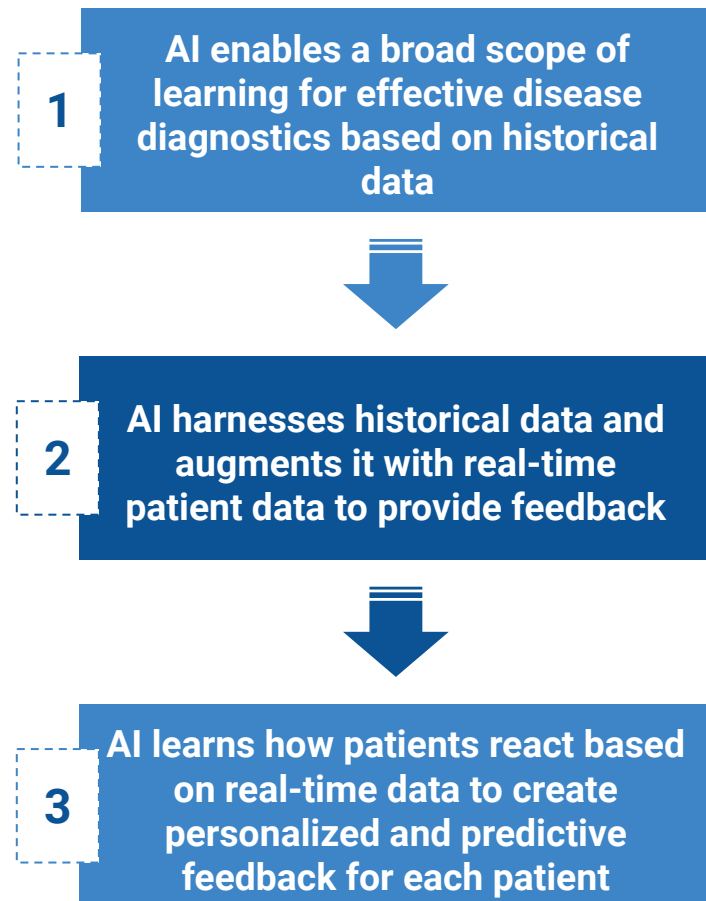
Consequently, **preventing the start of chronic disease** and managing the disease post-diagnosis has become the focus of preemptive measures in healthcare. For instance, predicting diabetes will bring the most significant profit for Oman and other Gulf countries as this disease is modern burden for the region. Here, AI offers a promising solution. A preventive healthcare system will capitalize on AI's ability to collect and analyze data to facilitate progressive and ultimately integrated stages of learning. In the context of broad learning, AI holds the potential to aid in the diagnostic process and identify problems before they become serious.

Once AI's broad learning can identify and assist in the diagnosis of a specific condition, it can leverage historic data to develop treatments plans that are interactive, driving patient engagement.

Integrated Stages of AI Learning

1 AI enables a broad scope of learning for effective disease diagnostics based on historical data

2 AI harnesses historical data and augments it with real-time patient data to provide feedback

3 AI learns how patients react based on real-time data to create personalized and predictive feedback for each patient

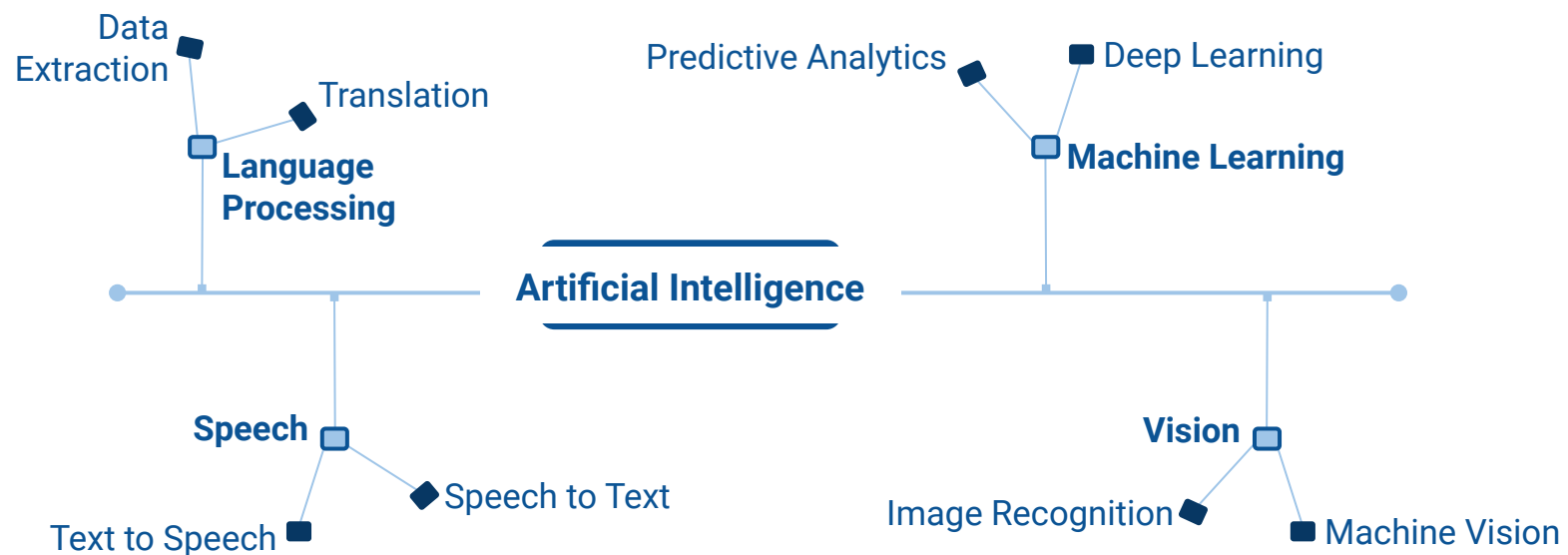**Source:** Inside Big Data | Oman Observer

Development of Artificial Intelligence in the Gulf Region

Gulf region countries have begin significantly prioritizing the development of their Artificial Intelligence industries in order to keep pace with global developments in this sphere. A recent study indicated that the AI would account for 14 percent on the UAE's GDP and 12.4 percent of Saudi Arabia's GDP by the year 2030.

Furthermore, a 2017 survey revealed that 66% of citizens in the Middle East would be positive about replacing human doctors with AI and robotics. More specifically, willingness ratios were 55% for EMEA, 66% in Saudi Arabia, 65% in Qatar and 62% in the UAE.

Additionally, the Gulf region's unique mix of (1) a shortage of medical professionals and clinical workforce, combined with (3) the high level of digital technology use and adoption in the region, puts the Gulf in a position that would favour the on-boarding of AI and robotics within its healthcare infrastructure and medical practices in a significant way.

Data Extraction

Translation

Language Processing

Predictive Analytics

Deep Learning

Machine Learning

Artificial Intelligence

Speech

Speech to Text

Text to Speech

Vision

Image Recognition

Machine Vision

Source: PwC Middle East   Gulf Research Centre Cambridge

AI for Precision Health

AI-Driven Precision Diagnostics

- Multi-Omic Sequencing
- Continuous monitoring powered by Big Data Analytics
- Continuous monitoring of health state based on changes in biomarkers of aging

AI-Driven Advanced Prognostics

- AI-driven prognostics
- Advanced biomarker-based prognostics
- AI-driven predictive prognostics based on personalized multi-omics

Personalised Treatment Optimization

- AI-driven in silico personalised treatment optimization
- AI-driven personalised in vivo drug optimization
- Treatment optimization based on patient genetics

AI-Driven Preventative Treatment

- Maintenance state of precision health through preventive medicine
- AI-based predictions of optimal drug combination

Healthcare Reform and Recommendations for Insurance Companies

There are a number of challenges which the insurance sector in the Gulf region faces today, for example, pricing pressure, low quality of service, and scarcity of talents are the main ones. The ways to response these challenges include:

▶ **Multi-channel approach**. Through multiple touch channels, the customer first knows about a product; then compares it with similar products offered by the insurance company itself and by those being offered by competitors, and finally completes the sale through any one of the channels.

▶ **Collaborations between insurers and hospital providers.** The lack of a standardised and comprehensive data environment is an ongoing challenge that the government and insurers are set on addressing. Further collaborations between insurers and hospital providers has the scope to provide a more granular, population-wide view of risks and morbidity, from which better underwriting and product coverage may be derived.

▶ **Optimizing network distribution**. Insurers must revisit their network planning strategies and re-align the distribution network mix in line with the economic potential of a region or a city.

▶ **Collaborating to increase talent development**. The insurance industry currently faces a major scarcity of manpower with the right acumen to drive customer engagements and sales.

▶ **Adoption of best global practices**. Increased availability of the capital and know-how from foreign parents will go a long way in plugging the infrastructural gaps faced by insurers. From revamping policy administration systems to improving claims settlement processes, insurers can raise operational efficiency at each level of the value chain. Such improvements can provide a major boost to the long-term profitability of insurance companies.

▶ **Implementing a modern and integrated claims management system**. An integrated claims-processing system aids in simplifying processes and improving claims resolution, resulting in lower costs and enhanced customer fulfillment.

Source: U Capital   Lexology

Development of AgeTech

Business sector has to adapt in order to respond to the needs of the ageing population, which is the new big population group. This is the moment when AgeTech has to appear, as different segments of AgeTech can target directly the demands of the elderly.

AgeTech Sector

Elderly Care	**FinTech**
m-Health	**Senior Living Communities**
Social and Communication	**Caregiving**
Independence	**Social Protection**
Cognitive Care	
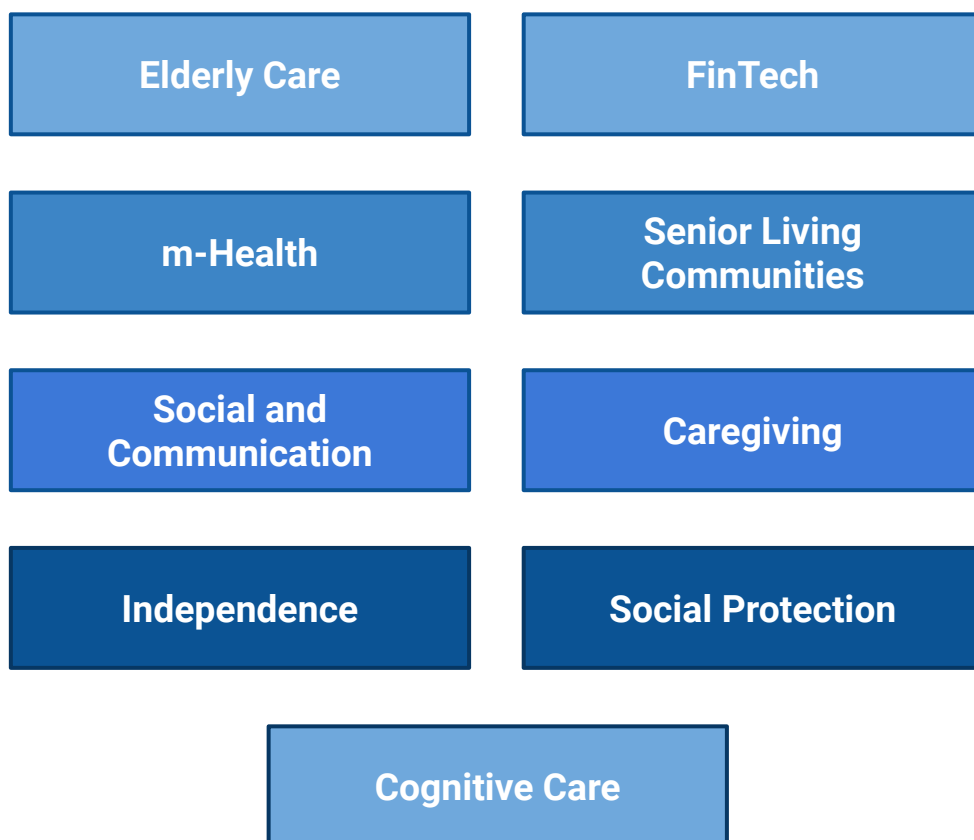
As the share of the population above 65 is increasing, banks in Oman may being lagging behind in finding solutions for this age group, especially taking into account the fact that seniors are holding the lion's share of the savings. The financial industry is likely to see the emergence of what can be referred to as **AgeTech Banks**, a novel type of institution focused on simplifying banking for people over 60. AgeTech bank provide:

- **Multipurpose products.** AgeTech Bank develops products for people of all ages.
- **Fraud protection.** It has tools for the protection from financial exploitation.
- **Accessibility.** Attracts seniors by developing easy-to-use and accessible products.
- **Special staff training.** The stuff in AgeTech Bank is trained to find special approach to seniors.

Source: Age-Friendly Banking

Healthy Longevity Progressiveness
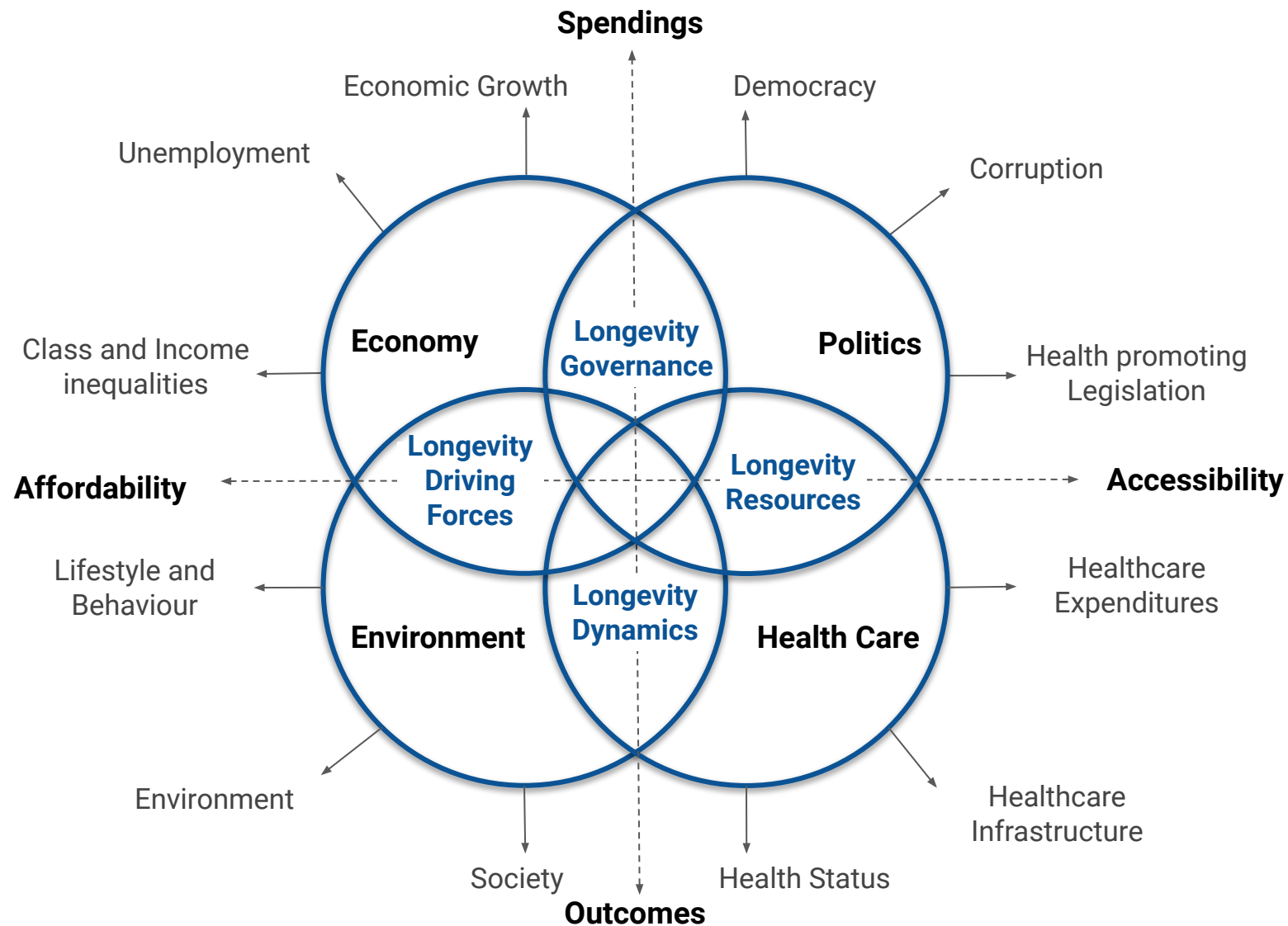
Healthy Longevity progressiveness is important for driving economic progress and competitiveness—both for developed and developing economies. Today longevity is about social inclusiveness, high quality of life, technical innovations in care delivery and medical treatment, and modified business and governmental models.

Report Methodology and Data

Metrics Structure. 1st Level

1. Absolute values						
General Health Status						**Government Healthcare Policies**
Both Sexes HALE	Male HALE	Female HALE	Both Sexes Life Expectancy	Male Life Expectancy	Female Life Expectancy	Existence of an Operational Policy that Integrates Several NCDs and Their Risk Factors
Government Healthcare Policies						
Existence of a Set of Time-Bound National Targets Based on WHO Guidance for NCDs	Existence of any Policies to Reduce Population Salt Consumption	Implementation of Physical Activity Public Awareness Program	Existence of Operational Policy/Strategy/Action Plan for Cancer	Existence of Operational Policy/Strategy/Action Plan for Cardiovascular Diseases	Existence of Operational Policy/Strategy/Action Plan for Diabetes	Existence of Operational Policy/Strategy/Action Plan for Chronic Respiratory Diseases
Government Healthcare Policies						
Existence of Operational Policy/Strategy/Action Plan to Decrease Tobacco Use	Existence of Operational Policy/Strategy/Action Plan to Reduce Physical Inactivity	Existence of Operational Policy/Strategy/Action Plan to Reduce the Harmful Use of Alcohol	Existence of Operational Policy/Strategy/Action Plan to Reduce Unhealthy Diet Related to NCDs	Existence of Operational Policy/Strategy/Action Plan for Oral Health	Stand-Alone Law for Mental Health	Stand-Alone Policy or Plan for Mental Health
Retirement and Ageing						**Demography**
Number of WHO Age Friendly Cities and Communities	Early Retirement Age Women	Early Retirement Age Men	Normal Retirement Age Women	Normal Retirement Age Men	Total Population	Population 65 +
Demography	**Temperature Conditions**		**Solar Radiation**	**Humidity**		
Net Migration	Diurnal Temperature Variation, °C	Daily Mean Air Temperature, °C	Sunshine Hours, Mean Monthly Number of Hours	Relative Humidity, %	Dew Point, °C	

The first level of metrics is used predominantly as a basis for the following more complicated levels of analysis.

Metrics Structure. 2nd Level

2. Indices								
Healthcare		**Melbourne Mercer Global Pension Index**				**Economy**		
Healthcare Efficiency Index	HAQ (The Healthcare Access and Quality Index)	Overall Value Index	Sustainability	Adequacy	Integrity	Inclusive Development Index	Global CompetitiveneSs Index	Consumer Price Index
International Health Regulations (2005) Monitoring Framework								
Legislation	Coordination	Surveillance	Response	Preparedness	Risk Communication	Human Resources	Laboratory	Points of Entry
International Health Regulations (2005) Monitoring Framework			**Society**					
Zoonosis	Food Safety	Chemical	Radionuclear	Education Index	Democracy Index	Human Development Index	Global Gender Gap Index	Corruption Perceptions Index 2016

The second level of metrics comprises a number of indices developed by international organizations and respected publications, such as WHO, The World Bank, Bloomberg, etc.

Metrics Structure. 3nd Level (1)

3. Ratios								
Mental Health			**Immunization**					
Mental Hospitals (per 100 000 Population)	Mental Health Units in General Hospitals (per 100 000 Population)	Mental Health Outpatient Facilities (per 100 000 Population)	BCG Immunization Coverage among 1-Year-Olds (%)	Diphtheria Tetanus Toxoid and Pertussis (DTP3) Immunization Coverage among 1-Year-Olds (%)	Hepatitis B (HepB3) Immunization Coverage among 1-Year-Olds (%)	Hib (Hib3) Immunization Coverage among 1-Year-Olds (%)	Measles-Containing-Vaccine First-Dose (MCV1) Immunization Coverage among 1-Year-Olds (%)	Measles-Containing-Vaccine Second-Dose (MCV2) Immunization Coverage by the Recommended Age (%)
Immunization				**Economy**				
Neonates Protected at Birth against Neonatal Tetanus (%)	Pneumococcal Conjugate Vaccines (PCV3) Immunization Coverage among 1-Year-Olds (%)	Polio (Pol3) Immunization Coverage among 1-Year-Olds (%)	Rotavirus Vaccines Completed Dose (RotaC) Immunization Coverage among 1-Year-Olds (%)	GDP per Capita (Current US$)	Adjusted Savings: Net National Savings (% of GNI)	Unemployment Rate, %	Net ODA Received (% of GNI)	% of People 65+ in Employment
Economy	**Healthcare**							
Income Gini Coefficient	Current Health Expenditure per Capita (Current US$)	Public Health Care Expenditure (as % of GDP)	Domestic Private Health Expenditure (% of Current Health Expenditure)	Out-of-Pocket Expenditure (% of Current Health Expenditure)	Risk of Catastrophic Expenditure for Surgical Care (% of People at Risk)	Medical Equipment (per 1.000.000 People)	Biomedical Engineers Density (per 10 000 Population)	

The third level of metrics includes open data ratios mostly provided by WHO, OECD, The World Bank and Governmental institutions of each country, that are subsequently used for countries comparison and advanced calculations of growth rates of ratios and effectiveness ratios.

Metrics Structure. 3nd Level (2)

3. Ratios							
General Health Status							
Population of Adults with AIDs (%)	Annual Cigarette Consumption per Capita	Alcohol Consumption per Capita (Litres of Pure Alcohol)	DALY Rates per 100 000 Population	Incidence of Tuberculosis (per 100 000 Population per year)	Prevalence of Overweight among Adults, BMI ≥ 25 (Age-Standardized Estimate) (%)	Prevalence of Undernourishment (% of Population)	Prevalence of Insufficient Physical Activity Among Adults aged 18+ Years (Age-Standardized Estimate) (%)
Environment and Infrastructure					**Demography**		
People Using Safely Managed Sanitation Services (% of Population)	Population Using Improved Water Sources (%))	Ambient Air Pollution, Concentration of Fine Particulate Matter (PM2.5)	Ambient Air Pollution, Concentration of Fine Particulate Matter PM2.5 (Ug/M3)	Ambient and Household Air Pollution Attributable Death Rate (per 100 000 Population)	Population Growth Rate, %	Total Fertility Rate (per Woman)	Crude Birth Rate (per 1 000 People)
Demography							
Crude Death Rate (per 1 000 People)	Population Density, Number of People/km2	Age Dependency Ratio	Total Age Dependency Ratio (per 1000 of Working-Age Population)	Population Over 65 (%)	Age Dependency Ratio, Old	Urban Population (% of Total)	Senior Poverty Ratio
Demography							
Murder rates 2016 per 100 000 population							

The third level of metrics includes open data ratios mostly provided by WHO, OECD, The World Bank and Governmental institutions of each country, that are subsequently used for countries comparison and advanced calculations of growth rates of ratios and effectiveness ratios.

Metrics Structure. 4th Level

4. Growth Rates				
Life Expectancy and HALE				
Both Sexes Life Expectancy, CAGR (6 years)	Male Life Expectancy, CAGR (6 years)	Female Life Expectancy, CAGR (6 years)	Both Sexes HALE CAGR (6 Years)	Male HALE CAGR (6 Years)
Life Expectancy and HALE				**Other**
Female HALE CAGR (6 Years)	Both Sexes HALE and Life Expectancy Difference, CAGR (6 Years)	Male HALE and Life Expectancy Difference, CAGR (6 Years)	Female HALE and Life Expectancy Difference, CAGR (6 Years)	Human Development Index Score, CAGR (6 Years)

The fourth level of metrics is based on the first two levels and mostly represent the average percentage changes of metrics of a certain country.

Growth rates refer to the percentage change of a specific variable within a 6 year period. A compound annual growth rate (CAGR) is used to measure country's performance in a certain area. Its calculation assumes that growth is steady over a specified period of time. CAGR is a widely used metric due to its simplicity and flexibility to forecast further growth.

Both sexes life expectancy growth rate, for example, is derived as the average annual rate of change at which a country's life expectancy increases or decreases. This rate of growth is used to measure country's overall changes in mortality level of a population.

Metrics Structure. 5th and 6th Level

5. Growth Rates of Ratios					
Economy			**Healthcare Expenditure**		
GDP (per Capita), CAGR (6 Years)	Adjusted Savings: Net National Savings (% of GNI), CAGR (6 Years)	Income Gini Coefficient, CAGR (6 Years)	Current Health Expenditure per Capita (Current US$), CAGR (6 Years)	Public Health Care Expenditure (as % of GDP), CAGR (6 Years)	Domestic Private Health Expenditure (% of Current Health Expenditure), CAGR (6 Years)
Healthcare Expenditure	**General Health State**				**Environment**
Out-of-Pocket Expenditure (% of Current Health Expenditure), CAGR (6 Years)	Population of Adults with AIDs (%), CAGR (6 Years)	Alcohol Consumption (per Capita), CAGR (6 Years)	Prevalence of Overweight among Adults, BMI ≥ 25 (Age-Standardized Estimate) (%), CAGR (6 Years)	Prevalence of Undernourishment (% of Population), CAGR (6 Years)	Ambient Air Pollution, Concentration of Fine Particulate Matter (PM2.5), CAGR (6 Years)

6. Effectiveness Ratios			
HALE CAGR (6 Years)/Current Health Expenditures per Capita (Current US$), CAGR (6 Years)	HALE and Life Expectancy Difference CAGR (6 Years)/Current Health Expenditures per Capita (Current US$), CAGR (6 Years)	HALE CAGR (6 Years)/GDP per Capita CAGR (6 Years)	HALE CAGR (6 Years)/Prevalence of Overweight among Adults, BMI ≥ 25 CAGR (6 Years)

The fifth and sixth levels are also based on the previous levels and are the main indicators of a country's position in the analysis of Healthy Longevity.

Methodology for Absolute Values: General Health Status

HALE (Health-Adjusted life expectancy) refers specifically to the healthy number of years someone is expected to live at birth, which equals their life expectancy minus the number of years expected to be lived in a state of illness or disability as opposed to life expectancy at birth that is defined as how long, on average, a newborn can expect to live, if current death rates do not change. It takes into account both fatal and nonfatal outcomes and has a summary measure of population health. An important measure for HALE is disease prevalence, which is a combination of the number of people living with the disease and the overall impact of the severity of this disease on the affected people. Therefore, HALE is a more useful and revealing metric compared with average life expectancy.

The following metrics were used in this report:

Metric definition	Calculation
Both Sexes HALE - an indicator of both sexes healthy life expectancy.	An absolute value that is derived from sourcing the data.
Male HALE - an indicator of men healthy life expectancy.	An absolute value that is derived from sourcing the data.
Female HALE - an indicator of female healthy life expectancy.	An absolute value that is derived from sourcing the data.

To be regarded as a country with high HALE, it should have the maximum possible values in all three aforementioned metrics, i.e. HALE must be equal or tend to the largest possible number. HALE is measured in years, and the greater is the metric value, the longer is expected health-adjusted life duration in the country.

The source for all the data for the analysis is WHO Life tables.

Methodology for Absolute Values: General Health Status

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Life expectancy could be considered as one of the most important measures of health. It is readily comparable across countries and indicates how well a government is doing in terms of healthcare improvements. It reflects the mortality level and pattern that prevails across different age groups of population - children, adolescents, adults, and elderly people.

For the report, the following metrics were used:

Metric definition	Calculation
Both sexes Life Expectancy - is a statistical measure of the average time a person is expected to live, based on the year of its birth, its current age and other demographic factors.	An absolute value that is derived from sourcing the data.
Male Life Expectancy - is a statistical measure of the average time men are expected to live.	An absolute value that is derived from sourcing the data.
Female Life Expectancy - is a statistical measure of the average time women are expected to live.	An absolute value that is derived from sourcing the data.

To be regarded as a country with high Life Expectancy, it should have the maximum possible values in all three aforementioned metrics, i.e. life expectancy must be equal or tend towards the largest possible number. Life Expectancy is measured in years, so the greater is the metric value, the longer is expected life duration in the country.

The source for all the data for the analysis is WHO Life tables.

Methodology for Absolute Values: Government Healthcare Policies

Existence of an Operational Policy that Integrates Several NCDs (Noncommunicable diseases) and Their Risk Factors defines that country has a policy, strategy or action plan which is being used and implemented, has resources and funding available to implement it, and one or more government sectors outside of health are engaged.

Existence of a physical activity program, plan for cancer and policies to reduce population salt consumption, as well as a set of time-bound national targets for NCDs (based on the 9 voluntary global targets from the WHO Global Monitoring Framework for NCDs), along with other policies, are aimed to create the conditions that ensure good health for the entire population. For the report, the following metrics were used:

Metric definition	Calculation
Existence of an Operational Policy that Integrates Several NCDs and Their Risk Factors	Existence or non-existence of an Operational, Policy that Integrates Several NCDs and Their Risk Factors.
Existence of a Set of Time-Bound National Targets Based on WHO Guidance for NCDs	Existence or non-existence of a Set of Time-Bound National Targets Based on WHO Guidance for NCDs.
Existence of any Policies to Reduce Population Salt Consumption	Existence or non-existence of any Policies to Reduce Population Salt Consumption.
Implementation of Physical Activity Public Awareness Program	Existence or non-existence of Physical Activity Public Awareness Program.
Existence of Operational Policy/Strategy/Action Plan for Cancer	Existence or non-existence of Operational Policy/Strategy/Action Plan for Cancer.

If the country has an operational policy, strategy, action plan or program from listed metrics, the metric takes on a value of 1, and if the aforementioned operational policy, strategy, action plan or program is not used and implemented, the metric takes on a value of 0. The source for all the data for the analysis is WHO Life tables.

Methodology for Absolute Values: Government Healthcare Policies

The main objective of national health policy is to provide them access to quality healthcare with optimal conditions for the entire population of the country. Proposed metrics indicate whether the country has an operational policy, strategy, or action plan for cardiovascular and chronic respiratory diseases, diabetes, tobacco use, and physical inactivity reduction.

For the report, the following metrics were used:

Metric definition	Calculation
Existence of Operational Policy/Strategy/Action Plan for Cardiovascular Diseases	Existence or non-existence of Operational Policy/Strategy/Action Plan for Cardiovascular Diseases.
Existence of Operational Policy/Strategy/Action Plan for Diabetes	Existence or non-existence of Operational Policy/Strategy/Action Plan for Diabetes.
Existence of Operational Policy/Strategy/Action Plan for Chronic Respiratory Diseases	Existence or non-existence of Operational Policy/Strategy/Action Plan for Chronic Respiratory Diseases.
Existence of Operational Policy/Strategy/Action Plan to Decrease Tobacco Use	Existence or non-existence of Operational Policy/Strategy/Action Plan to Decrease Tobacco Use.
Existence of Operational Policy/Strategy/Action Plan to Reduce Physical Inactivity	Existence or non-existence of Operational Policy/Strategy/Action Plan to Reduce Physical Inactivity.

If the country has an operational policy, strategy, action plan or program from listed metrics, the metric takes on a value of 1, and if the aforementioned operational policy, strategy, action plan or program is not used and implemented, the metric takes on a value of 0. The source for all the data for the analysis is WHO Life tables.

Methodology for Absolute Values: Government Healthcare Policies

The main objective of national health policy is to provide them access to quality healthcare with optimal conditions for the entire population of the country. Proposed metrics indicate whether the country has an operational policy, strategy, or action plan to reduce the harmful use of alcohol and unhealthy diet-related to NCDs, and plan for oral health. It is also important to determine the presence of stand-alone law and policy for mental health, as mental disorders take place among the leading causes of ill-health and disability worldwide.

For the report, the following metrics were used:

Metric definition	Calculation
Existence of Operational Policy/Strategy/Action Plan to Reduce the Harmful Use of Alcohol	Existence or non-existence of Operational Policy/Strategy/Action Plan to Reduce the Harmful Use of Alcohol.
Existence of Operational Policy/Strategy/Action Plan to Reduce Unhealthy Diet Related to NCDs	Existence or non-existence of Operational Policy/Strategy/Action Plan to Reduce Unhealthy Diet Related to NCDs.
Existence of Operational Policy/Strategy/Action Plan for Oral Health	Existence or non-existence of Operational Policy/Strategy/Action Plan for Oral Health.
Stand-Alone Law for Mental Health	Existence or non-existence of Stand-Alone Law for Mental Health.
Stand-Alone Policy or Plan for Mental Health	Existence or non-existence of Stand-Alone Policy or Plan for Mental Health.

If the country has an operational policy, strategy, action plan or program from listed metrics, the metric takes on a value of 1, and if the aforementioned operational policy, strategy, action plan or program is not used and implemented, the metric takes on a value of 0. The source for all the data for the analysis is WHO Life tables.

Methodology for Absolute Values: Retirement and Ageing

Retirement is defined when a person chooses to leave the workforce. Many people choose to retire when they are eligible for private or public pension benefits, although some are forced to retire when bodily conditions no longer allow the person to work any longer (by illness or accident) or as a result of legislation concerning their position.

Age-friendly cities/communities indicate whether cities and communities adapt their structures and services to the needs of older people. For the report, the following metrics were used:

Metric definition	Calculation
Number of WHO Age-Friendly Cities/Communities	Based on own research
Early retirement age Women - an indicator of female early pension withdrawal before age 60 that is possible in occupational and private pension plans.	An absolute value that is derived from sourcing the data.
Early retirement age Men - an indicator of male early pension withdrawal before age 60 that is possible in occupational and private pension plans.	An absolute value that is derived from sourcing the data.
Normal retirement age Women - an indicator of females the lowest normal statutory pension age.	An absolute value that is derived from sourcing the data.
Normal retirement age Men - an indicator of males the lowest normal statutory pension age.	An absolute value that is derived from sourcing the data.

To be regarded as a country with high Retirement, it should have the maximum possible values in a total number of retired. Countries with a high number of WHO age-friendly cities/communities have a metric value that tends towards the largest possible number.

The source for all the data for the analysis is WHO Life tables, World Bank, National Bureaus of Statistics.

Methodology for Absolute Values: Demography

Demography is an important part of public policy analysis and development. Furthermore, it can provide explanations of observed economic and social trends in the country. An increase in the number of people of retirement age (65+) in the total number of the country's population will lead to an increase in the burden on those of working age to cover expenses for social expenditure that provide comfortable conditions for the elderly.

Net migration is the difference between immigration into and emigration from the area during the year. If the number of emigrants exceeds the number of immigrants, it can cause problems relating to unemployment and, in some areas, a reduction or glut in a particular labor force.

For the report, the following metrics were used:

Metric definition	Calculation
Total population	An absolute value that is derived from sourcing the data.
Population 65+	An absolute value that is derived from sourcing the data.
Net migration	An absolute value that is derived from sourcing the data.

The total population is an absolute value that describes the total amount of people living in a specific country, the larger is value, the more people are living in the country. Population 65+ metric defines the elderly population in a country. Net migration value is positive when the number of immigrants exceeds the number of emigrants.

The source for all the data for the analysis is WHO Life tables, The World Bank, National Bureaus of Statistics.

Methodology for Meteorological Analysis: Temperature Conditions

Temperature conditions are major indicators of weather patterns and are one of the most well-known rates to the general public. Furthermore, diurnal temperature variation or diurnal temperature range (DTR) is a well-known risk factor of weather-related human health. Numerous studies have described a positive association between DTR and mortality (Caoet al. 2009; Limet al. 2015; Tamet al. 2009; Vutcoviciet al. 2014; Yanget al. 2013a), and have reported that people who are elderly, less educated, female or have cardiovascular or respiratory disease are more susceptible to DTR than others (Kan et al. 2007b; Lim et al. 2012a; Yang et al. 2013b).

For the report, the following metrics were used:

Metric definition	Formula
Diurnal Temperature Variation, °C is the difference between the daily maximum and minimum temperature.	$(1/n \sum_{i=1}^{n}(T_{max\,i} - T_{min\,i})*P_i + 1/n \sum_{j=1}^{n}(T_{max\,j} - T_{min\,j})*P_j + 1/n \sum_{k=1}^{n}(T_{max\,k} - T_{min\,k})*P_k + 1/n \sum_{l=1}^{n}(T_{max\,l} - T_{min\,l})*P_l)/(P_i + P_j + P_k + P_l)$, where i-l stand for the respective weather station, P_i-P_l stand for 2016 population value of the city weather station is situated in, $T_{max\,i}$ is monthly mean maximum temperature observed at the respective weather station, $T_{min\,i}$ is monthly mean minimum temperature observed at the respective weather station.
Daily Mean Air Temperature, °C is daily average air temperature value.	$(1/n \sum_{i=1}^{n}T_i*P_i + 1/n \sum_{j=1}^{n}T_j*P_j + 1/n \sum_{k=1}^{n}T_k*P_k + 1/n \sum_{l=1}^{n}(T_l*P_l)/(P_i + P_j + P_k + P_l)$, where i-l stand for the respective weather station, P_i-P_l stand for 2016 population value of the city weather station is situated in, T_i is monthly mean temperature observed at the respective weather station.

There are no definite "best" values, but scientific evidence suggests that for the country to have a comfortable temperature condition, Diurnal Temperature Variation should have the least possible value, Daily Mean Air Temperature should have the value close to 15°C. The source for all the data for the analysis is Ogimet, RP5.

Methodology for Meteorological Analysis: Solar Radiation

Sunlight, an essential prerequisite for life, may be extremely dangerous to human health. Excessive exposure to the sun is known to be associated with increased risks of various skin cancers, cataracts, and other eye diseases, as well as accelerated skin ageing. It may also adversely affect people's ability to resist infectious diseases and compromise the effectiveness of vaccination programmes. Within the Bureau of Meteorology network, bright sunshine has generally been recorded with a Campbell-Stokes recorder. This device only measures the duration of "bright" sunshine, which is less than the amount of "visible" sunshine. For example, sunshine immediately after sunrise and just before sunset is visible, but would not be bright enough to register on the Campbell-Stokes recorder.

For the report, the following metrics were used:

Metric definition	Formula
Sunshine Hours, Mean Monthly Number of Hours is an average number of hours of bright sunshine each month in a calendar year. Hours of bright sunshine is measured from midnight to midnight.	$(^{1}/n \sum_{i=1}^{n} H_i * P_i + ^{1}/n \sum_{j=1}^{n} H_j * P_j + ^{1}/n \sum_{k=1}^{n} H_k * P_k + ^{1}/n \sum_{l=1}^{n} H_l * P_l)/(P_i + P_j + P_k + P_l)$, where i-l stand for the respective weather station, P_i-P_l stand for 2016 population value of the city weather station is situated in, H_i is monthly mean number of sunshine hours observed at the respective weather station.

There are no definite "best" values, but scientific evidence suggests that for the country to have comfortable levels of solar radiation, Sunshine Hours, Mean Monthly Number of Hours should not have extreme values, i.e. the function should avoid its maximum and minimum values.

The source for all the data for the analysis is Ogimet, RP5.

Methodology for Meteorological Analysis: Humidity

Humidity affects human health in various ways. Humid conditions disrupt the human body temperature regulation system: the sweat evaporates more slowly, making it hard for our bodies to cool off, so they get more stressed and over-exercised. When combined with high temperatures, high humidity levels can cause several symptoms including dehydration, muscle cramps, fatigue, heat exhaustion, fainting, and heatstroke.

For the report, the following metrics were used:

Metric definition	Formula
Relative Humidity, % is a measure of the actual amount of water vapor in the air compared to the total amount of vapor that can exist in the air at its current temperature.	$(1/n \sum_{i=1}^{n} RH_i * P_i + 1/n \sum_{j=1}^{n} RH_j * P_j + 1/n \sum_{k=1}^{n} RH_k * P_k + 1/n \sum_{l=1}^{n} RH_l * P_l)/(P_i + P_j + P_k + P_l)$, where i-l stand for the respective weather station, P_i-P_l stand for 2016 population value of the city weather station is situated in, RH_i is monthly mean relative humidity value observed at the respective weather station.
Dew Point, °C provides a measure of the actual amount of water vapor in the air, is the temperature to which the air must be cooled for air to be saturated.	$(1/n \sum_{i=1}^{n} T_{di} * P_i + 1/n \sum_{j=1}^{n} T_{dj} * P_j + 1/n \sum_{k=1}^{n} T_{dk} * P_k + 1/n \sum_{l=1}^{n} T_{dl} * P_l)/(P_i + P_j + P_k + P_l)$, where i-l stand for the respective weather station, P_i-P_l stand for 2016 population value of the city weather station is situated in, T_{di} is monthly mean dew point value observed at the respective weather station.

There are no definite best values, but scientific evidence suggests that for the country to have comfortable levels of humidity, Relative Humidity and Dew Point should not have extreme values, i.e. the function should avoid its maximum and minimum values.

The source for all the data for the analysis is Ogimet, RP5.

Methodology for Indexes: Healthcare

Healthcare efficiency measures whether healthcare resources are being used to get the best value for money, where the value of healthcare is as a means to improve health. Efficiency is concerned with the relation between resource inputs (costs, in the form of labor, capital, or equipment) and either intermediate outputs (numbers treated, waiting time, etc) or final health outcomes (lives saved, life years gained, quality-adjusted life-years (QALYs)).

The HAQ Index encompasses 32 causes of death considered to be avoidable provided that quality healthcare is available. The general trend shows that country index values improved in nearly all countries compared to 1990.

For the report, the following metrics were used:

Metric definition	Calculation
Healthcare Efficiency Index	A weighted average of Life Expectancy, Relative Healthcare Cost, Absolute Healthcare Cost.
HAQ (The Healthcare Access and Quality Index)	Based on 32 causes from which death should not occur in the presence of effective care to approximate personal health-care access.

To be regarded as a country with high Healthcare, two aforementioned metrics should have the largest possible value, i.e. Health-Efficiency Index and Global Healthcare Access and Quality Index should be equal to the largest possible number on the scale of 0 to 100, with 0 as the first percentile (worst) and 100 as the best. It would indicate that the country's healthcare system is not just of high quality but affordable and cost-effective as well.

The source for all the data for the analysis is Bloomberg, The Lancet.

Methodology for Indexes: Melbourne Mercer Global Pension Index

The Melbourne Mercer Global Pension Index (MMGPI) compares retirement income systems around the world based on their adequacy, sustainability, and integrity. The provision of financial security in retirement is critical for both individuals and societies as countries grapple with the social and economic effects of aging populations. The Index provides a valuable contribution to the global debate about how best to support older members of our societies. It is encouraging to see governments responding to their Index ranking as they develop their national schemes.

For the report, the following metrics were used:

Metric definition	Formula
Overall Value Index	A weighted average of Sustainability, Adequacy, Integrity sub-indexes.
Sustainability - considers a number of indicators which influence the long-term sustainability of current retirement income systems.	Based on the economic importance of the private pension system, its level of funding, the length of expected retirement both now and in the future, etc.
Adequacy - considers the benefits provided to the poor and the average-income earner as well as several design features and characteristics which enhance the efficacy of the overall retirement income system.	Based on the net household saving rate, the level of household debt and the homeownership rate are also included as non-pension savings represent an important source of financial security during retirement.
Integrity - defines the requirements that apply to the funded pension plans which normally exist in the private sector.	Based on three broad areas of the pension system, namely regulation and governance, protection and communication for members, and costs.

Melbourne Mercer Global Pension Index in all four aforementioned metrics has a range of values of 0-100. The source for all the data for the analysis is the Australian Centre for Financial Studies.

Methodology for Indexes: Retirement

Retirement is when a person chooses to leave the workforce. The concept of full retirement as an ability to permanently leave the workforce later in life is relatively new, and for the most part, only culturally widespread in first-world countries. Dramatic advances in healthcare have extended the lives of people in predominantly first-world and developed countries. That means that an increasing number of people are going to become retirees, which will pose a significant burden on the government and the workforce.

For the report, the following metrics were used:

Metric definition	Formula
Global Retirement Index (%)	Based on Health, Material well-being, Quality of life/environment, and Finances in retirement.
Global AgeWatch Index	Based on Income security, Health status, Capability, and Enabling environment .

Global Retirement Index and the Global AgeWatch Index are indicating a good state of retirement in the country when two aforementioned metrics are equal or tend towards the largest possible number on the scale of 0 to 100.

Global Retirement Index value of 0 means that the state of retirement in the country is the lowest possible, and 100 means that the state of retirement in the country is the largest possible. The bigger is the Global AgeWatch Index value, the better the fare older people have in the country.

The source for all the data for the analysis is Naxitis, Global AgeWatch Index.

Methodology for Indexes: Society

The Human Development Index (HDI) is a summary measure of average achievement in key aspects of human development: a long and healthy life, being knowledgeable and have a decent standard of living. Well-being, population development level, and capabilities should be the ultimate criteria for assessing the development of a country. For the report, the following metrics were used:

Metric definition	Formula
Education Index	Based on Mean Years of Schooling and Expected Years of Schooling.
Democracy Index	Based on the Electoral Process and Pluralism, Civil Liberties, the Functioning of Government, Political Participation, and Political Culture.
Human Development Index (HDI)	Based on Life expectancy at birth, Expected Years of Schooling and Mean Years of Schooling, and GNI (Gross national income) per capita (PPP $).
Global Gender Gap Index	Based on Economic Participation and Opportunity, Educational Attainment, Health and Survival, and Political Empowerment.
Corruption Perceptions Index 2016	Based on data from 13 different sources, which is rescaled and averaged

Society indexes are indicating a healthy state of society in the country when two aforementioned metrics are equal or tend towards the largest possible number. Education Index, Human Development Index, and the Global Gender Gap Index have a range of values of 0 to 1. Democracy Index has a range of values of 0 to 10.

Methodology for Indexes: International Health Regulations (2005) Monitoring Framework

International Health Regulations (2005) Monitoring Framework use listed metrics to detect, assess, and respond to public health events in the country and international levels. For each capacity, one to three indicators is used to measure the country's progress towards fully developed and functional IHR capacities.

For the report, the following metrics were used:

Metric definition	Formula
Legislation	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 1: National legislation, policy, and financing.
Coordination	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 2: Coordination and NFP Communication.
Surveillance	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 3: Surveillance.
Response	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 4: Response.

Methodology for Indexes: International Health Regulations (2005) Monitoring Framework

International Health Regulations (2005) Monitoring Framework use listed metrics to detect, assess, and respond to public health events in the country and international levels. For each capacity, one to three indicators is used to measure the country's progress towards fully developed and functional IHR capacities.

For the report, the following metrics were used:

Metric definition	Formula
Preparedness	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 5: Preparedness.
Risk Communication	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 6: Risk communication.
Human Resources	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 7: Human resources.
Laboratory	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Core Capacity 8: Laboratory.
Points of Entry	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of Points of Entry.

Methodology for Indexes: International Health Regulations (2005) Monitoring Framework

International Health Regulations (2005) Monitoring Framework use listed metrics to detect, assess, and respond to public health events in the country and international levels. For each capacity, one to three indicators is used to measure the country's progress towards fully developed and functional IHR capacities.

For the report, the following metrics were used:

Metric definition	Formula
Zoonosis	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of IHR Potential hazards 1: Zoonotic events.
Food Safety	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of IHR Potential hazards 2: Food safety.
Chemical	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of IHR Potential hazards 3: Chemical events.
Radionuclear	Based on the proportion/percentage of a set of specific elements or functions which reflect the level of performance or achievement of IHR Potential hazards 4: Radionuclear emergencies.

To be regarded as a country with high International Health Regulations (2005) Monitoring Framework Indexes, value of the aforementioned metrics should be equal or tend to the largest possible number on the scale of 0 to 100.

The source for all the data for the analysis is WHO Life tables, World Bank.

Methodology for Indexes: Economy

The **Inclusive Development Index** (IDI) was submitted in 2017 as part of the World Economic Forum's System Initiative. It is a new, annual economic index that recognize broad-based and sustained progress in living standards as the key measure for national economic performance, rather than GDP growth alone. A comparison between a country's IDI and GDP rank reveals to what extent economic growth has been inclusive, meaning it is distributed fairly across society and creates opportunities for all. The **Consumer Price Index** (CPI) is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation, food, and medical care. CPI is one of the most common indexes which is used to identify inflation and deflation processes in the country.

For the report, the following metrics were used:

Metric definition	Formula
Inclusive Development Index	Based on Growth and Development, Inclusion, Intergenerational Equity, and Sustainability.
Global Competitiveness Index	Based on 12 pillars of competitiveness, which are grouped into the Basic requirements subindex, Efficiency enhancers subindex, Innovation, and Sophistication factors subindex.
Consumer Price Index	(Cost of Market Basket in Given Year/Cost of Market Basket in Base Year)* 100

Inclusive Development Index and Global Development Index scores are limited to a scale of 1 to 7, and 1 means the country has the lowest index score, and 7 is the largest score the country can get.

The source for all the data for the analysis is the National Bureaus of Statistics, WEF.

Methodology for Ratios: Mental Health

Mental health includes emotional, psychological, and social well-being. According to the World Health Organization (WHO), mental health includes "subjective well-being, perceived self-efficacy, autonomy, competence, intergenerational dependence, and self-actualization of one's intellectual and emotional potential, among others."

The WHO further states that the well-being of an individual is encompassed in the realization of their abilities, coping with normal stresses of life, productive work, and contribution to their community. Cultural differences, subjective assessments, and competing professional theories all affect how one defines mental health.

The following Mental Health metrics were used in this report:

Metric definition	Formula
Mental Hospitals (per 100 000 Population)	(Number of Mental Hospitals*Total population) 100 000 population
Mental Health Units in General Hospitals (per 100 000 Population)	(Number of Mental Health Units in General Hospitals*Total population)/100 000 population
Mental Health Outpatient Facilities (per 100 000 Population)	(Number of Mental Health Outpatient Facilities*Total population)/100 000 population

To be regarded as a country with high Mental Health ratios, it should have the maximum values in all aforementioned metrics, e.g. amount of mental hospitals, mental health units in general hospitals and mental health outpatient facilities per 100 000 population should tend towards the largest possible number.

The source for all the data for the analysis is WHO Life tables.

Methodology for Indexes: Immunization

For the report, the following metrics were used:

Metric definition	Formula
Measles-Containing-Vaccine Second-Dose (MCV2) Immunization Coverage by the Recommended Age (%)	Number of people who have received the second dose of Measles-Containing-Vaccine/ Population (total number)
Neonates Protected at Birth against Neonatal Tetanus (%) - the proportion of neonates in a given year that can be considered as having been protected against tetanus as a result of maternal immunization.	Number of neonates that can be considered as having been protected against tetanus as a result of maternal immunization/ Total number of neonates
Pneumococcal Conjugate Vaccines (PCV3) Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received three doses of pneumococcal conjugate vaccine (PCV3) in a given year.	Number of one-year-olds who have received three doses of pneumococcal conjugate vaccine/ Population aged under 12 months
Polio (Pol3) Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received three doses of polio vaccine in a given year.	Number of one-year-olds who have received three doses of polio vaccine/ Population aged under 12 months
Rotavirus Vaccines Completed Dose (RotaC) Immunization Coverage among 1-Year-Olds (%) - the percentage of surviving infants who received the final recommended dose of rotavirus vaccine, which can be either the 2nd or the 3rd dose depending on the vaccine in a given year.	Number of surviving infants who received the final recommended dose of rotavirus vaccine/ Total number of surviving infants

To be regarded as a country with high Immunization, it should have the maximum possible values in all ten aforementioned metrics, i.e. percentile must be equal or tend to the greatest value of 100%. The source for all the data for the analysis is WHO.

Methodology for Indexes: Healthcare

Immunization is a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to avert 2-3 million deaths each year. It is one of the most cost-effective health investments, with proven strategies that make it accessible to even the most hard-to-reach and vulnerable populations. For the report, the following metrics were used:

Metric definition	Formula
BCG Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received 1 dose of bacilli Calmette-Guérin (BCG) vaccine in a given year.	Number of one-year-olds who have received one dose of bacilli Calmette-Guérin/ Population aged under 12 months
Diphtheria Tetanus Toxoid and Pertussis (DTP3) Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received 3 doses of the combined DTP vaccine in a given year.	Number of one-year-olds who have received three doses of the combined diphtheria, tetanus toxoid and pertussis vaccine/ Population aged under 12 months
Hepatitis B (HepB3) Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received 3 doses of hepatitis B vaccine in a given year.	Number of one-year-olds who have received three doses of hepatitis B vaccine/ Population aged under 12 months
Hib (Hib3) Immunization Coverage among 1-Year-Olds (%) - the percentage of one-year-olds who have received 3 doses of Haemophilus influenzae type B vaccine in a given year.	Number of one-year-olds who have received three doses of Haemophilus influenzae type B vaccine/ Population aged under 12 months
Measles-Containing-Vaccine First-Dose (MCV1) Immunization Coverage among 1-Year-Olds (%) - the percentage of children under one year of age who have received at least one dose of measles-containing vaccine in a given year.	Number of one-year-olds who have received at least one dose of measles-containing vaccine/ Population aged under 12 months

Methodology for Indexes: Economy

The impacts of the economy are measured using the following key indicators: gross domestic product (GDP), worker headcount in the employment pool, and wages and salaries earned workers as a result of the spending of those aged 50 years or older. Therefore, for the report, there were used the following metrics:

Metric definition	Formula
GDP per Capita (Current US$)	GDP, Current Prices 2016 value/Population (total number)
Adjusted Savings: Net National Savings (% of GNI)	Net savings volume/Gross national income
Unemployment Rate, %	Number of unemployed people/Population (total number)
Net ODA Received (% of GNI)	Net official development assistance volume/Gross national income
% of People 65+ in Employment	Number of employed people of the age group/ Population aged over 65 years
Income Gini Coefficient	$$G = 1 - 2\sum_{i=1}^{n} x_i cumy_i + \sum_{i=1}^{n} x_i y_i$$ X_i - share of the group in the population; Y_i - group share in revenue.

To be regarded as a country with high Economy ratios, GDP per capita and Adjusted savings should tend towards the largest possible value. Net ODA and Unemployment rate should tend towards the lowest possible value. Gini Coefficient should be as close to 0 as possible. The source for all the data for the analysis is WHO, National National Bureaus of Statistics and World Bank.

Methodology for Ratios: Healthcare

Health spending measures the final consumption of health care goods and services (i.e. current health expenditure) including personal health care (curative care, rehabilitative care, long-term care, ancillary services, and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. The following ratio metrics were used in this report:

Metric definition	Formula
Current Health Expenditure per Capita (Current US$)	Total health expenditure in US$/Total number of population
Public Health Care Expenditure (as % of GDP)	Total Public Health Care Expenditure/GDP
Domestic Private Health Expenditure (% of Current Health Expenditure)	Total Domestic Private Health Expenditure/Total health expenditure in US$
Out-of-Pocket Expenditure (% of Current Health Expenditure)	Out-of-Pocket payments volume/Total health expenditure in US$
Risk of Catastrophic Expenditure for Surgical Care (% of People at Risk)	The proportion of population at risk of catastrophic expenditure (direct out of pocket payments for surgical and anaesthesia care exceeding 10% of total income) when surgical care is required.
Medical Equipment (per 1.000.000 People)	Number of medical devices/1 000 000 population
Biomedical Engineers Density (per 10 000 Population)	Number of biomedical engineers (holding the corresponding university degree) and biomedical technicians/10 000 population

To be regarded as a country with high Healthcare ratios, all aforementioned metrics (besides out-of-pocket expenditures and risks of catastrophic expenditure for surgical care) should have the largest possible values.

Methodology for Ratios: General Healthcare Status

The prevalence of HIV refers to the percentage of people aged 15-49 who are infected with HIV. HIV prevalence rates reflect the rate of HIV infection in each country's population.

Low national prevalence rates can be misleading, however. They often disguise epidemics that are initially concentrated in certain localities or population groups and threaten to spill over into the wider population. In many developing countries most new infections occur in young adults, with young women especially vulnerable. Tobacco use causes significant economic damage, which, in particular, is expressed in the form of significant health care costs associated with the treatment of diseases caused by tobacco use, as well as in the loss of human capital due to tobacco morbidity and mortality. The following ratio metrics were used in this report:

Metric definition	Formula
Population of Adults with AIDs (% of total) - percentage of population ages 15-49 with HIV .	N/(defined population)*100%, where N - the number of adults with AIDs.
Alcohol Consumption per Capita (litres of pure alcohol) - litres of pure Alcohol are consumed by one person per year.	Total (sum of recorded and unrecorded alcohol, over a calendar year) amount of alcohol / Population 15 and over years old, adjusted for tourist consumption.
Annual Cigarette Consumption (per Capita) - the number of cigarettes that a person consumes per year.	Total (sum of legally-sold machine-made and roll-your-own, over a calendar year) amount of cigarettes/ Population 15 and over years old.

To be regarded as a country with high General Healthcare status basing on population of adults with AIDs, alcohol and cigarette consumption, three aforementioned metrics should have the lowest possible value.

Methodology for Ratios: General Healthcare Status

One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population. Using DALYs, the burden of diseases that cause premature death but little disability (such as drowning or measles) can be compared to that of diseases that do not cause death but do cause disability (such as cataract causing blindness).

Incidence of tuberculosis is the estimated number of new and relapse tuberculosis cases arising in a given year, expressed as the rate per 100,000 population. All forms of TB are included, including cases in people living with HIV. For the report, the following metrics were used:

Metric definition	Formula
Disability-adjusted life years (DALY) Rates per 100 000 Population - years of healthy life lost to premature death and disability per 100 000 Population (2016 - WHO).	(YLL + YLD)/100 000 Population where YLLs - years of life lost due to premature mortality, years of healthy life lost due to disability (YLDs) .
Incidence of tuberculosis (per 100,000 people) - new cases per 100 000 population per year.	N/100 000 Population, where N - the number of new cases.

To be regarded as a country with high General Healthcare status basing on DALY and Incidence of tuberculosis data, both aforementioned metrics should have the lowest possible value. The source for all the data for the analysis is WHO and World Data Bank.

Methodology for Ratios: General Healthcare Status

Underweight, overweight, and obesity in childhood and adolescence are associated with adverse health consequences throughout the life-course. The given data helps to estimate worldwide trends in mean body-mass index (BMI) and a comprehensive set of BMI categories that cover underweight to obesity in children and adolescents and to compare trends with those of adults.

Population below minimum level of dietary energy consumption (also referred to as the prevalence of undernourishment) shows the percentage of the population whose food intake is insufficient to meet dietary energy requirements continuously. Prevalence of insufficient physical activity among adults aged 18+ years is a percent of defined population attaining less than 150 minutes of moderate-intensity physical activity per week, or less than 75 minutes of vigorous-intensity physical activity per week, or equivalent. Therefore, for the report, there were used the following metrics:

Metric definition	Formula
Prevalence of overweight among adults, BMI ≥ 25, percentage of defined population with a body mass index (BMI) of 25 kg/m2 or higher.	N/(defined population)*100%, where N - the number of adults with a body mass index (BMI) of 25 kg/m2 or higher.
Prevalence of undernourishment (% of population), population (in percentage) below minimum level of dietary energy consumption.	N/(defined population)*100%, where N - the number of persons below minimum level of dietary energy consumption.
Prevalence of insufficient physical activity among adults aged 18+ years (age-standardized estimate).	N/(defined population)*100%, Where N- the number of adults attaining less than 150 minutes of moderate-intensity physical activity per week.

To be regarded as a country with high General Healthcare status basing on the prevalence of overweight among adults, undernourishment, and insufficient physical activity among adults, three aforementioned metrics should have the lowest possible value. The source for all the data for the analysis is WHO and World Data Bank.

Methodology for Ratios: Environment and Infrastructure

Global access to safe water and proper hygiene education can reduce illness and death from disease, leading to improved health, poverty reduction, and socio-economic development. However, many countries are challenged to provide these necessities to their populations, leaving people at risk for water, sanitation, and hygiene (WASH)-related diseases.

Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines: ventilated improved pit latrines, composting toilets or pit latrines with slabs. Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. Inadequate sanitation is a major cause of disease worldwide, and improving sanitation is known to have a significant beneficial impact on people's health. Basic and safely managed sanitation services can reduce diarrheal disease, and can significantly lessen the adverse health impacts of other disorders responsible for death and disease among millions of children.

For the report, the following metrics were used:

Metric definition	Formula
Population using improved water sources (%) - percentage of the country population that uses improved water sources.	N/(country Population)*100%, Where N - the number of persons that uses improved water sources.
People using safely managed sanitation services (% of population)	N/(country Population)*100%, Where N - the number of persons that uses managed sanitation services.

To be regarded as a country with wide access to Improved water sources and Safely managed sanitation services, both aforementioned metrics should have the largest possible value.

The source for all the data for the analysis is World Data Bank.

Methodology for Ratios: Environment and Infrastructure

Ambient air pollution results from emissions from industrial activity, households, cars, and trucks which are complex mixtures of air pollutants, many of which are harmful to health. Of all of these pollutants, fine particulate matter has the greatest effect on human health. The majority of the burden is borne by the populations in low and middle-income countries.

Air pollution consists of many pollutants, among other particulate matter. These particles can penetrate deeply into the respiratory tract and therefore constitute a risk for health by increasing mortality from respiratory infections and diseases, lung cancer, and selected cardiovascular diseases. The mean annual concentration of fine suspended particles of less than 2.5 microns in diameters is a common measure of air pollution. The mean is a population-weighted average for the urban population in a country.

For the report, the following metrics were used:

Metric definition	Formula
Ambient and Household Air Pollution Attributable Death Rate (per 100 000 Population) - the country deaths are summed according to the region of interest and divided by the corresponding regional population.	N/100 000 Population, N - the number of deaths caused by ambient and household air pollution.
Ambient Air Pollution, Concentration of Fine Particulate Matter PM2.5 (µg/M3)	Concentration of Fine Particulate matter PM2.5 measured in 3000 cities (µg/m3)

To be regarded as a country with low air pollution, both aforementioned metrics should have the lowest possible value. The source for all the data for the analysis is WHO.

Methodology for Ratios: Demography

One of the tasks of demography is the development of a demographic policy based on the study of the laws of population reproduction. The demographic policy is a system of measures aimed at bringing the course of demographic processes as close as possible to the optimal one. Since demographic processes influence socio-economic development, in particular, economics, the task is to determine the most favorable (optimal) course of these demographic processes. The policy should influence all demographic processes, not only population changes. It is also important to assess the possible effect of certain measures, as well as their consequences.

For the report, the following metrics were used:

Metric definition	Formula
Murder rates 2016 per 100 000 population	(Amount of homicides* Total population)/100 000
Population Growth Rate, %	Ln (the end period population / the beginning period population) / the number of years in between
Total Fertility Rate (per Woman)	A measure of the fertility of an imaginary woman who passes through her reproductive life subject to all the age-specific fertility rates for ages 15–49 that were recorded for a given population in a given year.
Crude Birth Rate (per 1 000 People)	(Number of live births / Total midyear population)*1000
Crude Death Rate (per 1 000 People)	(Number of deaths / Total midyear population)*1000
Population Density, Number of People/km2	Population / Area

Methodology for Ratios: Demography

For the report, the following metrics were used:

Metric definition	Formula
Age Dependency Ratio	((Percentage of children aged under 15 years + Percentage of older population aged 65+)/ Percentage of working-age population aged 15-64 years)* 100
Total Age Dependency Ratio (per 1000 of Working-Age Population)	((Percentage of children aged under 15 years + Percentage of older population aged 65+)/ Percentage of working-age population aged 15-64 years)* 1000
Population Over 65 (%)	Population over 65 years / Population (total number)
Age Dependency Ratio, Old	(Percentage of older population aged 65+/ Percentage of working-age population aged 15-64 years)* 1000
Urban Population (% of Total)	The numbers of persons residing in an area defined as "urban"/Population (total number)
Senior Poverty Ratio	Number of senior people whose income falls below the poverty line / Total number of senior people.

To be regarded as a country with high demography ratios, the Senior poverty ratio should be as near to 0 as possible. Age dependency ratios and Crude death rates should tend towards the lowest possible value and crude birth rate - towards the largest.

Methodology for Growths Rates: Life Expectancy and HALE

Healthy life expectancy (HALE) is a form of health expectancy that applies disability weights to health states to compute the equivalent number of years of good health that a newborn can expect. It adjusts overall life expectancy by the amount of time lived in less than perfect health. This is calculated by subtracting from the life expectancy a figure which is the number of years lived with disability multiplied by weighting to represent the effect of the disability. If: A = years lived healthily, B = years lived with a disability; then A+B = life expectancy; A+fB = healthy life expectancy, where f is a weighting to reflect disability level.

For the report, the following metrics were used:

Metric definition	Formula
Both Sexes Life Expectancy, CAGR - an indicator of life expectancy average annual growth over the last 6 years.	(Life expectancy 2016 value/Life expectancy 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Male Life Expectancy, CAGR - an indicator of male life expectancy average annual growth over the last 6 years.	(Male life expectancy 2016 value/Male life expectancy 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Female Life Expectancy, CAGR - an indicator of female life expectancy average annual growth over the last 6 years.	(Female life expectancy 2016 value/Female life expectancy 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Both Sexes HALE CAGR - an indicator of healthy life expectancy average annual growth over the last 6 years. It is a more useful and revealing metric compared with life expectancy CAGR.	(HALE 2016 value/HALE 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.

Methodology for Growths Rates: Life Expectancy and HALE

Metric definition	Formula
Male HALE CAGR - an indicator of male healthy life expectancy average annual growth over the last 6 years.	(Male HALE 2016 value/Male HALE 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Female HALE CAGR - an indicator of female healthy life expectancy average annual growth over the last 6 years.	(Female HALE 2016 value/Female HALE 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Both Sexes HALE and Life Expectancy Difference, CAGR - an indicator of years of healthy life lost to disability average annual growth over the last 6 years.	((HALE 2016 value-Life expectancy 2016 value)/(HALE 2010 value-Life expectancy 2010 value))^(⅙)-1, where 6 is the number of years between the start and finish values.
Male HALE and Life Expectancy Difference, CAGR - an indicator of years of healthy male life lost to disability average annual growth over the last 6 years.	((Male HALE 2016 value-Male Life expectancy 2016 value)/(Male HALE 2010 value-Male Life expectancy 2010 value))^(⅙)-1, where 6 is the number of years between the start and finish values.
Female HALE and Life Expectancy Difference, CAGR - an indicator of years of healthy female life lost to disability average annual growth over the last 6 years.	((Female HALE 2016 value-Female Life expectancy 2016 value)/(Female HALE 2010 value-Female Life expectancy 2010 value))^(⅙)-1, where 6 is the number of years between the start and finish values.

To be regarded as a country with high life expectancy and HALE, it should have the maximum possible values in all aforementioned metrics, i.e. both sexes life expectancy, CAGR (6 years) must be greater than zero, HALE CAGR (6 years) must be equal to the greatest possible number, as it is the most important metric in the category.

The source for all the data for the analysis is WHO Life tables, National National Bureaus of Statistics.

Methodology for Growths Rates: Other

The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities.

The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.

Metric definition	Formula
Human Development Index Score, CAGR - a composite indicator of life expectancy, education, and per capita income average annual growth over the last 6 years.	(HDI 2016 value/HDI 2010 value)^($\frac{1}{6}$)-1, where 6 is the number of years between the start and finish values.

To be regarded as a country with a high Human Development Index, it should have the maximum possible value in the corresponding CAGR (>0). Countries with a high HDI value demonstrate efficient results and achievement in its social and economic dimensions.

The source for all the data for the analysis is Human Development Reports by the United Nations Development Programme.

Methodology for Growths Rates of Ratios: Economy

Gross Domestic Product (GDP) is a broad measurement of a nation's overall economic activity. GDP is the monetary value of all the finished goods and services produced within a country's borders in a specific period. GDP includes all private and public consumption, government outlays, investments, additions to private inventories, paid-in construction costs, and the foreign balance of trade. **Adjusted net saving** is a relatively new measure of economic sustainability. It monitors whether savings and investment in a country compensate for the depreciation and depletion of physical and natural capital and pollution damages. **The Gini coefficient** measures the deviation of the distribution of income among individuals or households within a country from a perfectly equal distribution. A value of 0 represents absolute equality, a value of 100 absolute inequality.

Metric definition	Formula
GDP (per Capita, Current Prices), CAGR	(GDP per capita, Current Prices 2016 value/GDP per capita, Current Prices 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Adjusted Savings: Net National Savings (% of GNI), CAGR	(Net National Savings 2016 value/Net National Savings 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.
Income Gini Coefficient, CAGR	(Income Gini Coefficient 2016 value/Income Gini Coefficient 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.

For the country to be considered as a leader in economic development, two of the above metrics (GDP and Net Savings) should have the greatest possible values, i.e. GDP per Capita, Current Prices, CAGR (6 Years) must be greater than zero, as it would indicate the growing average living standards and economic well being. Income Gini Index CAGR inversely affects the income mobility and economic development (indicator should be minimized).

Methodology for Growths Rates of Ratios: Healthcare Expenditure

Health spending measures the final consumption of health care goods and services (i.e. current health expenditure) including personal health care (curative care, rehabilitative care, long-term care, ancillary services, and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments.

Metric definition	Formula
Current Health Expenditure per Capita (Current US$), CAGR	(Healthcare Expenditure per capita 2016 value/Healthcare Expenditure per capita 2010 value)^(1/6)-1, where 6 is the number of years between the start and finish values.
Public Health Care Expenditure (as % of GDP), CAGR	(Public Health Care Expenditure 2016 value/Public Health Care Expenditure 2010 value)^(1/6)-1, where 6 is the number of years between the start and finish values.
Domestic Private Health Expenditure (% of Current Health Expenditure), CAGR	(Domestic Private Health Expenditure 2016 value/Domestic Private Health Expenditure 2010 value)^(1/6)-1, where 6 is the number of years between the start and finish values.
Out-of-Pocket Expenditure (% of Current Health Expenditure), CAGR	(Out-of-Pocket Expenditure 2016 value/Out-of-Pocket Expenditure 2010 value)^(1/6)-1, where 6 is the number of years between the start and finish values.

To be regarded as a country with high Healthcare Expenditure, all aforementioned metrics should tend towards the largest possible values. The sources for all the data for the analysis are OECD, National National Bureaus of Statistics, World Bank, WHO.

Methodology for Growths Rates of Ratios: General health State

Measures of general health status provide information on the health of a population. Tracking trends in general health status can help identify where interventions have improved the health of a population or where interventions may be needed (e.g., by exploring causative factors and preventive measures).

Metric definition	Formula
Population of Adults with AIDs (%), CAGR	(Population of Adults with AIDs 2016 value/Population of Adults with AIDs 2010 value)^($\frac{1}{6}$)-1, where 6 is the number of years between the start and finish values.
Alcohol Consumption (per Capita), CAGR	(Alcohol Consumption per Capita 2016 value/Alcohol Consumption per Capita 2010 value)^($\frac{1}{6}$)-1, where 6 is the number of years between the start and finish values.
Prevalence of Overweight among Adults, BMI ≥ 25 (Age-Standardized Estimate) (%), CAGR	(Prevalence of Overweight among Adults Index 2016 value/Prevalence of Overweight among Adults Index 2010 value)^($\frac{1}{6}$)-1, where 6 is the number of years between the start and finish values.
Prevalence of Undernourishment (% of Population), CAGR.	(Prevalence of Undernourishment 2016 value/Prevalence of Undernourishment 2010 value)^($\frac{1}{6}$)-1, where 6 is the number of years between the start and finish values.

To be considered a country that provides for the above potential negative results, the above indicators should have the lowest possible value (potentially 0).

The source of all data for analysis is the World Bank, the National Bureau of Statistics.

Methodology for Growths Rates of Ratios: Environment

Industries, households, cars, and trucks emit complex mixtures of air pollutants, many of which are harmful to health. Of all of these pollutants, fine particulate matter has the greatest effect on human health. Most fine particulate matter comes from fuel combustion, both from mobile sources such as vehicles and from stationary sources such as power plants, industry, households or biomass burning.

Air pollution is associated with a broad spectrum of acute and chronic illness, such as lung cancer, chronic obstructive pulmonary disease (COPD) and cardiovascular diseases. "By reducing particulate matter (PM) pollution from 70 to 20 micrograms per cubic metre (μg/m), we can cut air pollution-related deaths by around 15%", - WHO says. Particulate matter pollution is an environmental health problem that affects people worldwide, but low- and middle-income countries disproportionately experience this burden.

Metric definition	Formula
Ambient Air Pollution, Concentration of Fine Particulate Matter (PM2.5), CAGR	(Ambient air pollution, concentration of fine particulate matter PM2.5 (ug/m3) 2016 value/Ambient air pollution, concentration of fine particulate matter PM2.5 (ug/m3) 2010 value)^(⅙)-1, where 6 is the number of years between the start and finish values.

To be considered a country that provides for the above potential negative outcome, the indicator should have the lowest possible value (potentially 0).

The source for all the data for the analysis is WHO.

Methodology for Effectiveness Ratios

HALE (health-adjusted life expectancy) is a measure of population health that takes into account mortality and morbidity. It adjusts overall life expectancy by the amount of time lived in less than perfect health. It is calculated by subtracting from the life expectancy a figure which is the number of years lived with disability multiplied by weighting to represent the effect of the disability. The comparison of HALE CAGR to the financial indicators CAGR is crucial for understanding what value of health Expenditure is needed for the increase of Healthy Life expectancy. Also, it allows comparing the growth of these two indicators.

Metric definition	Formula
HALE CAGR/Current Health Expenditures per Capita (Current US$), CAGR	((HALE 2016 value/HALE 2010 value)^(⅙)-1) / ((Healthcare Expenditure per capita 2016 value/Healthcare Expenditure per capita 2010 value)^(⅙)-1)
HALE and Life Expectancy Difference CAGR/Current Health Expenditures per Capita (Current US$), CAGR	(((HALE 2016 value-Life expectancy 2016 value)/(HALE 2010 value-Life expectancy 2010 value))^(⅙)-1) / ((Healthcare Expenditure per capita 2016 value/Healthcare Expenditure per capita 2010 value)^(⅙)-1)
HALE CAGR/GDP per Capita CAGR.	((HALE 2016 value/HALE 2010 value)^(⅙)-1) / ((GDP per capita, Current Prices 2016 value/GDP per capita, Current Prices 2010 value)^(⅙)-1)
HALE CAGR/Prevalence of Overweight among Adults, BMI ≥ 25 CAGR	((HALE 2016 value/HALE 2010 value)^(⅙)-1) / ((Prevalence of Overweight among Adults Index 2016 value/Prevalence of Overweight among Adults Index 2010 value)^(⅙)-1)

To be regarded as a country with high HALE, the aforementioned metrics should have the greatest possible value, i.e. HALE CAGR (5 years)/Health Expenditure per capita (current US$) should have the highest ratio. Special weighting is given to this metric as it signifies the extent to which increased health is producing longer lives, and it is, therefore, a crucial metric in the ranking of longevity national development plans.
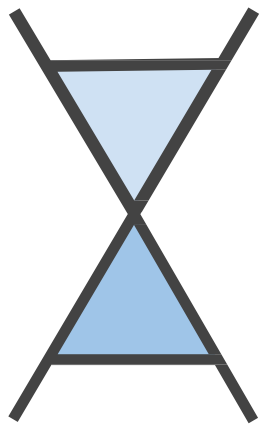
AGING ANALYTICS AGENCY

Aging Analytics Agency is primarily interested in strategic collaboration with international corporations, organisations and governments of progressive countries on projects and initiatives related to Longevity.

Aging Analytics Agency is open to engage with strategic clients via a variety of approaches, including:

- Conducting customised case studies, research and analytics for internal (organizational) use, tailored to the precise needs of specific clients;
- Producing open-access analytical reports;
- Offeringcustomised analysis using specialised interactive industry and technology databases and IT-platforms.

In certain specific cases, if it fits our interests, Aging Analytics Agency is open to co-sponsoring research and analytics for the production of both internal and openly-access industry reports and special case studies for a variety of governmental, international and corporate clients on the topics of Longevity, the Longevity Financial Industry, Longevity Policy and Governance, and the development and execution of full-integrated National Healthy Longevity Development Plans tuned to the specifics of national governments and economies

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