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The case for investing in the prevention and control of non-communicable diseases in the six countries of the Gulf Cooperation Council: an economic evaluation

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ABSTRACT

Background While the non-communicable disease (NCD) burden in the countries of the Gulf Cooperation Council (GCC) (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) has surged over the past decades, the costs and return on investment (ROI) of implementing cost-effective, WHO-recommended NCD interventions have not been established.

Methods We performed an economic analysis to estimate the ROI from scaling up four sets of NCD interventions over 15 years. We estimated the direct costs of the four main NCDs (cancer, diabetes, cardiovascular diseases and chronic respiratory diseases) using a prevalence-based, bottom-up cost-of-illness approach. We estimated indirect costs based on productivity loss due to absenteeism, presenteeism and premature deaths. We costed the scaling up of interventions using the WHO Costing Tool and assessed the health impact of interventions using the OneHealth Tool. We calculated ROI by comparing productivity and social benefits with the total costs of implementing the interventions.

Results The four main NCDs cost the GCC economy nearly US$50 billion in 2019, equal to 3.3% of its gross domestic product. The indirect costs are estimated at US$20 billion or 40% of the total burden. Implementing the four modelled intervention packages in the six GCC countries over 15 years will cost US$14 billion, with an ROI of US$4.9 for every US$1 invested and significant health and social benefits, including 290 000 averted premature deaths.

Conclusion Based on the results of these six investment cases, we recommend actions to scale up current WHO-recommended cost-effective interventions, strengthen whole-of-government action, drive the NCD legislative agenda, build out the evidence base, generate additional advocacy material, and increase regional collaboration and data-sharing to establish best practices and monitor impact.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Non-communicable diseases (NCDs) pose a significant health and economic burden to societies globally.
⇒ Understanding the NCD economic burden and cost-effective action is increasingly important and desired by countries.
⇒ A national and regional return-on-investment analysis of NCD interventions was not performed in the Gulf Cooperation Council (GCC) countries.

WHAT THIS STUDY ADDS

⇒ The economic burden of NCDs in GCC countries in 2019 is estimated at US$50 billion, or 3.3% of gross domestic product.
⇒ Investing in four WHO-recommended NCD intervention packages in the six GCC countries over 15 years will cost US$14 billion.
⇒ Return on investment of the interventions is significant and includes 290 000 averted premature deaths and US$4.9 for every US$1 invested over 15 years.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ NCDs impede efforts to strengthen human capital, inclusive of economic growth and health finance in GCC countries.
⇒ Implementing WHO-recommended NCD interventions in the GCC countries not only reduces the NCD burden but also provides significant positive return on investment.
⇒ There is a need to strengthen whole-of-government action, drive the NCD legislative agenda, build out the evidence base, generate additional advocacy material, and increase regional collaboration and data-sharing to establish best practices and monitor impact.

INTRODUCTION

The prevention and control of non-communicable diseases (NCDs)—principally cancer, diabetes, cardiovascular diseases (CVDs) and chronic respiratory diseases (CRDs)—is the biggest public health challenge for most countries in the world, including those across the Gulf Cooperation Council (GCC). In 2019, 74% of global deaths were due to NCDs, and most Gulf countries surpassed this global average.[1] In 2016, 13.1% of the global adult population was obese. On average, the prevalence of obesity in Gulf countries was more than double, and for some countries was nearly triple this.[2] In addition to their impact on health, NCDs pose a significant economic burden to the health system, as well as to the wider economy through reduced productivity in the labour market, for example, through employees being absent from work or working at reduced capacity.

Successful approaches to reduce NCD burden are well established. In 2017, WHO[3] updated a set of cost-effective interventions, first to prevent and control NCDs by reducing population-level exposure to a common set of NCD risk factors, namely tobacco use, harmful use of alcohol, physical inactivity and unhealthy diet, and second to strengthen the health system response, including the treatment and management of those with NCDs. These interventions remain underimplemented globally, and a key challenge is making the economic argument for their implementation.

While estimates for the global economic burden of NCDs and return on investment (ROI) of a core set of NCD interventions have been developed in the past,[4] countries are increasingly looking to understand the detailed impact of NCDs on their own economies as well as the ROI from implementing interventions to prevent and control NCDs. While there is a wealth of information on NCDs and the cost-effective interventions to address them,[5] there is a lack of research comparing the NCD intervention benefits within and across countries, including those in the Gulf region.

The aims of this study were: (1) to estimate the overall economic burden from NCDs in the six countries in the GCC: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE); (2) to determine the cost of scaling up a set of WHO-recommended interventions for the prevention and control of NCDs in each country[2]; and (3) to quantify the ROI from these interventions over 15 years. This study adds to the growing body of research on investments in NCD prevention and control, and addresses the need for more comparative analyses of NCD intervention benefits across regions of concern.

METHODS

Study design and scope

Investment cases were generated for each of the six countries to support governments gaining political traction to prioritise investments in NCD prevention and control.[6]

Data sources

National data were complemented by relevant regional and international proxy data where no national data were available. Population figures were obtained from local reports and the World Bank database.[7] Morbidity and mortality data were obtained from local literature, STEPwise Approach to NCD Risk Factor Surveillance Survey,[8] and estimates from the Institute for Health Metrics and Evaluation.[9] Health expenditure data were collected from local reports published by Ministries of Health, the WHO Global Health Expenditure database[10–12] and the World Bank database.[13] Labour force data were collected from the World Bank database[14–17] and local literature (online supplemental material).

The economic burden

The economic burden of NCDs was estimated by combining direct and indirect costs. Direct costs were considered as costs incurred by individuals and the health system to treat the four main NCDs: cancer, diabetes, CVDs and CRDs. Indirect costs were considered as the economic loss in the labour market from premature death for the four main NCDs, as well as time off from work (absenteeism), and work at reduced capacity (presenteeism) due to CVDs and diabetes. An Excel file was developed to calculate the economic burden in each country.

Direct costs

Direct costs include medical staff salaries, procedures and treatment. This study followed the prevalence-based, bottom-up cost-of-illness approach to estimate the direct cost of NCDs. The total health expenditure on each of the four NCDs was calculated by multiplying the estimated average cost per patient by the estimated number of patients using the health services. The epidemiological data used to estimate the number of patients using the health services for NCDs were extracted from Bahrain Ministry of Health Statistics report 2018,[18] Bahrain Health Information System I-Seha,[19] Kuwait Ministry of Health annual health report 2016,[20] Oman Ministry of Health statistics report 2018,[21] Saudi Arabia World Health Survey 2019,[22] Saudi Arabia Household Health Survey 2017[23] and local literature.[24] In the absence of local data or literature, national data were complemented by Institute for Health Metrics and Evaluation country profile.[9] In the UAE, the number of patients using the health services was estimated by the UAE Ministry of Health and Prevention (MOHAP) based on the proportion of population using the services in the three insurance schemes in 2019 and adjusted for rest of the Emirates (UAE).[25]

The average medical cost per patient for each NCD was estimated based on local, regional and international literature. The annual average cost of diabetes treatment was estimated based on a study done in Bahrain[26] in year 2015 and we adjusted it to year 2018 price using Bahrain consumer price index. Bahrain-adjusted estimation was used as a proxy for Kuwait, Oman, Qatar and

Saudi Arabia. The annual average cost of CVDs treatment was estimated based on a local study done by the Bahrain Defense Force Hospital[27] in 2016. Bahrain estimation was used as a proxy for Kuwait, Oman and Qatar. The cost of CVDs treatment in Saudi Arabia was based on a study done in Saudi Arabia and published in 2019.[28] The annual average cost of cancer treatment for Bahrain and Kuwait was estimated based on a local study done by the Bahrain Defense Force Hospital[27] in 2016. The cost for Oman and Saudi Arabia was based on estimation done by Oman National Oncology Centre of the Ministry of Health[29] in 2015. The cost for Qatar was based on estimation done by Qatar Cancer Society [30] in 2018. The annual average cost of CRDs treatment was based on a study done in the USA[31] in 2010. We adjusted the figures to year 2018 price using the USA consumer price index. The USA-adjusted estimation was used as a proxy for Kuwait, Oman, Qatar and Saudi Arabia. The average cost per patient in UAE for the four diseases in 2019 was estimated by the UAE MOHAP based on three tightly identified insurance schemes.[25] Once the estimations and calculation were done for each country, a committee from the Ministry of Health reviewed these estimations and approved them (more details are available in online supplemental material).

Indirect costs

These were estimated as follows. First, the number of people of working age (15–60 years) with NCDs in each country was estimated. The size of the working-age population with NCDs was then multiplied by the rate of participation in the labour force and employment to determine the prevalence of NCDs in workers. Similarly, the number of deaths from NCDs was multiplied by the rate of participation in the labour force and employment to estimate the number of workers who died from NCDs. The number of deaths was subtracted from the number of workers with prevalent NCDs to estimate the number of workers who survived despite their illness. The rate of reduction in productivity due to absenteeism,[13 32] presenteeism[26 33] and labour force participation rate reduction[34] because of NCDs was multiplied by the number of surviving workers to estimate the total number of unproductive days that resulted from NCDs. Gross domestic product (GDP) per worker was then used to approximate each worker's productive output in the year 2019 with GDP per worker multiplied by the total number of unproductive working days. Values from previous studies[13 26 32–34] were used to calculate the percentage decrease in productivity due to absenteeism and presenteeism, and the reduction in labour force participation rate because of NCDs (online supplemental material).

The loss of GDP due to premature death of workers was estimated using the human capital approach. This assumes that forgone economic output is equivalent to the total output that would have been generated by workers through their life until reaching retirement age. In this method, all future potential income lost by a worker who dies during his or her working lifetime is calculated from the number of working years lost between the age at death and the age at which the deceased employee would have reached the average retirement age. Productivity losses due to premature deaths were calculated as the product of the total working years lost in all age groups multiplied by the labour force participation rate, age-specific employment rate and GDP per worker.

Return on investment

Interventions

Based on the WHO 'best buys' and recommended interventions for the prevention and control of NCDs, four policy and clinical intervention packages were included in the analysis.[3] They were: (1) a tobacco control package; (2) a physical activity awareness package; (3) a salt reduction package; and (4) primary care-level clinical interventions to screen and treat CVDs and diabetes. The time frame for implementing these interventions was 15 years. The model employed a front-growth scale-up scenario for policy interventions. This pattern assumed that much of the capacity to scale up policy interventions was already in place, meaning that coverage can escalate rapidly, within 2 years. For clinical interventions, the model employed a linear scale-up. This pattern assumed a gradual but sustained increase in coverage, aiming to reach 80% coverage within 15 years. Intervention-specific data on current effective coverage of clinical interventions are not available. The current effective coverage was estimated to be 5% in line with previous WHO analyses in the area of NCDs[35] and validated with focal persons from the Ministry of Health in each country (online supplemental material).

Costs of interventions

Costs of intervention packages were calculated using the WHO Costing Tool for NCD prevention and control,[36] which costs human resources, training, external meetings, mass media campaigns, and miscellaneous equipment needed to enact the tobacco, salt and physical activity awareness packages. Each policy intervention contains assumptions, set by WHO experts, about the quantity of inputs required to implement and enforce it. The WHO Costing Tool estimates the quantity of resources needed at the national, regional and district levels. For clinical interventions, the WHO Costing Tool estimates costs of treatment interventions, primary care visits, ancillary care visits, laboratory and diagnostic tests, and drugs for the total number of NCD cases that are expected to be covered each year. To estimate the total cost of interventions as a percentage of total health expenditure (THE) over 15 years, the 2019 THE in each country was multiplied by 15 years and discounted at a rate of 3%.

Estimating the impact of interventions

The WHO OneHealth Tool[37] was used to assess the health benefits of implementing and scaling up policy and clinical interventions by modelling the number of

disease cases averted, lives saved and healthy life-years gained over the 15 years under study. We used the default impact sizes of the interventions and default relative risks that are inserted into the OneHealth Tool based on WHO best available evidence.[38 39] The healthy years lived (HYL) is the number of remaining years that a person of a certain age is still supposed to live without disability. In the OneHealth Tool, HYL at time t are estimated as follows: $HYL\ (t,s)=P(t,s)\times(1-DW(t,s))$. Where P(t,S) is the prevalence of state S at time t and DW(t,S) is the disability weight associated with state S at time t. Description of the model used and assumptions are available elsewhere[40] (more details are available in online supplemental material). The same scale-up patterns used for the cost of the policy and clinical intervention were used for modelling the impact and benefits. The productivity benefits were calculated by adding the value of avoided presenteeism, the value of avoided absenteeism and the value of avoided premature mortality, using the GDP per worker in 2019 as a proxy for each worker's productive output. Treatment costs prevented were not included in the benefits analysis. The social benefits were calculated by applying a value of 0.5 times GDP per capita to each healthy life-year gained from the interventions.[41]

Calculating the ROI

The ROI for each intervention package was reached by comparing the productivity and social benefits with the total costs of setting up and implementing the interventions. The model employed a 3% discount rate to arrive at the net present value of all costs and economic benefits. The ROI analysis was based on a spreadsheet model developed by WHO.

RESULTS

Economic and health burden of NCDs

The investment cases found that in 2019, across the six GCC countries, nearly 43 000 people died due to the four major NCDs (cancer, diabetes, CVDs and CRDs), accounting for roughly 46% of all deaths in the region, ranging from 41% of all deaths in Saudi Arabia and 65% of all deaths in Kuwait. Of these deaths, nearly 32 000 people died due to CVDs, equivalent to 75% of the deaths due to the four major NCDs and 34% of all deaths in the region. The cost to the GCC economy from these four NCDs was nearly US$50 billion, equivalent to 3% of the GCC's 2019 GDP. The average economic burden in each country as a share of its GDP in 2019 was 3.3%, ranging from 2.7% of GDP in the UAE and Qatar to 3.9% of GDP in Kuwait.

The direct costs were estimated at US$30 billion, accounting for 60% of the total economic burden. Direct costs of treating the four NCDs constituted 36.5% of GCC total health expenditure. The indirect costs were estimated at US$20 billion, accounting for 40% of the total economic burden.

The average economic burden due to direct costs in each country as a share of its GDP in 2019 is 1.8%, ranging from 1.1% of GDP in Qatar to 2.2% of GDP in Saudi Arabia. The average economic burden due to indirect costs in each country as a share of its GDP in 2019 was 1.5%, ranging from 0.9% of GDP in Saudi Arabia to 1.9% of GDP in Kuwait. Table 1 depicts direct and indirect costs due to NCDs for the six countries.

Cost of interventions

The total cost of implementing the four intervention packages over 15 years in the six GCC countries was estimated at US$14 billion. Table 2 presents these costs for each country, including the share by which each country would need to increase its THE to implement all intervention packages.

On average, countries would need to increase THE by 1.4% over 15 years, ranging from 1.2% in Saudi Arabia to 4.6% in Bahrain. Implementing all interventions over 15 years would cost an average of US$243 per capita (US$16 per capita per year), ranging from US$149 per capita in Oman to US$584 in Bahrain. Of note, the package of CVD and diabetes clinical interventions cost the most at US$12.4 per capita per year, while implementing only the population-based measures decreases cost per capita to US$3.8 per year.

Benefits

Implementing intervention packages at the recommended scale-up would avert more than 290 000 premature deaths and add nearly 2 million healthy life-years to the population in the GCC over the next 15 years. Their implementation would also prevent more than 266 000 stroke events and more than 207 000 ischaemic heart disease events over the next 15 years. The number of lives saved ranges from 13 479 in Bahrain to 191 713 in Saudi Arabia (table 3).

Beyond fostering healthier societies, investing in NCDs brings economic benefits. The recovered economic output from implementing the recommended intervention packages was estimated to be US$49 billion in labour productivity gains over the 15 years, equivalent to 3% of the GCC's 2019 GDP. The social benefits resulting from healthy life-years gained over the 15 years was estimated at US$19.5 billion. Adding the social value to the recovered economic output results in economic benefits of US$68.5 billion over the 15-year period (equivalent to US$1200 per capita over the 15 years, or US$80 per capita per year). Differences in benefits between countries are primarily due to economic measures of GDP per employed person and labour force participation rates.

The ROI

Comparing costs and benefits showed that, on average, interventions had ROI over 15 years that was greater than US$4.9 for each US$1 invested now (ROI=493%). Figure 1 depicts the costs and benefits over 15 years by country, with costs per capita ranging from US$149 in

Table 1 Direct and indirect costs of four main NCDs per country share of GDP in 2019 (in million US$)

Country	Cost type	CVDs (million US$)	Cancers (million US$)	Diabetes (million US$)	CRDs (million US$)	Total cost (million US$)	Cost as share of GDP	Direct cost per capita
Bahrain	Direct cost	232.9	98.4	315	98.5	744.8	2.0%	$488
	Absenteeism	64.1	No data	9.8	No data	73.9	1.8%	$433
	Presenteeism	387.8	No data	18.9	No data	406.8		
	Premature death	146.4	31.2	0.5	1.6	179.7		
	Total cost	**831.3**	**129.7**	**344.2**	**100.1**	**1405.2**	**3.8%**	**$921**
Kuwait	Direct cost	961.6	161.3	936.7	603.7	2663.3	2.0%	$603
	Absenteeism	271.7	No data	60.3	No data	332.0	1.9%	$583
	Presenteeism	1532.1	No data	114.5	No data	1646.6		
	Premature death	466.1	106.2	22.5	5.2	599.9		
	Total cost	**3231.5**	**267.5**	**1134.0**	**608.8**	**5241.9**	**3.9%**	**$1186**
Oman	Direct cost	767.9	60.1	504.2	254.6	1586.8	2.0%	$355
	Absenteeism	117	No data	17.6	No data	134.6	1.6%	$283
	Presenteeism	755.6	No data	35.3	No data	790.9		
	Premature death	212.2	104.1	28.3	8.1	352.8		
	Total cost	**1852.8**	**164.3**	**585.4**	**262.7**	**2865.2**	**3.6%**	**$639**
Qatar	Direct cost	926.5	137.8	605.4	322.6	1992.3	1.1%	$712
	Absenteeism	338.1	No data	43.1	No data	381.2	1.6%	$1068
	Presenteeism	2028.7	No data	82.0	No data	2110.7		
	Premature death	362.7	112.8	16.5	6.2	498.3		
	Total cost	**3656.0**	**250.6**	**747.0**	**328.8**	**4982.5**	**2.7%**	**$1780**
Saudi Arabia	Direct cost	8222.7	811.7	7198.6	1368.2	17 601.2	2.2%	$514
	Absenteeism	468.1	No data	207.5	No data	675.6	0.9%	$188
	Presenteeism	2835.5	No data	418.7	No data	3254.2		
	Premature death	2315.3	504.9	49.5	37.2	2906.9		
	Total cost	**13 841.7**	**1316.6**	**7874.3**	**1405.4**	**24 438.0**	**3.1%**	**$702**
UAE	Direct cost	2028.1	395	2228.8	415	5066.9	1.3%	$519
	Absenteeism	579.4	No data	92.2	No data	671.5	1.4%	$593
	Presenteeism	3661.4	No data	181.8	No data	3843.2		
	Premature death	859.6	202.7	30.5	183.6	1276.5		
	Total cost	**7128.5**	**597.7**	**2533.3**	**598.6**	**10 858.1**	**2.7%**	**$1112**
Total	Direct cost	13 139.7	1664.4	11 788.7	3062.6	29 655.3	1.8%	$532
	Absenteeism	1838.5	No data	430.5	No data	2269.0	1.5%	$525
	Presenteeism	11 201.2	No data	851.3	No data	12 052.5		
	Premature death	4362.4	1062.0	147.8	241.9	5814.1		
	Total cost/*average	**30 541.7**	**2726.3**	**13 218.3**	**3304.4**	**49 790.8**	***3.3%**	***$1057**

*The average cost as a share of GDP was calculated by summation of the cost as a share of GDP in each country and division by the number of countries. The average direct cost per capita was calculated by summation of the direct cost per capita in each country and division by the number of countries.
CRDs, chronic respiratory diseases; CVDs, cardiovascular diseases; GDP, gross domestic product; NCDs, non-communicable diseases; UAE, United Arab Emirates.

Oman to US$584 in Bahrain. The average cost across the region per year per capita to implement all intervention packages was US$16, while the average benefits per year per capita amounted to US$80. Table 4 depicts the ROI of each intervention package for each country, with the tobacco control and salt reduction packages providing the highest ROI among all intervention packages.

DISCUSSION

To our knowledge, this is the first study that estimated the economic and health burden of NCDs, as well as the ROI of scaling up WHO-recommended interventions for the prevention and control of NCDs in the six countries of the GCC. The findings indicate that four major NCDs cost the GCC economy around 3.3% of GDP every year, and

Table 2 Cost of implementing four intervention packages over 15 years in the GCC

Country	Tobacco control (million US$)	Physical activity (million US$)	Salt reduction (million US$)	CVD and diabetes clinical interventions (million US$)	The total cost of interventions (million US$)	Cost of interventions as a percentage of total health expenditure for 15 years	The total cost of interventions per capita (US$)	The total cost of interventions per capita per year (US$)
Bahrain	79	92	128	592	891	4.6%	584	39
Kuwait	92	161	155	1039	1447	1.7%	327	22
Oman	42	88	97	439	666	2.6%	149	10
Qatar	83	149	169	772	1173	2.1%	419	28
Saudi Arabia	241	520	514	5954	7228	1.2%	211	14
UAE	131	228	259	1875	2493	1.3%	255	17
Total	669	1237	1321	10671	13898	1.4%	243	16

CVD, cardiovascular disease; GCC, Gulf Cooperation Council; UAE, United Arab Emirates.

Table 3 Health, social and economic benefits of implementing interventions over 15 years in the GCC

Country	Strokes averted	Acute IHD averted	Premature deaths averted (<70 years)	Healthy life-years gained	Total productivity restored (million US$)	The social value of investment (million US$)	Productivity and social benefits (million US$)	Productivity and social benefits per capita for 15 years	Productivity and social benefits per capita per year
Bahrain	13804	8359	13479	86999	1674	759	2433	$1594	$106.28
Kuwait	14242	13432	15656	117148	2934	1262	4195	$949	$63.28
Oman	17140	15012	17258	116974	1748	738	2486	$557	$37.12
Qatar	19453	11010	22889	134068	7472	3136	10607	$3789	$252.62
Saudi Arabia	173432	132247	191713	1246569	29736	10319	40055	$1171	$78.04
UAE	28389	27823	29989	220673	5563	3240	8803	$901	$60.08
Total	266460	207883	290984	1922431	49127	19452	68579	$1199	$79.94

GCC, Gulf Cooperation Council; IHD, ischaemic heart disease; UAE, United Arab Emirates.

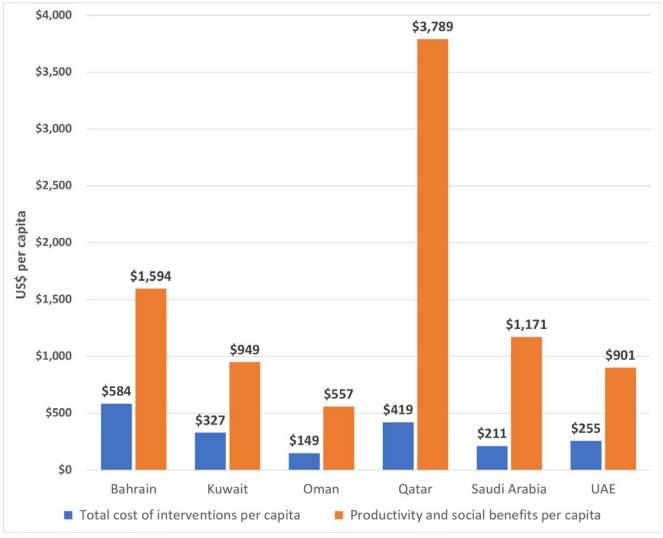

Figure 1 Cost and benefit of implementing interventions over 15 years in the GCC, US$ per capita. The blue columns are the total cost of implementing the interventions over 15 years estimated as per capita. The orange columns are the economic and social benefits of implementing the interventions over 15 years estimated as per capita in US$. GCC, Gulf Cooperation Council; UAE, United Arab Emirates.

account for over 45% of GCC country THE, impeding the GCC's efforts to increase efficiency in the health sector and to achieve fiscal balance. Rising prevalence trends in GCC countries of the major NCDs examined imply that the challenge will only become more difficult with time.

The investment cases also show that investing in four proven and cost-effective intervention packages (best buys) would avert US$49 billion over 15 years and 290 000 premature deaths. The ROI is high, averaging US$4.9 over 15 years for every US$1 invested now. Thus, the best buys can increase people's life expectancy and quality of life while decreasing the burden on the national economy and accelerating economic growth.

The burden of NCDs in the GCC countries

While similar studies were focused on low/middle-income countries (LMICs),[42 43] relatively few studies have estimated the health and economic burden of NCDs in GCC countries, and fewer still have drawn comparisons between GCC countries. Our study expands on the most comprehensive studies to date on the burden of NCDs in GCC countries,[44] by using national data for morbidity, mortality and cost of treatment data where possible, and other data from other GCC countries as proxies where necessary (Finkelstein *et al* use international estimates only).[9 45] Finkelstein *et al*[44] found diabetes to contribute the most to the NCD burden, while our study finds CVDs to be the largest contributor. This is likely due to the aforementioned differences in data sources, in addition to our study's inclusion of premature death into the burden calculation. Finkelstein *et al*'s estimates for per-patient costs and productivity reductions for diabetes are higher than ours[46 47]; we believe lower productivity reduction estimates for diabetes and higher per CVD patient costs used under our study to be more defensible.

Other relevant studies were conducted in Saudi Arabia. In 2017, WHO estimated the economic burden due to NCDs in Saudi Arabia to be US$18.6 billion annually with direct costs accounting for 30% of the burden.[48] Our analysis estimated the economic burden in Saudi Arabia to be US$24.4 billion every year with direct costs accounting for 45% of the burden. These differences in results are likely explained by the increased prevalence of NCDs and the availability of more accurate cost per patient data in our study.

Globally, the most methodologically comparable studies conducted to date are 18 NCD investment cases completed under the WHO-United Nations Development Programme joint programme on catalysing multisectoral action for NCDs, coordinated under the United Nations Interagency Task Force on NCDs (UNIATF).[49] Most notably, the GCC countries face higher direct costs than in other countries, accounting for 60% of the burden compared with 16% on average across other countries.

Table 4 ROI (productivity and social benefits) of each intervention over 15 years

Country	ROI of tobacco control package		ROI of salt reduction package		ROI of physical activity		ROI of CVD and diabetes clinical intervention package	
	Productivity benefits	Productivity and social benefits	Productivity benefits	Productivity and social benefits	Productivity benefits	Productivity and social benefits	Productivity benefits	Productivity and social benefits
Bahrain	2.7	4.2	7.2	10.8	1.7	2.7	1.4	1.8
Kuwait	3.1	4.5	8.2	11.9	1.5	2.4	1.8	2.6
Oman	4.8	7.0	8.6	12.6	2.0	3.0	2.3	3.1
Qatar	5.6	8.4	25.0	37.5	1.5	2.3	5.9	7.8
Saudi Arabia	7.7	10.8	35.7	50.2	3.0	4.3	2.6	3.3
UAE	1.9	3.1	12.0	19.0	1.4	2.3	1.8	2.8
Total	4.3	6.3	16.1	23.7	1.9	2.8	2.6	3.6

CVD, cardiovascular disease; ROI, return on investment; UAE, United Arab Emirates.

This is likely due to higher costs of treatment, NCD prevalence and treatment coverage rates in GCC countries than in the other countries examined. All other investment cases are among LMICs where expensive treatment options are less available and THE is overall lower, and consumption of healthcare is lower.

Comparing the six investment case findings with each other, differences between GCC countries are driven mainly by differences in GDP per employed person, labour force participation rates, prevalence of NCDs and mortality rates, prices difference of healthcare and implementation costs for the modelled interventions.

ROI of NCD interventions in the GCC countries

The NCD investment cases indicate that the costs required to fully scale WHO-recommended NCD policy and clinical interventions are relatively low. Differences in implementation costs between GCC countries are likely due to differences in costs of healthcare service provision—especially for clinical interventions which are more costly—and population size, as countries with larger populations have a lower per-person cost for the population-based measures due to the economy of scale. To illustrate, the package of CVD and diabetes clinical interventions cost the most at US$12.4 per capita per year while implementing only the population-based measures decreases cost per capita to US$3.8 per year.

Among all intervention packages, the salt reduction measures had by far the highest ROI. This is due primarily to salt reduction's high effectiveness at reducing high blood pressure and hence CVD prevalence. The package of clinical interventions has lower ROI due to their high costs of implementation. Importantly, however, while constituting the most expensive package, our findings indicate that the CVD and diabetes interventions have the greatest potential to avoid premature mortality and morbidity; thus, they are necessary to support the population's right to health. Differences in ROI between countries are likely driven mainly by implementation costs and population size, as well as economic measures of GDP per employed person and labour force participation rates.

Limitations

The investment case methodology used has several limitations. Our study does not include all NCDs and does not capture all productivity losses associated with NCD morbidity and mortality such as unpaid productivity. This is due mostly to limitations of the model, which focuses on the four major NCD categories and productivity losses at the workplace since these are simpler to estimate. Furthermore, the model calculates productivity losses from absenteeism and presenteeism associated with CVDs and diabetes only, as there are no available parameters for reductions in productivity due to cancer and CRD in the region and limited information globally. Besides healthcare treatment costs, the investment case model does not estimate other direct costs associated with NCDs such as non-medical costs (eg, transport to a health provider), retirement benefits and disability payments, in addition to intangible costs such as care provided by relatives and quality of life. There were no available data in each country to estimate the average medical costs per patient and we had to use international data to estimate the direct costs. Some of these data were not recent data. Adjustments were done using consumer price index. There were no available data in each country to estimate the baseline effective coverage of the clinical interventions. The suggested[35] assumption of 5% is one of the limitations. However, we used the same coverage scale-up pattern for estimating the cost and for estimating the benefits. Once the estimations and calculation were done for each country, a committee from the Ministry of Health reviewed these estimations and approved them. We included detailed description of the estimations and adjustments in the online supplemental materials.

We used the GDP per worker as a proxy for each worker's productive output. It is important for the reader to note that the main economic driver in GCC countries is hydrocarbon and natural resources, and we included the GDP of hydrocarbon in the estimation of GDP per employment.

On the benefits side, the model does not estimate reductions in direct healthcare costs to treat NCDs, nor does it estimate the benefits from reductions in presenteeism and absenteeism associated with reductions in cancer and CRD prevalence. Moreover, the calculated returns only include the economic benefits of improved health outcomes and do not account for the significant additional revenue that would come from the recommended increases in excise tax rates on health-harming products including tobacco and alcohol. Combined, these limitations imply that the model is conservative in its estimates and that both the burden of NCDs as well as the benefits of investing in NCD prevention and control are higher than estimated.

Finally, data collection relied heavily on project countries' abilities to provide national data for NCD prevalence and mortality, as well as intervention coverage and cost estimates. The model employed regional and international estimates where countries were not able to collect national data or national data presented gaps. Data triangulation from different sources was used to improve the accuracy of the model.

Recommendations for strengthening NCD prevention and control among GCC countries

The analysis indicates that among the four NCD categories examined, CVDs account for the largest share of premature mortality, morbidity and economic losses each year, followed by diabetes. This study confirms the high cost of treating these conditions and the much lower cost of preventing them. Investing in preventing diabetes and CVDs is both cost-effective and ultimately increases the sustainability of the health sector. The GCC countries should therefore invest in measures to promote healthy diets and physical activity; detect, diagnose and treat

NCDs early; and reduce consumption of health-harming products.

GCC countries have already made considerable progress in advancing the prevention and control of NCDs, and several have received WHO and UNIATF awards for progress and leadership in combating NCDs and advancing health. Most GCC countries have multisectoral NCD coordination mechanisms, ambitious NCD strategies and targeted programmes and initiatives to drive NCD prevention and control. However, in practice, key challenges remain, particularly around efficient and lasting engagement of non-health stakeholders, slow legislative action and insufficient evidence due to the absence of standardised NCD surveillance systems.

Used as advocacy tools to demonstrate the substantial health and economic gains of investing in NCD action, the six GCC NCD investment cases can help engage non-health stakeholders, gather high-level support and enhance regional collaboration. GCC countries and relevant United Nations bodies should now consider establishing a multiyear plan to invest in scaling up the WHO-recommended cost-effective interventions; strengthen national multisectoral coordination, planning and strategy; pass strong NCD legislation; increase regional collaboration and data-sharing to establish best practices and monitor impact; expand efforts to monitor the entire population for NCDs and their risk factors; and implement novel policy approaches and test innovative solutions to increase utilisation of existing services and incentivise healthy behaviour. This would not only benefit GCC countries, as they could serve as a model of successful investment in NCD prevention and control in the rest of the region and beyond.

Finally, addressing the social, economic and environmental determinants of health which lay outside the health sector's purview requires investments beyond the ones modelled under the NCD investment cases. In GCC countries, given that most of the people live in urban areas and are insufficiently physically active, purposeful urban planning is required to incentivise healthy behaviour. Investments in food systems are required to improve access and availability of healthy foods; fiscal policies can also have a strong impact on shaping the food environment and consumer choice and should be considered. Taxes on health-harming products not only have the potential to prevent harm but also to generate enough revenue to fully scale the NCD measures modelled under the investment cases.

CONCLUSION

This is the only study to our knowledge that examines ROI of cost-effective interventions to address NCDs in GCC countries. It also estimates the social and economic burden of NCDs in the GCC countries using national prevalence and treatment cost data, and by examining productivity losses in greater detail across a wider range of NCDs than previous studies. The large NCD burden indicates the need to comprehensively address the main risk factors that contribute to NCDs. This study also shows that WHO-recommended interventions are highly cost-effective at reducing the burden of NCDs.

Based on the results of these six investment cases, we recommend actions to scale up current WHO-recommended cost-effective interventions, strengthen whole-of-government action, drive the NCD legislative agenda, build out the evidence base, generate additional advocacy material, and increase regional collaboration and data-sharing to establish best practices and monitor impact.

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The case for investing in the prevention and control of non-communicable diseases in the six countries of the Gulf Cooperation Council: an economic evaluation – (Supplemental materials)

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Table 1. Estimates used from previous studies to calculate the %age decrease in productivity due to absenteeism and presenteeism and Labour force participation rate reduction because of NCDs

	Absenteeism rate * Reduction in working days (%)	**Presenteeism rate** Working at reduced capacity	Labour force participation rate reduction
Hypertension	0.6% [1]	3.7% [2]	2% [3]
Stroke	6.3% [1]	3.7% [2]	18% [3]
Acute MI	1.3% [1]	3.7% [2]	11% [3]
Diabetes	0.3% [4]	0.5% [5]	10% [3]

Table2. The number of patients using the health services for NCDs and the average cost per patient in USD

Country	**Estimated number of patients using the health services**				**Estimated average cost per patient USD**				**Government health expenditure as a % of total health expenditure[6]**
	Diabetes	**CVD**	**Cancer**	**COPD**	**Diabetes**	**CVD**	**Cancer**	**COPD**	
Bahrain	96,809[7]	34,602[8]	21,834[8]	43,921[8]	*$3,253[5]*	*$6,732[9]*	*$4,508[9]*	*$2,242[10]*	57.3%
Kuwait	249,367[11]	123,721[11]	30,999[12]	234,781[12]	*$3,283[5]*	*$6,792[9]*	*$4,548[9]*	*$2,247[10]*	87.4%
Oman	135,255[13]	99,544[13]	4,464[13]	99,097[13]	*$3,292[5]*	*$6,813[9]*	*$11,891[14]*	*$2,268[10]*	88.3%
Qatar	137,478[12]	101,684[12]	18,727[12]	106,297[12]	*$3,288[5]*	*$6,803[9]*	*$5,495[15]*	*$2,266[10]*	74.7%
Saudi Arabia	2,189,963[16]	2,819,577[16]	68,436[16]	603,609[17]	*$3,287[5]*	*$2,916[18]*	*$11,861[14]*	*$2,267[10]*	62.4%
UAE	1,145,941[19]	1,498,560[19]	74,185[19]	1,244,767[19]	*$1,945[19]*	*$1,353[19]*	*$5,324[19]*	*$333[19]*	55.6%

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Table 3. The number of patients using the health services for NCDs and the average cost per patient in USD

Country	Estimated number of patients using the health services							
	Diabetes		**CVD**		**Cancer**		**COPD**	
Bahrain	96,809[7]	PHC 2018 MOH statistics	34,602[8]	Bahrain Health Information System I-Seha	21,834[8]	Bahrain Health Information System I-Seha	43,921[8]	Bahrain Health Information System I-Seha
Kuwait	249,367[11]	No. of visits to diabetic care in 2016 was 997,469. We assume that each patient has four visits per year.	123,721[11]	No. of visits to cardiology outpatients and causality in 2016 was 123,721	30,999[12]	Actual estimated number of existing cases of cancer based on IHME-GBD 2017	234,781[12]	No. of existing chronic respiratory disease cases is 469,561 based on IHME-GBD 2017. We assume that 50% of them use the service.
Oman	135,255[13]	Health statistics, Oman MOH, 2018	99,544[13]	Health statistics, Oman MOH, 2018	4,464[13]	Health statistics, Oman MOH, 2018	99,097[13]	Health statistics, Oman MOH, 2018
Qatar	137,478[12]	Assume that 50% of actual estimated number (274,956) of existing cases used the service. Existing cases estimation is based on IHME-GBD_2017 higher estimate.	101,684[12]	Assume that 80% of actual estimated number (127,104) of existing cases used the service. Existing cases estimation is based on IHME-GBD_2017 higher estimate.	18,727[12]	Assume that actual estimated number of existing cases (18,727) used the service. Existing cases estimation is based on IHME-GBD_2017 higher estimate.	106,297[12]	Assume that 50% of actual estimated number (212,595) of existing cases used the service. Existing cases estimation is based on IHME-GBD_2017 higher estimate.
Saudi Arabia	2,189,963[20]	Saudi Arabia Household Health Survey 2017 (Prevalence of 8% and utilization rate of 80%)	2,819,577[16]	Saudi Arabia World Health Survey 2019 *	68,436[16]	Saudi Arabia Household Health Survey 2017 (Prevalence of 0.2% and utilization rate of 100%)	603,609[17]	M Al Ghobain, 2015 (Prevalence of 4.2% and utilization rate of 42%)
UAE	1,145,941[19]	Estimated By MOHAP **	1,498,560[19]	Estimated By MOHAP **	74,185[19]	Estimated By MOHAP **	1,244,767[19]	Estimated By MOHAP **

* KSA: Myocardial infarction (242,949 cases: Prevalence of 1% and utilization rate of 71%), Stroke (85,203 cases: Prevalence of 0.3% and utilization rate of 83%), Heart Failure (284,011 cases: Prevalence of 1% and utilization rate of 83%), Hypertension (2,272,086 cases: Prevalence of 8% and utilization rate of 80%)

** The number of patients using the health services was estimated by United Arab Emirates Ministry of Health and Prevention MOHAP based on the proportion of population using the services in the three insurance schemes in Abu Dhabi in 2019 and adjusted for rest of the Emirates UAE.

Table 4. The estimated average cost per patient in USD

Country	Estimated average cost per patient USD							
	Diabetes	**Note**	**CVD**	**Note**	**Cancer**	**Note**	**COPD**	**Note**
Bahrain	*$3,253[5]*	*(1)*	*$6,732[9]*	*(3)*	*$4,508[9]*	*(5)*	*$2,242[10]*	*(8)*
Kuwait	*$3,283[5]*	*(1)*	*$6,792[9]*	*(3)*	*$4,548[9]*	*(5)*	*$2,247[10]*	*(8)*
Oman	*$3,292[5]*	*(1)*	*$6,813[9]*	*(3)*	*$11,891[14]*	*(6)*	*$2,268[10]*	*(8)*
Qatar	*$3,288[5]*	*(1)*	*$6,803[9]*	*(3)*	*$5,495[15]*	*(7)*	*$2,266[10]*	*(8)*
Saudi Arabia	*$3,287[5]*	*(1)*	*$2,916[18]*	*(4)*	*$11,861[14]*	*(6)*	*$2,267[10]*	*(8)*
UAE	*$1,945[19]*	*(2)*	*$1,353[19]*	*(2)*	*$5,324[19]*	*(2)*	*$333[19]*	*(2)*

(1) Estimating the cost diabetes treatment: The annual average cost of diabetes treatment was estimated at 1,162 Bahraini Dinar based on a study done in Bahrain in 2015. Bahrain CPI Consumer price index was 110.518 in 2015 and was 117.591 in 2018. Adjustment factor is 1.06. The adjusted annual average costs of diabetes treatment for 2018 is 1,236 Bahraini Dinar (US$ 3,253).

(2) Estimating direct cost in UAE: The average cost per patient and the number of patients using the health services in 2019 was estimated based on three tightly identified financing schemes, namely the basic financing scheme, enhanced financing scheme and governmental financing schemes. The three schemes were characterised in terms of the number of beneficiaries, the number of users per disease, the total expenditure per disease, and the total health expenditure of each scheme. Accordingly, the average cost per patient per disease and the number of service users were calculated for these schemes, then the average was adjusted for the whole country based on two factors: first, the percentage of the health expenditure of the three schemes to domestic current health expenditure of the country, which was 50 percent according to the national health account; second, the percentage of the population in the geographical area, which was estimated at 30 percent. The current health expenditure was known from the national health account, the overall expenditure per disease was counted for the three schemes, and the percentage service users was calculated for the three schemes and verified with another large district in the country. Accordingly, an assumption was made that the average percentage of service users in the selected schemes represents the average percentage of service users in the UAE. A smaller number of system users in other districts increases the cost of illness per patient; thus the above assumption renders this study more conservative

(3) We used the estimation done by the Bahrain Defence Force Hospital of the annual average costs of cardiovascular diseases treatment in 2016 which was 2,558 Bahraini Dinar (US$6,732). The slight variations between countries are due to exchange rate from Bahraini Dinar to other local currencies.

(4) The cost of cardiovascular diseases treatment in Saudi Arabia was based on a study done in Saudi Arabia and published in 2019 [18]. We calculated the average cost per patients by dividing the total estimated cost 4 types of CVDs by the estimated number of estimated number of patients using the health services. The average cost is 10,936 Saudi Riyal (US$ 2,916)

Type of CVDs	**Estimated average cost per patient (SAR)** [18]	**Estimated number of patients using the health services**	Total cost
Myocardial infarction	16,720	242,949	4,062,107,278
Stroke	44,203	85,203	3,766,238,854
Heart Failure	34,263	284,011	9,731,062,133
Hypertension	5,843	2,272,086	13,275,800,961
Total		**2,819,577**	**30,835,209,226**

(5) We used the estimation done by the Bahrain Defence Force Hospital of the annual average costs of cancer treatment in 2016 which was 1,713 Bahraini Dinar (US$2,242). The slight variations between countries are due to exchange rate from Bahraini Dinar to other local currencies.

(6) The National Oncology Centre of the Ministry of Health estimated that Oman spent than 6 million Omani Riyals on cancer treatment in 2015. We estimated the average cost of cancer treatment at 1344 Omani Riyals ($11,891) We divided this number by the estimated number of number of patients received cancer treatment in 2015 which was 1314 patients.

(7) The Qatar Cancer Society estimated that they spent on average 20,000 Qatari Riyals (US$ 5,495) per cancer patient.

(8) Estimating the cost COPD treatment. The cost of COPD treatment was estimated at a range from $1,681 to $10,812 depending in the severity based on a study done in USA in 2010. We used the conservative lower estimate of $10,812. We adjusted the figure based on the cost categories (Medication, non-medication costs, and Hospitalization cost) using the consumer price index for each category as per the table below:

Annual median costs for COPD treatment based on disease severity					**ADJUSTED**			
Cost categories	**Severity of COPD**				**Cost categories**	**Severity of COPD**		
	Stage I*	**Stage II***	**Stage III***			**Stage I***	**Stage II***	**Stage III***
Total medication cost	512	720	766		Total medication cost (Adjustment factor = 1.3)	663	932	992
Total non-medication costs	489	1659	3276		Total non-medication costs (Adjustment factor = 1.2)	609	2,066	4,080
Hospitalization cost	680	2658	6700		Hospitalization cost (Adjustment factor = 1.5)	994	3,886	9,796
Total cost	**$1,681**	**$5,037**	**$10,812**		**Total cost**	**$2,266**	**$6,885**	**$14,868**

Notes:

*$P < 0.01$ for each cost variable and total cost across the three severities of COPD. All figures are in US$ per patient.

Abbreviation: COPD, chronic obstructive pulmonary disease.

Medication CPI		**CPI Medical Care Services in U.S. City average**		**CPI hospital and related services in U.S. City average**	
2010	407.824	**2010**	388.436	**2010**	227.227
2018	528.008	**2018**	483.808	**2018**	332.237
Adjustment factor 2018/2010	1.3	**Adjustment factor 2018/2010**	1.2	**Adjustment factor 2018/2010**	1.5

*CPI Source: U.S. Bureau of Labor Statistics <https://data.bls.gov/pdq/SurveyOutputServlet>….All CPIs extracted from the annual column

Note:
Once the estimations and calculation were done for each country, a committee from the Ministry of Health reviewed these estimations and approved them.

Table 5. Intervention packages included in the analysis and their coverage levels

	Current estimated coverage levels (2019)						Target
Intervention levels	**Bahrain**	**Kuwait**	**Oman**	**Qatar**	**Saudi Arabia**	**UAE**	
Tobacco							
Monitor tobacco use/prevention policies	Level 2	Level 4	Level 3	Level 2	Level 1	Level 3	Level 4
Protect people from tobacco smoke (Eliminate exposure to second-hand tobacco smoke in all indoor workplaces, public places, public transport)	Level 2	Level 2	Level 2	Level 1	Level 2	Level 2	Level 4
Offer to help quit tobacco use: Brief intervention	Level 2	Level 4	Level 1	Level 3	Level 3	Level 4	Level 4
Offer to help quit tobacco use: mCessation	Level 3	Level 1	Level 1	Level 3	Level 4	Level 1	Level 4
Warn about danger: Warning Labels (Implement large graphic health warnings on all tobacco packages)	Level 3	Level 1	Level 1	Level 1	Level 1	Level 2	Level 4
Warn about danger: Mass Media Campaign (Implement effective mass media campaigns that educate the public about the harms of smoking/tobacco use and second hand smoke)	Level 4	Level 1	Level 3	Level 3	Level 4	Level 1	Level 4
Enforce bans on tobacco advertising (Enact and enforce comprehensive bans on tobacco advertising, promotion and sponsorship)	Level 2	Level 3	Level 2	Level 3	Level 3	Level 3	Level 4
Enforce youth access restriction	Level 4	Level 3	Level 3	Level 3	Level 3	Level 4	Level 4
Raise taxes on tobacco (Increase excise taxes and prices on tobacco products)	Level 3	Level 2	Level 3	Level 4	Level 3	Level 4	Level 4
Plain packaging of tobacco products	Level 3	Level 1	Level 3	Level 1	Level 4	Level 1	Level 4
Physical Inactivity							
Awareness campaigns to encourage increased physical activity (Implement community wide public education and awareness campaign for physical activity which includes a mass media campaign combined with other community-based education, motivational and environmental programmes aimed at supporting behavioural change of physical activity levels)	Level 2	Level 1	Level 2	Level 1	Level 1	Level 3	Level 4
Brief advice as part of routine care (Provide physical activity counselling and referral as part of routine primary health care services through the use of a brief intervention)	Level 1	Level 1	Level 1	Level 1	Level 1	Level 1	Level 4
Salt							
Surveillance	Level 2	Level 1	Level 1	Level 1	Level 1	Level 1	Level 4
Harness industry for reformulation	Level 2	Level 1	Level 2	Level 1	Level 1	Level 1	Level 4
Adopt Standards: Front of Pack Labelling	Level 1	Level 1	Level 2	Level 1	Level 1	Level 1	Level 4

Adopt Standards: Strategies to combat misleading marketing	Level 1	Level 1	Level 2	Level 1	Level 1	Level 1	Level 4
Knowledge: Education and Communication	Level 1	Level 1	Level 3	Level 2	Level 1	Level 1	Level 4
Environment: Salt reduction strategies in community based eating spaces	Level 1	Level 1	Level 2	Level 1	Level 1	Level 1	Level 4
Clinical interventions [21]							
Screening for risk of CVDs and diabetes	5%	5%	5%	5%	5%	5%	80%
Treatment for those with **high absolute risk** of CVD/diabetes (>30%)	5%	5%	5%	5%	5%	5%	80%
Treatment of new cases of acute **myocardial infarction** (AMI) with aspirin	5%	5%	5%	5%	5%	5%	80%
Treatment of cases with established **ischaemic heart disease** (IHD)	5%	5%	5%	5%	5%	5%	80%
Treatment for those with established cerebrovascular disease and post **stroke**	5%	5%	5%	5%	5%	5%	80%
Standard Glycemic control (Effective glycaemic control for people with diabetes, along with standard home glucose monitoring for people treated with insulin to reduce diabetes complications)	5%	5%	5%	5%	5%	5%	80%
Retinopathy screening and photocoagulation (Diabetic retinopathy screening for all diabetes patients and laser photocoagulation for prevention of blindness)	5%	5%	5%	5%	5%	5%	80%
Neuropathy screening and preventive foot care (Preventive foot care for people with diabetes (including educational programmes, access to appropriate footwear, multidisciplinary clinics)	5%	5%	5%	5%	5%	5%	80%

Table 6. Effect sizes of interventions

Intervention levels	Effect Size
Tobacco [22 23]	
Protect people from tobacco smoke (Eliminate exposure to second-hand tobacco smoke in all indoor workplaces, public places, public transport)	4% reduce demand for tobacco
Offer to help quit tobacco use: Brief intervention	2% reduce demand for tobacco
Warn about danger: Warning Labels (Implement large graphic health warnings on all tobacco packages)	4% reduce demand for tobacco
Warn about danger: Mass Media Campaign (Implement effective mass media campaigns that educate the public about the harms of smoking/tobacco use and second hand smoke)	3.25% reduce demand for tobacco
Enforce bans on tobacco advertising (Enact and enforce comprehensive bans on tobacco advertising, promotion and sponsorship)	10% reduce demand for tobacco
Enforce youth access restriction	15% reduce demand for tobacco
Raise taxes on tobacco (Increase excise taxes and prices on tobacco products)	The impact of the tobacco tax increases are mediated by the size of the increase in price generated by the tax increases and elasticity of consumption (-0.2 for cigarettes)
Plain packaging of tobacco products	1.25% reduce demand for tobacco
Physical Inactivity	
Awareness campaigns to encourage increased physical activity (Implement community wide public education and awareness campaign for physical activity which includes a mass media campaign combined with other community-based education, motivational and environmental programmes aimed at supporting behavioural change of physical activity levels)	1% reduce physical inactivity
Brief advice as part of routine care (Provide physical activity counselling and referral as part of routine primary health care services through the use of a brief intervention)	8.3% reduce physical inactivity
Salt	
Harness industry for reformulation	0.86% reduce sodium intake
Adopt Standards: Front of Pack Labelling	0.7% reduce sodium intake
Knowledge: Education and Communication	5% reduce sodium intake
Environment: Salt reduction strategies in community based eating spaces	6.6% reduce sodium intake
Clinical interventions [24 25 26 27 28 29]	
Treatment for those with **high absolute risk** of CVD/diabetes (>30%)	1.05 mmol/L reduction in cholesterol 5.9mmHg reduction in systolic blood pressure
Treatment of new cases of acute **myocardial infarction** (AMI) with aspirin	24% reduction in CVD mortality
Treatment of cases with established **ischaemic heart disease** (IHD)	46% reduction in CVD mortality
Treatment for those with established cerebrovascular disease and post **stroke**	39% reduction in CVD mortality
Standard Glycemic control (Effective glycaemic control for people with diabetes, along with standard home glucose monitoring for people treated with insulin to reduce diabetes complications)	75% reduction in the incidence of retinopathy
Retinopathy screening and photocoagulation (Diabetic retinopathy screening for all diabetes patients and laser photocoagulation for prevention of blindness)	20% reduction in blindness due to retinopathy
Neuropathy screening and preventive foot care (Preventive foot care for people with diabetes (including educational programmes, access to appropriate footwear, multidisciplinary clinics)	35% reduction in lower-limb amputation due to severe neuropathy

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