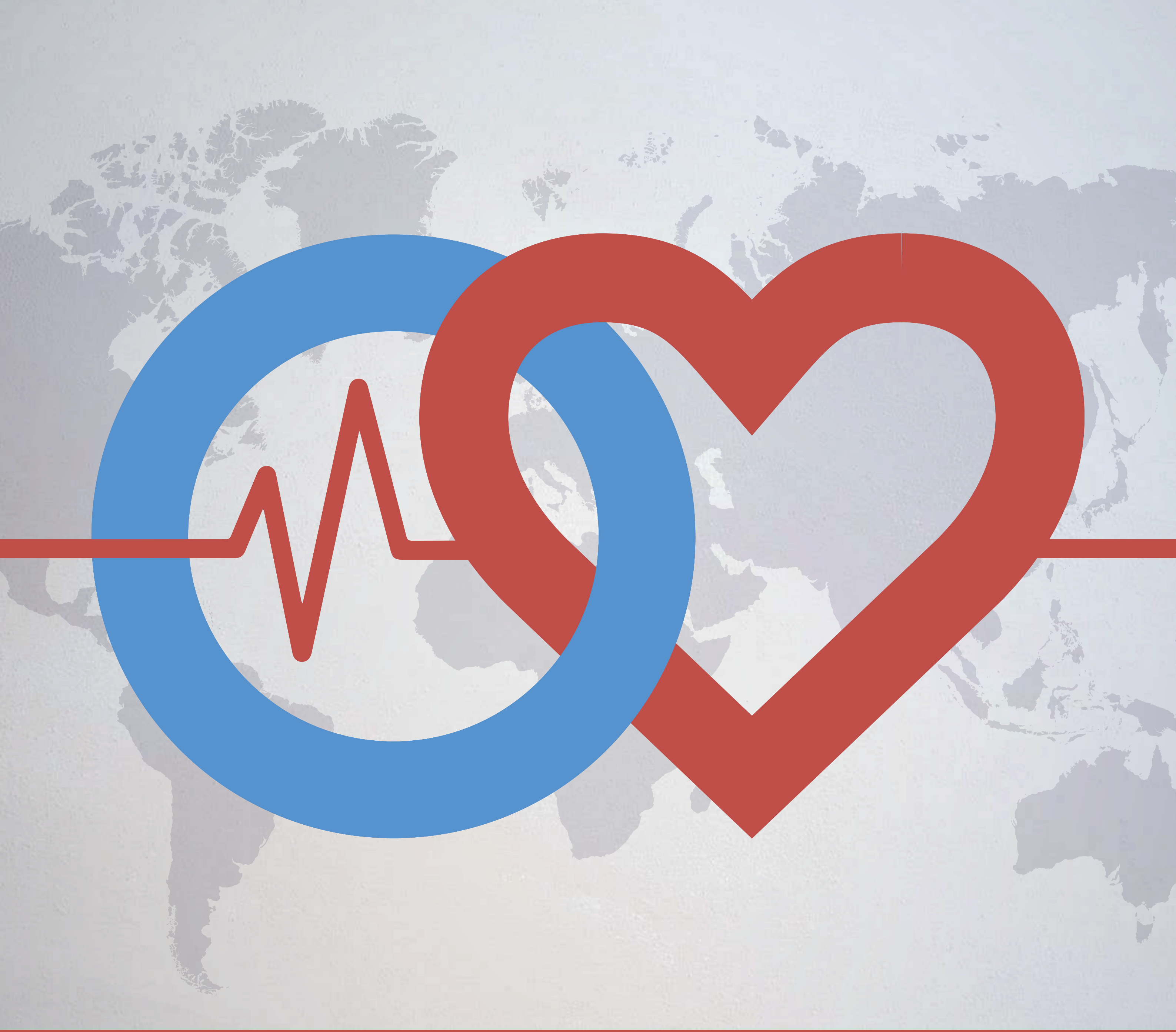

Diabetes and **cardiovascular** disease

www.idf.org/cvd

International Diabetes Federation

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AstraZeneca

Beat NCDs

The #beatNCDs campaign and symbol are initiatives of the World Health Organization. The symbol is a half ribbon; the four strokes that create it symbolize the four diseases that account for the majority of non-communicable disease deaths worldwide — diabetes, cardiovascular disease, cancer and chronic respiratory disease. The symbol also evokes the idea of legs walking.

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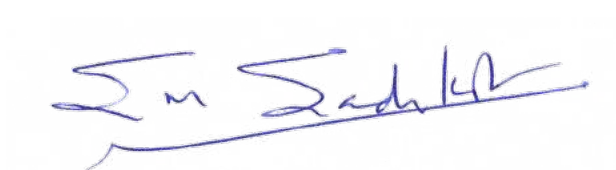
Foreword

This *Diabetes and cardiovascular disease* report introduces diabetes and cardio-vascular disease, summarises the latest data on the impact of cardiovascular disease from around the world, and outlines public health policy solutions. This new report facilitates evidence-based decision making and encourages intersectoral collaboration to strengthen health systems and implement cost-effective interventions.

The International Diabetes Federation estimates that approximately 5 million people die each year as a consequence of diabetes. Many of these are premature deaths, occurring during working age; a high proportion result from cardiovascular diseases such as heart attacks or strokes that often occur at a younger age and with increased frequency in people with diabetes.

However, it does not have to be like this. There are many cost-effective interventions that can prevent or delay cardiovascular disease in people with diabetes, and that can help prevent early deaths in those with cardiovascular disease and diabetes. At an individual level, people with diabetes can work with health professionals to improve their control of blood glucose, blood pressure, and cholesterol, as well as seeking support to stop smoking and implement sustainable improvements in their diet and physical activity. At a population level, policy makers can implement cost-effective public health policies to prevent type 2 diabetes, ensure access to essential medicines, implement non-communicable disease monitoring systems, screen for diabetes in at-risk populations and implement policies that reduce tobacco consumption.

We produced this report so that policy makers, policy implementers and diabetes advocates would have a complete and accessible summary of the current impact of cardiovascular disease in people with diabetes, as well as provide evidence on actionable solutions. We are very grateful to the Baker IDI Heart and Diabetes Institute and the *Diabetes and cardiovascular disease* committee in helping to bring it to fruition.



Dr Shaukat Sadikot
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International Diabetes Federation

Table of contents

Executive summary

Executive summary

Non-communicable diseases

The four main types of non-communicable diseases are diabetes, cardiovascular disease (CVD), cancer and chronic respiratory diseases. Many of these diseases share modifiable risk factors such as unhealthy eating, physical inactivity, excess alcohol and tobacco use.

NON-COMMUNICABLE DISEASES INCLUDE:

- Diabetes
- Cardiovascular diseases
- Chronic respiratory diseases
- Cancer

Diabetes

Diabetes is a non-communicable disease that occurs when the body cannot produce enough insulin and/or cannot use insulin effectively, and is diagnosed by observing raised levels of glucose in the blood. Over time, high levels of glucose in the blood (known as hyperglycaemia) can lead to the development of disabling and life-threatening health complications.

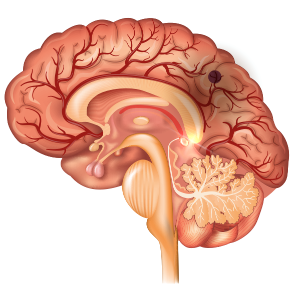
Diabetes is one of the largest global health emergencies of the 21st century, with the number of people with diabetes growing rapidly worldwide. In 2015, 415 million adults were estimated to live with diabetes around the world. This number is predicted to increase to 642 million by 2040.

Cardiovascular disease

CVD is a major cause of death and disability among people with diabetes. CVD includes stroke, coronary artery disease and peripheral artery disease (Figure E.1). People with diabetes are at increased risk of CVD, and these events generally occur at an earlier age compared to people without diabetes. As the number of people with diabetes is predicted to increase, the outlook for CVD becomes even more alarming.

Figure E.1
THE MAIN TYPES OF CARDIOVASCULAR DISEASE

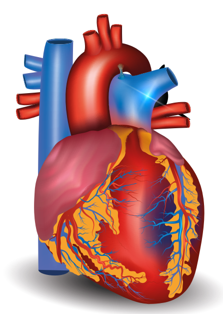
STROKE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE BRAIN

includes:
cerebrovascular disease,
cerebral arterial disease,
intracerebral hemorrhage,
cerebral infarction

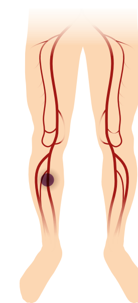
CORONARY ARTERY DISEASE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE HEART

includes:
ischaemic heart disease,
atherosclerotic heart disease,
coronary heart disease,
angina pectoris, heart attack (myocardial infarction),
sudden coronary death

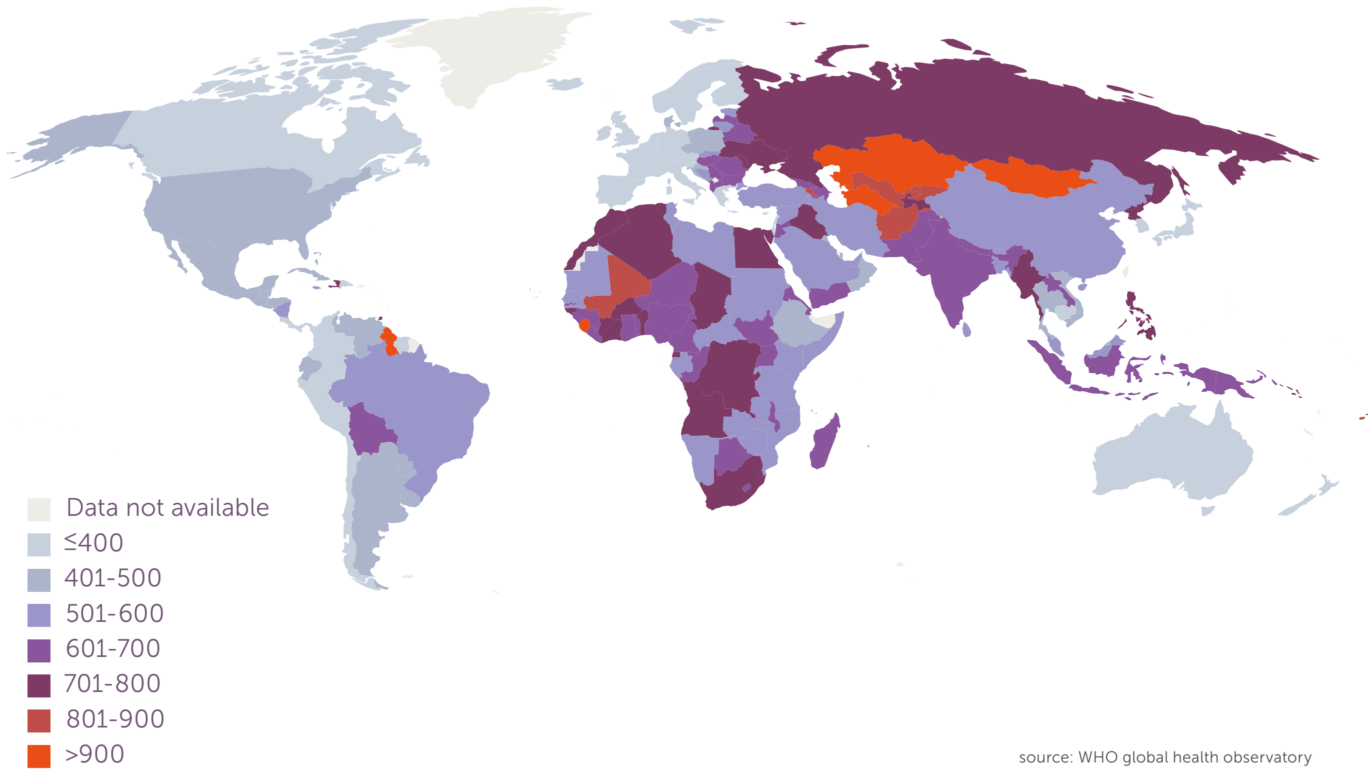
PERIPHERAL ARTERY DISEASE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE LEGS AND FEET

includes:
lower-extremity arterial disease,
limb threatening ischaemia,
intermittent claudication,
critical limb ischaemia

Figure E.2
ESTIMATED AGE-STANDARDISED MORTALITY DUE TO CARDIOVASCULAR DISEASES PER 100,000



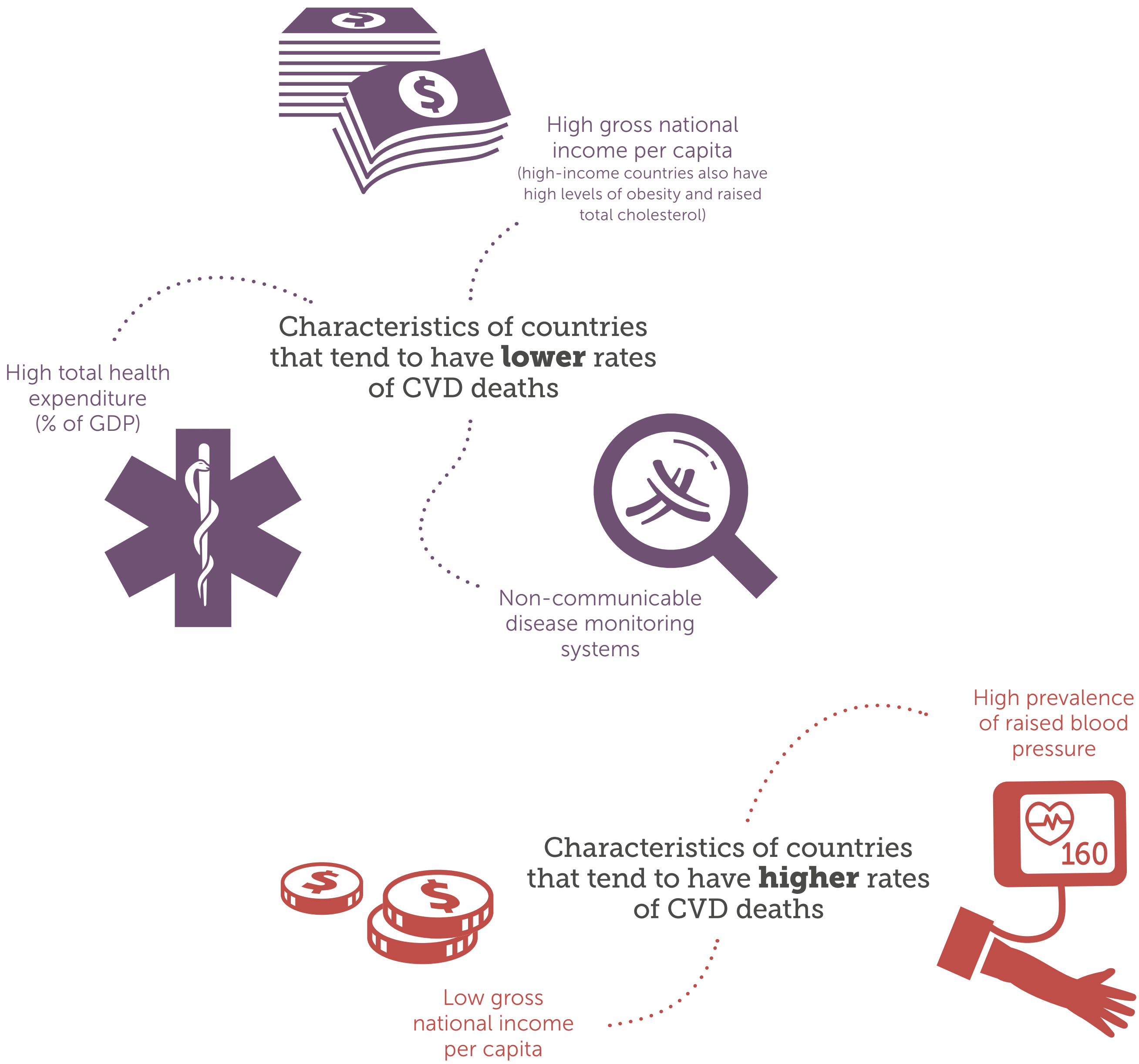
Global impact of non-communicable diseases

In 2012, it was estimated that over 37.9 million people worldwide died from non-communicable diseases, of which 17.5 million were due to CVD. In 2015, approximately 5.0 million were estimated to have died from diabetes, the majority of these as a result of cardiovascular complications. The regions with the highest rates of age-standardised CVD disease mortality are situated in Central Asia, the Middle East and Africa (Figure E.2). The countries with the highest diabetes-attributable mortality rates are Mauritius and Pacific Islands in the Western Pacific Region.

Populous countries have the largest absolute number of people dying from CVD, and include China, India and the Russian Federation. High-income countries are more likely to have low CVD mortality rates, despite having a high prevalence of CVD risk factors such as diabetes, obesity and raised cholesterol. This suggests a beneficial impact of investment in healthcare and access to essential medicines.

Countries with lower rates of age-standardised CVD mortality rates are likely to have high gross national income per

Figure E.3
CHARACTERISTICS OF COUNTRIES WITH HIGH AND LOW RATES OF AGE-STANDARDISED CARDIOVASCULAR DISEASE (CVD) MORTALITY



source: WHO global health observatory

capita, have high total health expenditure as a proportion of gross domestic product and have non-communicable disease monitoring systems. Countries with higher rates of age-standardised CVD mortality rates are likely to have a high prevalence of raised blood pressure (Figure E.3).

In high-income countries, non-communicable diseases are associated with over 6.3 million deaths per year. In many of these regions, such as Australia, North America, Western Europe and Japan, policymakers should be aware that most people with diabetes are over 50 years of age, and are at a higher risk of CVD than people without diabetes. Integrated non-communicable disease monitoring systems using the most recent International Classification of Diseases classification system should be adopted in all high-income countries.

In middle-income countries, non-communicable diseases are responsible for nearly 10 million deaths per year. Policymakers in Central Asia should be aware that they have the world's highest rates of age-standardised CVD mortality, and that increasing economic growth will be associated with higher prevalence rates of diabetes, obesity and cholesterol.

In low-income countries, non-communicable diseases are responsible for over 1.8 million deaths per year. In Africa, policymakers should be aware of the very high rates of age-adjusted CVD-related mortality in the region, and know that diabetes is an additional risk factor.

Community health workers should be trained to check for high blood pressure and diabetes, give appropriate lifestyle advice, and offer access to effective treatments. These services should be integrated into existing health services, such as those for TB, HIV and antenatal clinics.

Cardiovascular disease in people with diabetes

People with diabetes are at increased risk of CVD, compared to people without diabetes. The risk of CVD also increases with age.

A global systematic literature review on CVD in diabetes was conducted. There were substantial differences found in the methodologies used in the studies on CVD in people with diabetes in different countries, meaning that accurate global estimates of CVD in people with diabetes were not able to be produced. There is a need for future studies to utilise standardised methodology that incorporates the most recent International Classification of Diseases classifications, to enable better comparability across countries and more accurate meta-analyses. There is also a lack of data for people with diabetes living in low-income countries.

Figure E.4

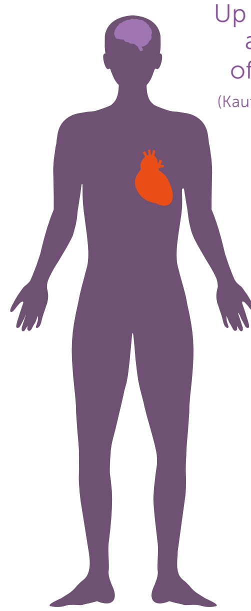
PREVALENCE OF CARDIOVASCULAR DISEASE IN YOUNGER PEOPLE WITH TYPE 1 DIABETES IN HIGH- AND MIDDLE- INCOME COUNTRIES

In studies of middle-aged people with diabetes living in high- and middle-income countries:

Up to **16%** had a history of **CVD**

includes stroke, coronary artery disease, and peripheral artery disease

(David, 2010)



Up to **2%** had a history of **STROKE**

(Kautzy-Willer, 2013)

Up to **1%** had a history of **HEART ATTACK**

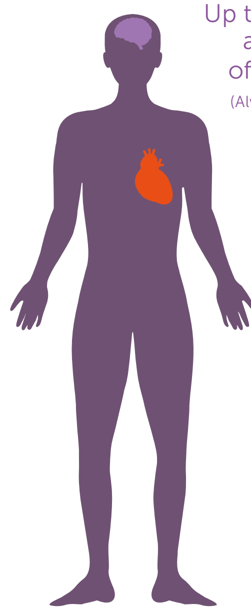
(Koivisto, 1996)

Mean age of study population: 28 to 44 years

In high-income countries, in studies of people with type 1 diabetes where the mean age of the study population was between 28 and 44 years, the prevalence of all CVD ranged from 2.6% to 16.2%. (Figure E.4)

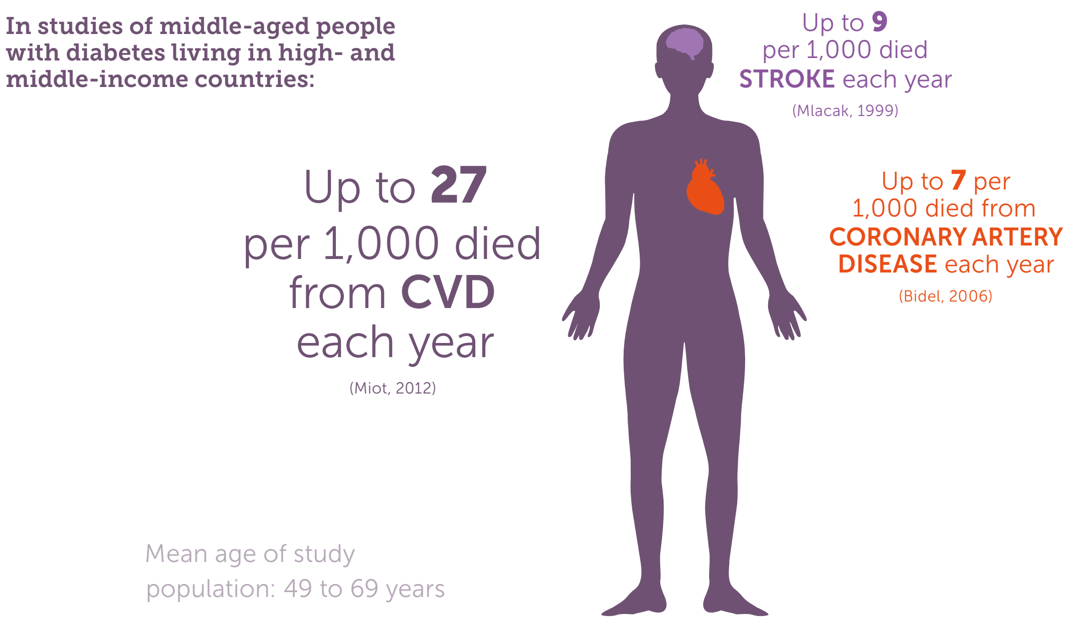
Figure E.5

PREVALENCE OF CARDIOVASCULAR DISEASE IN MIDDLE-AGED PEOPLE WITH DIABETES IN HIGH- AND MIDDLE- INCOME COUNTRIES



In high- and middle-income countries, in studies of people with type 1 and type 2 diabetes where the mean age of the study population was between 56 and 66 years, the prevalence of all CVD ranged from 14.8% to 40.5%. In high- and middle-income countries, in studies where the mean age of the study population was between 53 and 67 years, the prevalence of stroke in people with diabetes ranged from 3.5% to 10.4% (Figure E.5). There is a lack of data for people with diabetes living in low-income countries.

Figure E.6
CARDIOVASCULAR DISEASE MORTALITY IN MIDDLE-AGED PEOPLE WITH DIABETES



Mortality rates estimate the number of deaths that occur each year per 1,000 people. The most recent United Nations crude mortality rate for death by all causes was estimated at 7.8 deaths per 1,000 people per year.

In studies of middle-aged people with type 2 diabetes and unspecified diabetes (mean age of study population 49 to 69 years), 2 to 27 people out of 1,000 died from CVD each year. Two to seven deaths were from coronary artery disease and one to nine deaths were from stroke (Figure E.6). The mortality risk increased with age. There is a lack of data for people with diabetes living in low-income countries.

> “Countries with non-communicable disease monitoring systems generally have lower rates of age-standardised CVD mortality, even when the income level of the country is taken into account.”

The way forward

A focus on preventing CVD events in high risk populations can reduce mortality as well as decrease the economic burden from heart attack and stroke. CVD can be prevented or delayed by controlling blood glucose, blood pressure and cholesterol, as well as by smoking cessation, eating healthily and increasing physical activity.

The threat of non-communicable diseases faces countries at all stages of development, with more than 80 percent of deaths related to diabetes and CVD occurring in low- and middle-income countries. Non-communicable diseases will continue to dominate mortality trends in the future, and by 2030, it is estimated that they will account for more than three-quarters of deaths worldwide.

CVD is a major cause of death and disability in people with diabetes, and a barrier to sustainable development. Action must be taken to decrease the impact of CVD in people with diabetes. This requires environments that promote healthy lifestyle choices as well as building health systems that can detect and manage diabetes and CVD (Figure E.7).

In order to decrease the impact of diabetes and CVD, national governments should:

implement public health policies and lifestyle interventions to increase healthy eating and physical activity.

As non-communicable diseases share many modifiable risk factors, integrated action to combat the risk of all non-communicable diseases and to reduce premature mortality is vital. However, the majority of countries worldwide do not have such comprehensive action plans in place. In addition, inter-sectorial collaboration is needed to strengthen health systems and implement cost-effective interventions.

prioritise control of blood pressure and access to essential medicines.

There is a very strong association between the prevalence of raised blood pressure and the national CVD mortality rate. Even when controlling for gross national income, the prevalence of raised blood pressure still shows a significant positive association with CVD mortality. Therefore, good blood pressure control is crucial in reducing CVD mortality. Prevalence of high blood pressure can be decreased through salt reduction, improved fruit and vegetable intake, increased physical activity and avoidance of excessive alcohol.

Access to essential medicines for diabetes and CVD should be increased, ensuring that these medicines are affordable and available for everyone at secondary, primary and community level. In order to improve access, good procurement practices such as bulk purchasing and efficient distribution should be implemented.

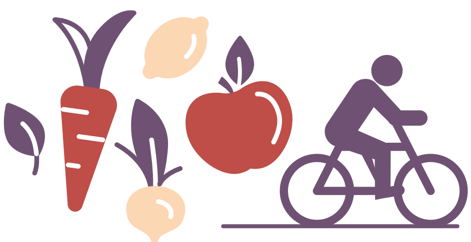
implement non-communicable disease monitoring systems.

Non-communicable disease monitoring systems include regular data collection on mortality by cause as well as risk factor surveillance. This information is essential in determining the impact of non-communicable diseases and for understanding how best to intervene. Countries with non-communicable disease monitoring systems generally have lower rates of age-standardised CVD mortality, even when the income level of the country is taken into account. However, only 20 percent of countries worldwide have implemented such a system, and they are very rare in low-income countries. All countries with appropriate resources should move towards implementing internationally standardised monitoring systems.

legislate and implement policies that eliminate use of tobacco.

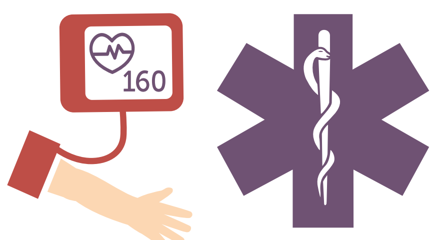
Governments should implement the *WHO Framework Convention on Tobacco Control.* Actions should include raising tobacco taxes, implementing comprehensive bans on tobacco advertising and sponsorship, placing large health warnings on packaging and legislating for smoke-free environments. These actions will reduce the initiation of smoking, increase smoking cessation and reduce the exposure to second-hand smoke.

Figure E.7
STRATEGIES TO DECREASE THE IMPACT OF DIABETES AND CARDIOVASCULAR DISEASES



Increase **HEALTHY EATING** and **PHYSICAL ACTIVITY**

Implement non-communicable disease **MONITORING SYSTEMS** and **SCREENING** plans for diabetes in high-risk populations



Improve **BLOOD PRESSURE** control and access to essential **MEDICINES**

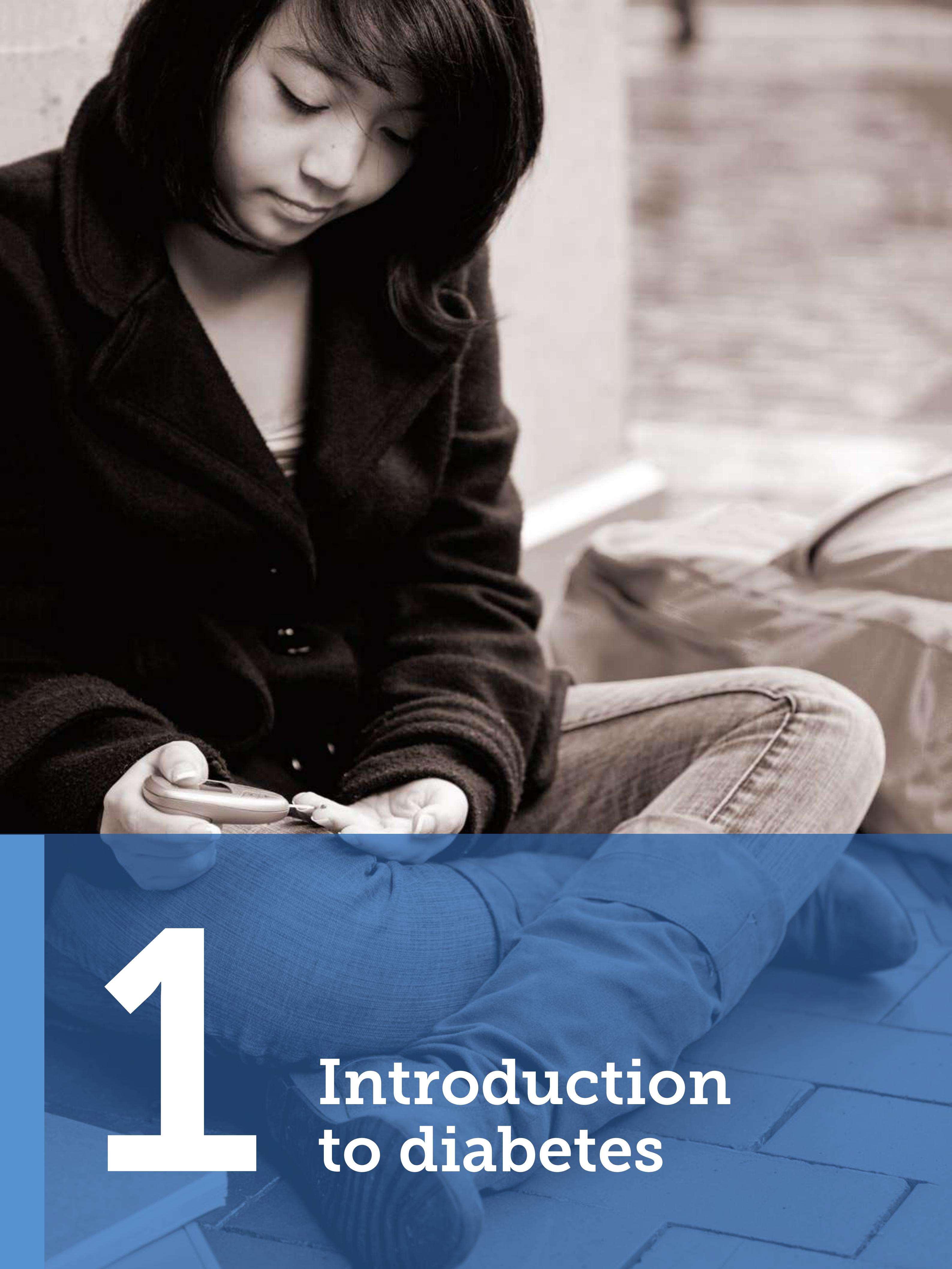
Decrease **TOBACCO** use

In order to reduce premature mortality from non-communicable diseases, an integrated action plan is needed in each country to strengthen health systems and implement cost-effective interventions.

The incidence of CVD in people with diabetes can be decreased through individual-level interventions such as reduction in intake of sugar, salt and fat, improved fruit and vegetable intake, increased physical activity, smoking cessation and avoidance of excessive alcohol. At a population level, the health care system should be strengthened, the education of people with non-communicable diseases should be improved and access to essential medicines should be increased.

The progress and efficacy of these interventions can be measured through internationally standardised monitoring systems and high quality epidemiological assessments.

The International Diabetes Federation endorses the recommendations in this report, and encourages all countries to work towards good health and well-being for all people living with diabetes.



1 Introduction to diabetes

What is diabetes?

Diabetes is a chronic condition that occurs when the body cannot produce enough insulin (a hormone produced in the pancreas) or cannot use this hormone[1], and is diagnosed by observing raised levels of glucose in the blood (Figure 1.1). Insulin is required to transport glucose from the bloodstream into the body's cells where it is used as energy. The lack, or ineffectiveness, of insulin in a person with diabetes means that glucose remains circulating in the blood. Over time, the resulting high levels of glucose in the blood (known as hyperglycaemia) causes damage to many tissues in the body, leading to the development of disabling and life-threatening health complications.

> “Diabetes occurs when the body cannot produce or use insulin, resulting in raised blood glucose.”

There are three main types of diabetes:

- Type 1 diabetes
- Type 2 diabetes
- Gestational diabetes

Figure 1.1

2006 WORLD HEALTH ORGANIZATION RECOMMENDATIONS FOR THE DIAGNOSTIC CRITERIA FOR DIABETES AND INTERMEDIATE HYPERGLYCAEMIA

DIABETES should be diagnosed if **ONE OR MORE** of the following criteria are met:

- Fasting plasma glucose ≥ 7.0mmol/L (126mg/dl)
- Two-hour plasma glucose ≥ 11.1mmol/L (200mg/dl) following a 75g oral glucose load

IMPAIRED GLUCOSE TOLERANCE (IGT) should be diagnosed if **BOTH** of the following criteria are met:

- Fasting plasma glucose < 7.0mmol/L (126mg/dl)
- Two-hour plasma glucose 7.8-11.1mmol/L (140-200mg/dl) following a 75g oral glucose load

IMPAIRED FASTING GLUCOSE (IFG) should be diagnosed if **BOTH** of the following criteria are met:

- Fasting plasma glucose 6.1-6.9mmol/L (110-125mg/dl)
- Two-hour plasma glucose < 7.8mmol/L (140) following a 75g oral glucose load

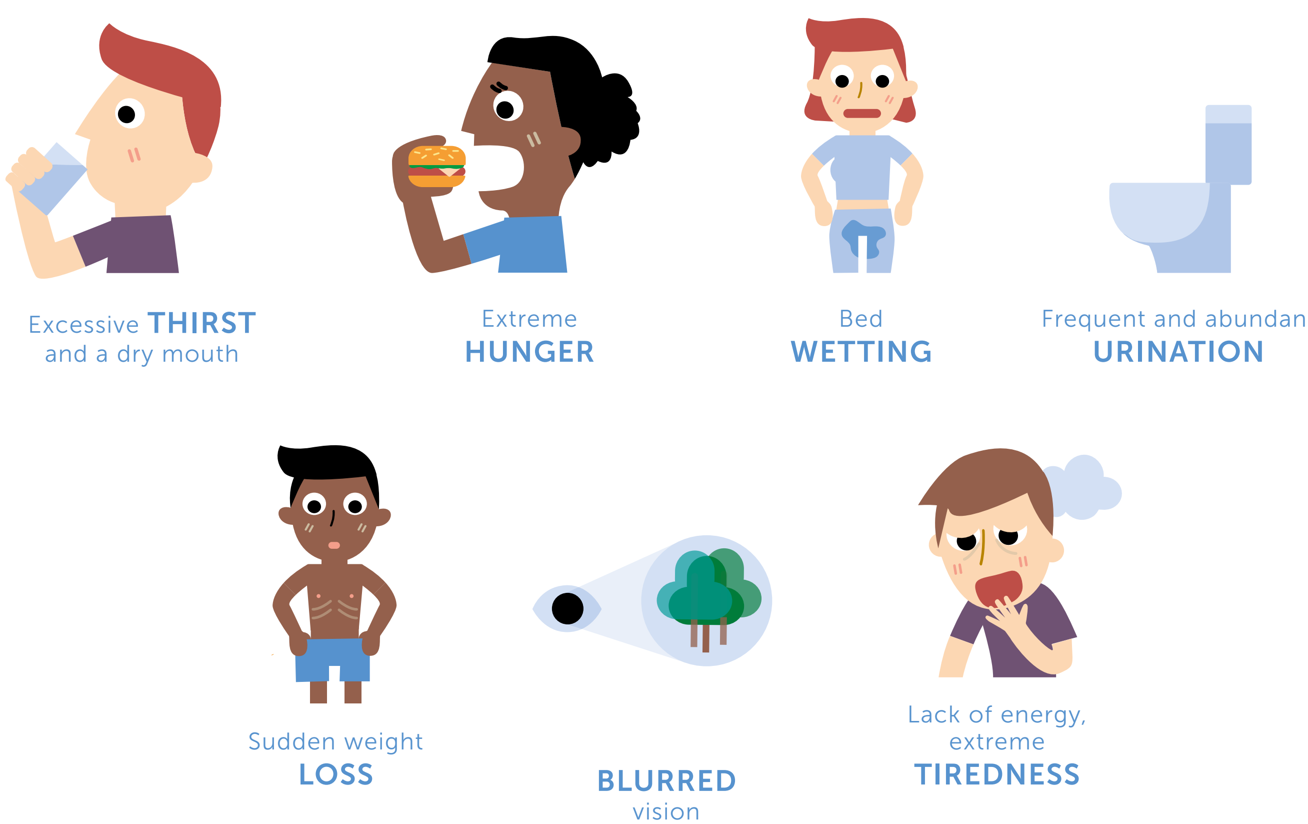
Type 1 diabetes

> “In type 1 diabetes the body can no longer produce the insulin it needs.”

Type 1 diabetes is caused by an autoimmune reaction, in which the body’s defence system attacks the insulin-producing beta cells in the pancreas. As a result, the body can no longer produce the insulin it needs. Why this occurs is not fully understood but is likely to result from an abnormal immune response to an environmental factor such as a virus in genetically-predisposed individuals. The disease can affect people of any age, but onset usually occurs in children or young adults. People with this form of diabetes need to inject insulin every day in order to control the levels of glucose in their blood. Without insulin, a person with type 1 diabetes will die.

Symptoms of type 1 diabetes can appear rapidly. Symptoms may include excessive thirst and frequent urination (Figure 1.2).

Figure 1.2
SYMPTOMS OF TYPE 1 DIABETES



Type 1 diabetes is diagnosed by an elevated blood glucose level in the presence of the symptoms listed in Figure 1.2. In some parts of the world, where type 1 diabetes is less common, the symptoms may be mistaken for other illnesses, and it is therefore essential that the blood glucose is measured when one or more of the symptoms on page 3 are present. Sometimes the type of diabetes is not clear and additional tests are required to distinguish between type 1 and type 2 diabetes or the rarer forms of diabetes(2).

With daily insulin treatment, regular blood glucose monitoring and maintenance of a healthy diet and lifestyle, people with type 1 diabetes can lead a normal, healthy life.

The number of people who develop type 1 diabetes is increasing. The reasons for this are still unclear, but may be due to changes in environmental risk factors, diet early in life and/or viral infections. Genetics plays a large role in determining the risk of developing type 1 diabetes(3).

Type 2 diabetes

Type 2 diabetes is the most common type of diabetes. It usually occurs in adults, but is increasingly seen in children and adolescents. In type 2 diabetes, there is a combination of inadequate production of insulin and an inability of the body to respond fully to insulin (insulin resistance).

The symptoms of type 2 diabetes may be similar to those of type 1 diabetes but are often less severe, and may develop more slowly. Symptoms may include frequent urination, excessive thirst and blurred vision (Figure 1.3). In some cases, type 2 diabetes may not be associated with any overt symptoms.

> “In type 2 diabetes, insulin is ineffective and may also be insufficient.”

Figure 1.3
SYMPTOMS OF TYPE 2 DIABETES

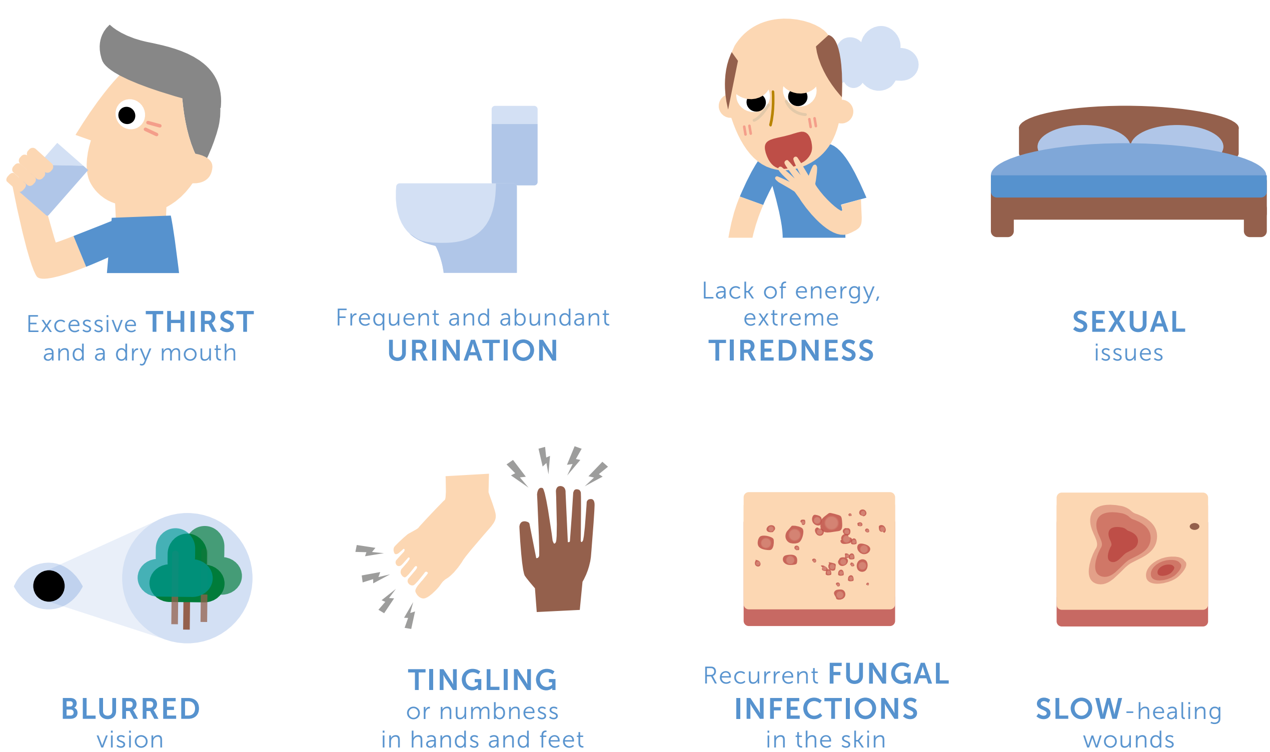
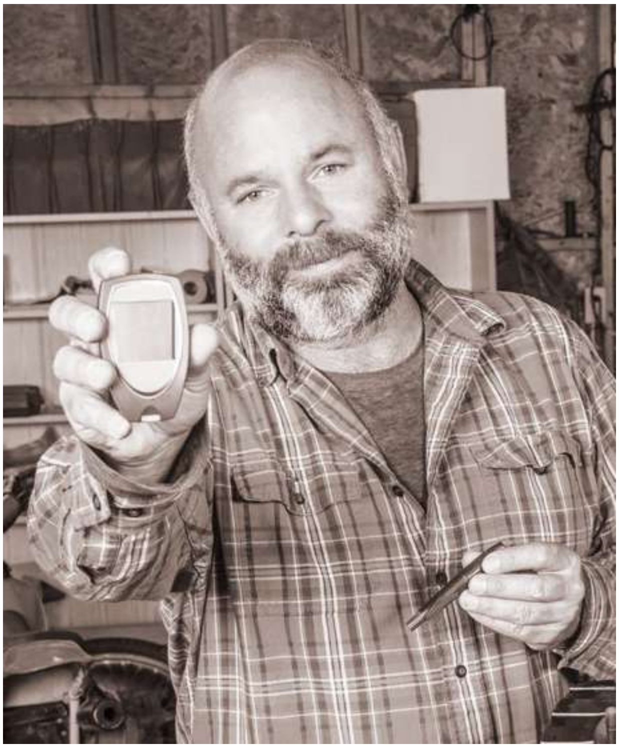


Table of contents



Many people with type 2 diabetes remain unaware of their condition for a long time because the symptoms are usually less marked than in type 1 diabetes and may take years to be recognised. However, during this time the body is already being damaged by excess blood glucose. As a result, many people already have evidence of complications when they are diagnosed with type 2 diabetes.

Although the exact causes for the development of type 2 diabetes are still not known, there are several important risk factors. The most important are excess body weight, physical inactivity and poor nutrition. Other factors which play a role are ethnicity, family history of diabetes, past history of gestational diabetes and age. The costs and benefits of screening for diabetes in high-risk populations should be assessed separately in each particular setting. Important health systems considerations to evaluate include the capacity to carry out the screening and the capacity to provide care for those with diabetes.

In contrast to people with type 1 diabetes, most people with type 2 diabetes do not require daily insulin treatment to survive. The cornerstone of treatment of type 2 diabetes is the adoption of a healthy diet and increased physical activity. A number of medications are available to help control blood glucose levels. If blood glucose levels continue to rise however, people with type 2 diabetes may be prescribed insulin.

The number of people with type 2 diabetes is growing rapidly worldwide. This rise is associated with ageing populations, economic development, increasing urbanisation, less healthy diets and reduced physical activity[4].

Gestational diabetes

Hyperglycaemia that is first detected at any time during pregnancy is classified as either[6]:

- Gestational diabetes mellitus
- Diabetes mellitus in pregnancy

Women with slightly elevated blood glucose levels are classified as having gestational diabetes, whilst women with substantially elevated blood glucose levels are classified as having diabetes mellitus in pregnancy.

Previously unknown diabetes should be detected as early as possible in the pregnancy. The onset of gestational diabetes usually begins around week 24 of gestation.

Overt symptoms of hyperglycaemia during pregnancy are rare and difficult to distinguish from normal pregnancy symptoms, but may include increased thirst and frequent urination. Women with hyperglycaemia detected during pregnancy are at greater risk of adverse pregnancy outcomes. These include very high blood pressure and foetal macrosomia (a significantly larger than average baby), which can make a vaginal birth difficult and risky. Good control of blood glucose during pregnancy can reduce these risks.

> “Overt symptoms of gestational diabetes are rare and difficult to distinguish from normal pregnancy symptoms.”

Women with hyperglycaemia during pregnancy can control their blood glucose levels through adopting a healthy diet and increasing physical activity. In some cases, insulin or oral medication may also be prescribed.

Gestational diabetes normally disappears after birth. However, women who have had gestational diabetes are at higher risk of developing gestational diabetes in subsequent pregnancies and type 2 diabetes later in life. Babies born to mothers with gestational diabetes also have a higher risk of developing type 2 diabetes in their teens or early adulthood[5].

Risk factors for gestational diabetes include genetics[6], increasing maternal age[7,8], family history of diabetes[7,8], maternal overweight or obesity[7,8], history of gestational diabetes in previous pregnancies[8] and physical inactivity[9].

Groups at risk: impaired glucose tolerance and impaired fasting glucose

People with raised blood glucose levels that are not high enough for a diagnosis of diabetes are said to have impaired glucose tolerance (IGT) or impaired fasting glucose (IFG)[10]. These conditions are known as intermediate hyperglycaemia and commonly referred to as "pre-diabetes".

Impaired glucose tolerance is diagnosed following a glucose tolerance test. This involves measuring the blood glucose concentration two hours after a drink containing 75g of glucose. In impaired glucose tolerance, the glucose level is higher than normal, but not high enough to make a diagnosis of diabetes (i.e. between 7.8 and 11.1mmol/l (140 to 200 mg/dl)). Impaired fasting glucose is diagnosed when the fasting glucose level is higher than normal, but not high enough to make a diagnosis of diabetes (between 6.1 and 7 mmol/l (110 and 125 mg/dl)). Raised levels of HbA1c in the non-diabetic range can also be used to identify people at risk of developing type 2 diabetes.

People with intermediate hyperglycaemia are at increased risk of developing type 2 diabetes. It shares many characteristics with type 2 diabetes, and is associated with advancing age and the inability of the body to use the insulin it produces. Not everyone with intermediate hyperglycaemia goes on to develop type 2 diabetes; lifestyle interventions – healthy diet and physical activity – can work to prevent the progression to diabetes[11].

2 Introduction to cardiovascular disease

Diabetes and cardiovascular disease

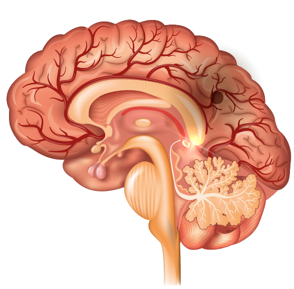
People with both type 1 and type 2 diabetes are at higher risk of developing a number of disabling and life-threatening health problems than people without diabetes. Consistently high blood glucose levels can lead to serious diseases affecting the heart and blood vessels, eyes, kidneys and nerves. The increase in prevalence of type 2 diabetes[1] means that without effective strategies to support better management of diabetes, it is likely that there will be large increases in the rates of these complications in low- and middle- income countries.

Diabetes complications can be prevented or delayed by maintaining blood glucose, blood pressure and cholesterol levels as close to normal as possible[2]. Many complications can be detected in their early stages by screening programmes that allow treatment to prevent them from becoming more serious.

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels, and is tone of the most common causes of death and disability among people with diabetes. Diabetes is associated with high blood pressure and cholesterol levels, and

Figure 2.1
THE MAIN TYPES OF CARDIOVASCULAR DISEASES (CVD) INCLUDE STROKE, CORONARY ARTERY DISEASE AND PERIPHERAL ARTERY DISEASE

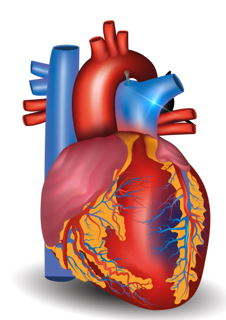
STROKE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE BRAIN

includes:
cerebrovascular disease,
cerebral arterial disease,
intracerebral hemorrhage,
cerebral infarction

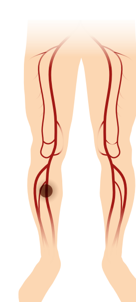
CORONARY ARTERY DISEASE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE HEART

includes:
ischaemic heart disease,
atherosclerotic heart disease,
coronary heart disease,
angina pectoris, heart attack (myocardial infarction),
sudden coronary death

PERIPHERAL ARTERY DISEASE



AFFECTS THE BLOOD VESSELS SUPPLYING BLOOD TO THE LEGS AND FEET

includes:
lower-extremity arterial disease,
limb threatening ischaemia,
intermittent claudication,
critical limb ischaemia

> “Diabetes complications can be prevented or delayed by maintaining blood glucose, blood pressure and cholesterol levels as close to normal as possible.”

these lead to increased risk of atherosclerosis (narrowing of the arteries). This can lead to symptoms such as angina pectoris or intermittent claudication. High blood glucose can make the blood coagulation system more active, increasing the risk of blood clots. Together these can lead to arteries being blocked completely, stopping the blood flow, resulting in conditions such as myocardial infarction, stroke and gangrene (Figure 2.1).

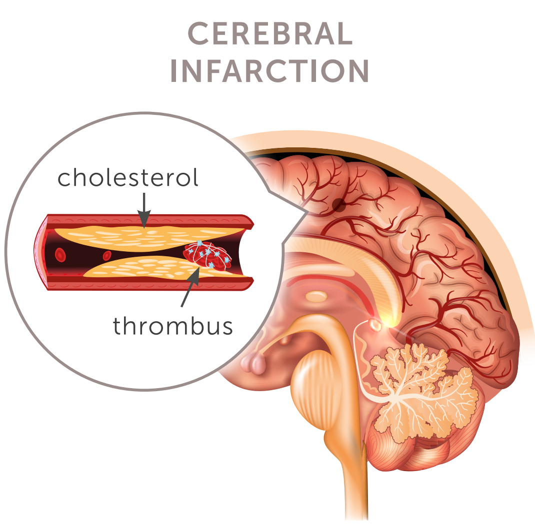
Stroke

Stroke is one form of cerebrovascular disease (cerebral arterial disease), which can result from cerebral infarction or cerebral haemorrhage (Figure 2.2).

The brain receives its blood supply from four main arteries: the two carotid arteries and the two vertebral arteries. The clinical

Figure 2.2
STROKE CAN ARISE FROM CEREBRAL INFARCTION OR CEREBRAL HAEMORRHAGE

A thrombus (blood clot) may originate the brain, or be formed in the heart or blood vessels and then travel to the brain. Cholesterol is not always present in the blood vessels of the brain.



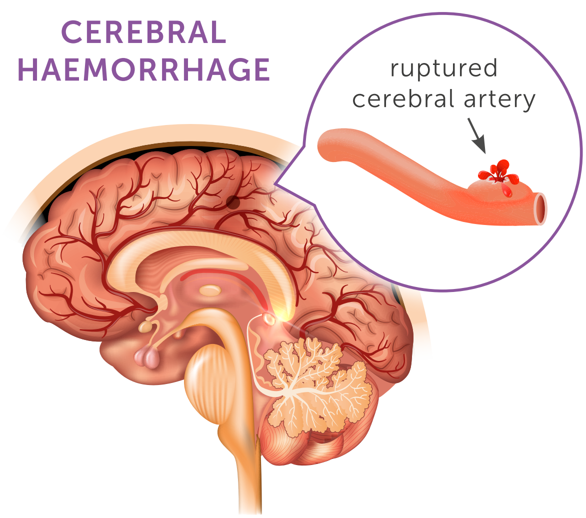
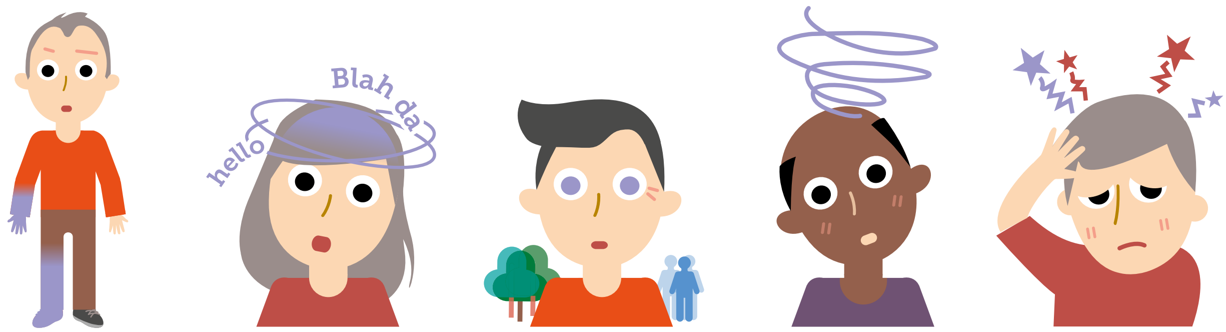


Figure 2.3
THE MAIN SYMPTOMS OF STROKE



SUDDEN WEAKNESS AND NUMBNESS (face, arm or leg)

SUDDEN CONFUSION (trouble speaking or understanding)

SUDDEN VISION PROBLEMS (one or both eyes)

SUDDEN DIZZINESS

SUDDEN HEADACHE with no known cause

consequences of vascular disease in the brain will depend upon the part of the brain that is affected.

Stroke occurs when a blood vessel becomes blocked or ruptures, resulting in damage to an area within the brain. If a large vessel is affected, the outcome may be rapidly fatal or may lead to very severe disability. If smaller blood vessels are affected, the outcome is less critical and recovery may be good. The most common types of disability are the loss of use of one side of the body and speech problems[(4)]. The main symptoms of stroke are sudden and include weakness, numbness, confusion, vision problems, dizziness and headache (Figure 2.3).

> “Stroke occurs when the blood supply to a part of the brain is blocked resulting in damage to an area within the brain.”

Coronary artery disease

The heart receives its blood supply from the coronary arteries. Coronary artery disease occurs when these arteries are narrowed or blocked. Coronary artery disease, also known as ischaemic heart disease, atherosclerotic heart disease or coronary heart disease is a group of diseases that includes angina pectoris, heart attack, heart failure and sudden coronary death.

> “Coronary artery disease occurs when arteries supplying blood to the heart are narrowed or blocked.”

Angina pectoris

Angina pectoris is used to describe pain in the chest due to a reduced blood supply to the heart (ischaemia). Angina pectoris results from insufficient blood supply to the muscle tissue of the heart, and may be life threatening when unstable. Typically angina pectoris causes central chest pain, which often radiates to the left arm, shoulder or jaw and is associated with exertion or emotional stress. Shortness of breath and sweating are also common. Angina pectoris and heart attack are both classified as acute coronary syndromes[5].

Heart attack (myocardial infarction)

Heart attack, also known as myocardial infarction, results from permanent damage to an area of the heart muscle due to blocked blood vessels. The onset of a heart attack is usually heralded by severe central chest pressure, which may also radiate to the left arm, shoulder or jaw. Severe shortness of breath, sweating and feeling faint are common additional symptoms. Symptoms may differ between women and men (Figure 2.4).

Heart failure

Heart failure occurs when damage to the heart muscle is severe enough to prevent it from functioning adequately as a pump. Symptoms include shortness of breath, swelling in the legs or ankles, fatigue and weakness. Early and appropriate treatment of heart failure is essential and differs from the treatment of heart attack[6].

Figure 2.4
HEART ATTACK WARNING SIGNS

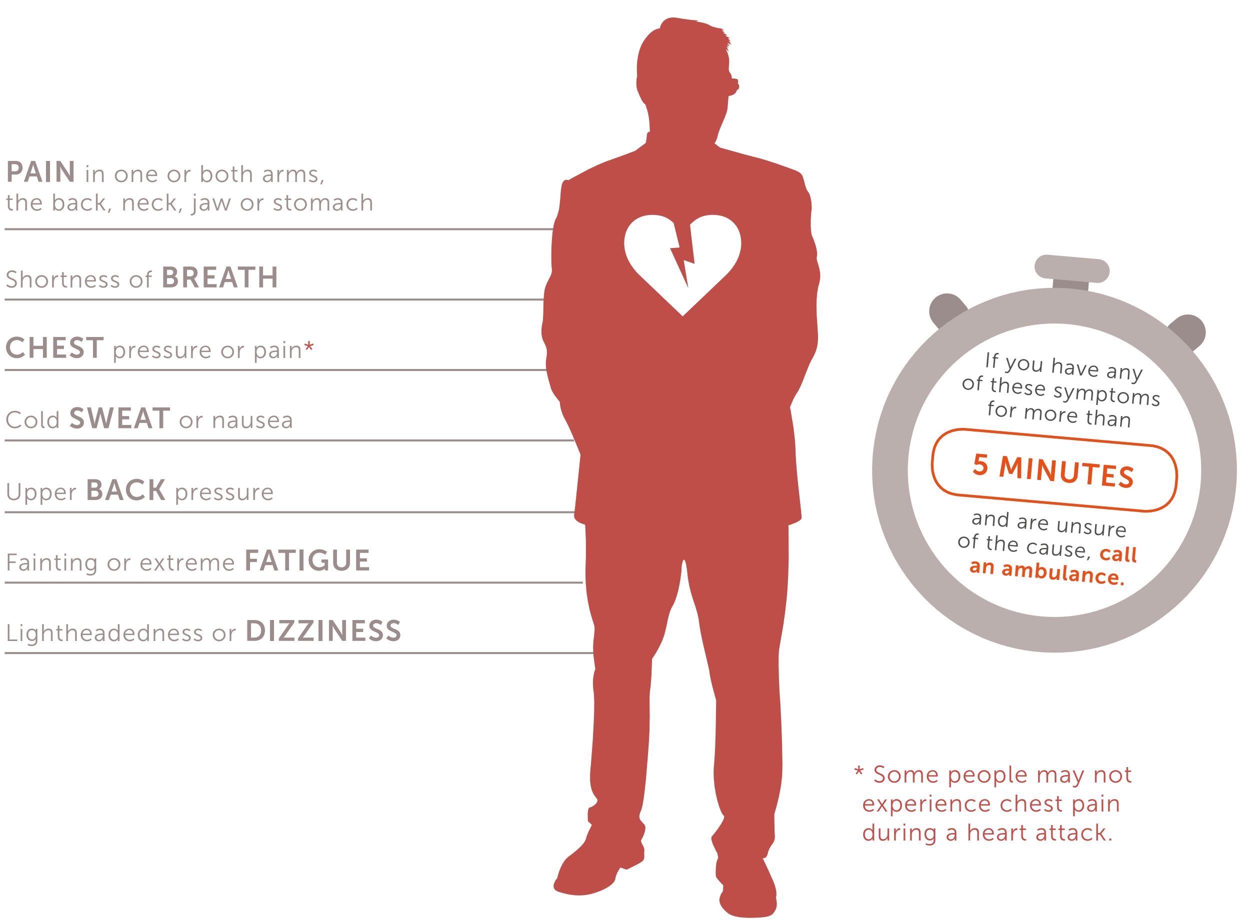


Table of contents

Sudden coronary death

Sudden death can occur as a consequence of an abrupt loss of the heart's ability to pump blood. It may result from a massive heart attack or a severe abnormality of the rhythm of the heartbeat.

> “Chest pressure or pain is an indicator of a possible heart attack.”

Peripheral vascular disease

Peripheral vascular disease, which includes lower-extremity arterial disease, is a narrowing of the arteries other than those that supply blood to the brain or the heart. Symptoms can include intermittent claudication and critical limb ischaemia(7).

Intermittent claudication

This term describes pain, usually in the calves when walking, and is due to an impaired blood supply to the calf muscles.

Critical limb ischaemia

Critical limb ischaemia, also known as limb threatening ischaemia, is an advanced stage of peripheral artery disease. It includes ischemic rest pain, arterial insufficiency ulcers and gangrene. Gangrene is used to describe the death of tissue due to a loss of blood supply. Severe gangrene can occur as a result of the blockage of a large blood vessel, and is more common in people with diabetes. Gangrene can also result from disease of the smaller blood vessels producing localized damage, for example in the toes(8).

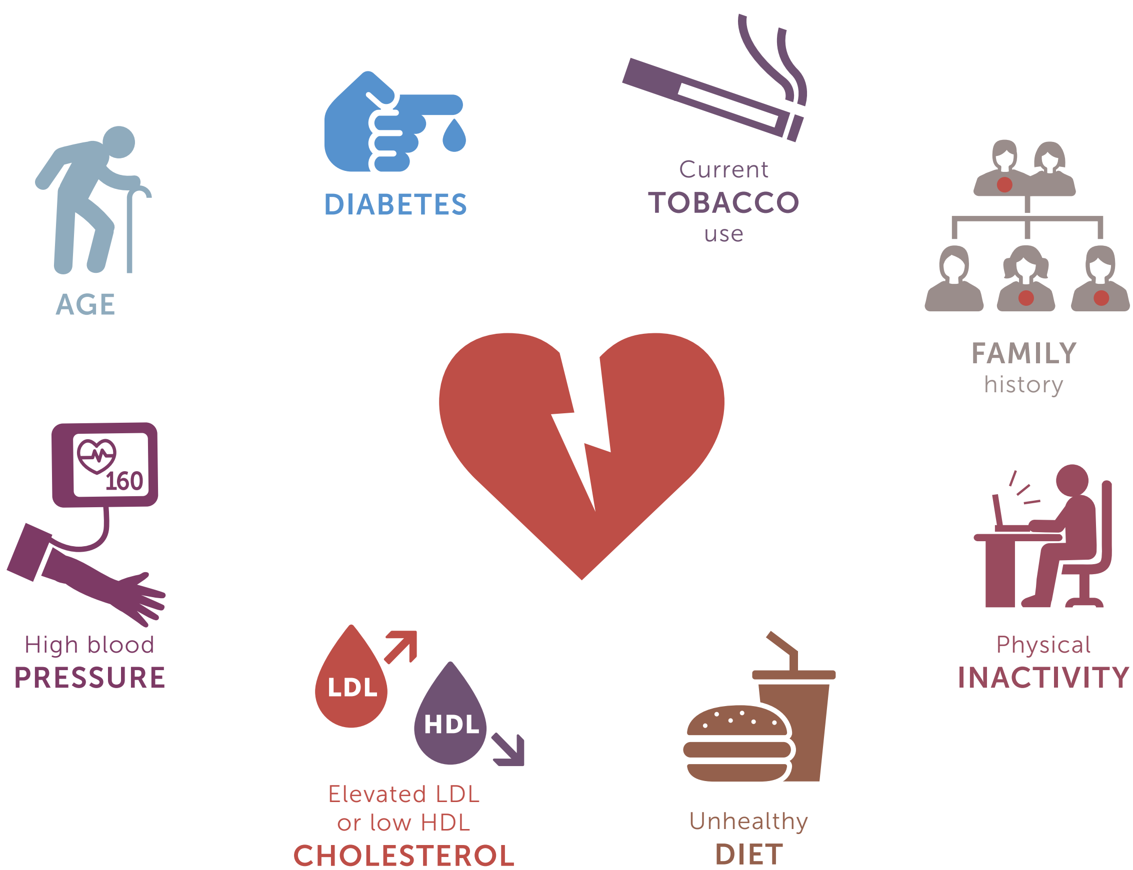
CVD-related mortality

CVD is the number one cause of death worldwide, with 17.5 million deaths in 2012, with the majority of these deaths occurring in low- and middle-income countries[9]. Furthermore, 75% of people with diabetes live in low- and middle-income countries[1]. CVD mortality is declining in high-income countries due to reductions in cardiovascular risk factors as well as to recent advances in prevention, treatment and management[10].

Risk factors

Risk factors that increase the likelihood of a CVD event include age, diabetes, current smoking, elevated low-density lipoproteins (LDL) or low high-density lipoproteins (HDL) cholesterol, high blood pressure, unhealthy diet, family history, overweight/obesity and physical inactivity (Figure 2.5)[11–13].

Figure 2.5
CARDIOVASCULAR DISEASE (CVD) RISK FACTORS



3 Global patterns in diabetes and cardiovascular disease

Introduction

The prevalence of cardiovascular disease is very high in many countries that also have high rates of diabetes. Diabetes now rivals smoking, high blood pressure and lipid disorders as a major risk factor for cardio-vascular disease[1]. As the number of people with diabetes around the world is predicted to increase from 642 million by 2040[2], the outlook for cardiovascular disease becomes even more alarming.

Cardiovascular disease is a major worldwide public health problem, and is the number one cause of death in industrialised countries. It is also set to overtake infectious diseases as the most common cause of death in many low- and middle-income countries, with levels becoming comparable to those in high-income countries[3].

Furthermore, people with diabetes also have a higher prevalence of many of the other common cardiovascular risk factors than the general population, such as high blood pressure[4].

This chapter contains an analysis of the global patterns of diabetes prevalence, cardiovascular disease mortality, non-communicable disease mortality, and the prevalence of associated risk factors.

Non-communicable diseases are medical conditions or diseases that are non-infectious and non-transmissible among people. They include cardiovascular diseases, diabetes, cancers and chronic respiratory diseases.

> “Diabetes now rivals smoking, high blood pressure and lipid disorders as a major risk factor for cardiovascular disease.”

See the abbreviations on page 116 and
the methodology of chapter 3 on page 120

Global patterns of non-communicable disease mortality

A retrospective country-based database analysis of global patterns of non-communicable disease mortality was conducted using the IDF Diabetes Atlas 2015 database and the World Health Organization global health observatory repository. The data repository contains health-related statistics from around the world with a focus on comparable country level estimates. The data collection helps to monitor global, regional and country specific situation and trends. The statistics on mortality and burden of disease, health systems, environmental health and non-communicable diseases were extracted from the repository and only the latest available information was utilised. Experts in the field selected a subset of parameters that were the most relevant for the analysis (see Table 3.1 and Methodology section in the Appendix). Complete data were available for 127 countries and territories. Tobacco control policies could not be examined due to lack of data.

Table 3.1
VARIABLES USED IN THE ANALYSIS OF GLOBAL PATTERNS OF CVD MORTALITY

Variables from IDF Diabetes Atlas
Age-standardised diabetes prevalence
Proportion of diabetes-attributable deaths that occur under 60
IDF Geographic Region (Europe, Africa, North America and Caribbean, Middle East and North Africa, Western Pacific, South-East Asia, South America and Central America)

Variables from World Health Organization global health observatory repository
Existence of evidence-based national guidelines/protocols/standards for the management of major NCDs through a primary care approach
Existence of operational policy/strategy/action plan to decrease tobacco use
Existence of operational policy/strategy/action plan to reduce unhealthy diets
General availability of metformin (medication used primarily for the treatment of type 2 diabetes) in the public health sector
General availability of ACE inhibitors (medications used primarily for the treatment of hypertension) in the public health sector
General availability of diabetes testing at the primary health care level
Existence of an NCD surveillance and monitoring system
Existence of operational policy/strategy/action plan for diabetes
Gross national income per capita
General government expenditure on health as a percentage of total government expenditure
Prevalence of raised total cholesterol
Prevalence of obesity
Prevalence of raised blood pressure

Main outcome
Cardiovascular diseases, deaths per 100,000

Non-communicable disease mortality

Non-communicable deaths primarily consist of those caused by cardiovascular diseases, cancers, diabetes and respiratory diseases. In 2012, over 37.9 million people worldwide died from non-communicable diseases. The countries with the highest age-standardised rates of non-communicable disease mortality are found in Central Asia, as well as Guyana in South America and Sierra Leone in Africa (Figure 3.1). In many of these countries, both life expectancy and population size has decreased since 1990, due to the increasing impact of non-communicable diseases and injuries[(5)]. For example, reducing the impact of non-communicable diseases and injuries in Russia to the levels of countries in the European Union would improve nationwide life expectancy by over 10 years[(6)]. Countries with the lowest age-standardised rates of non-communicable disease mortality include Switzerland, Singapore and Japan.

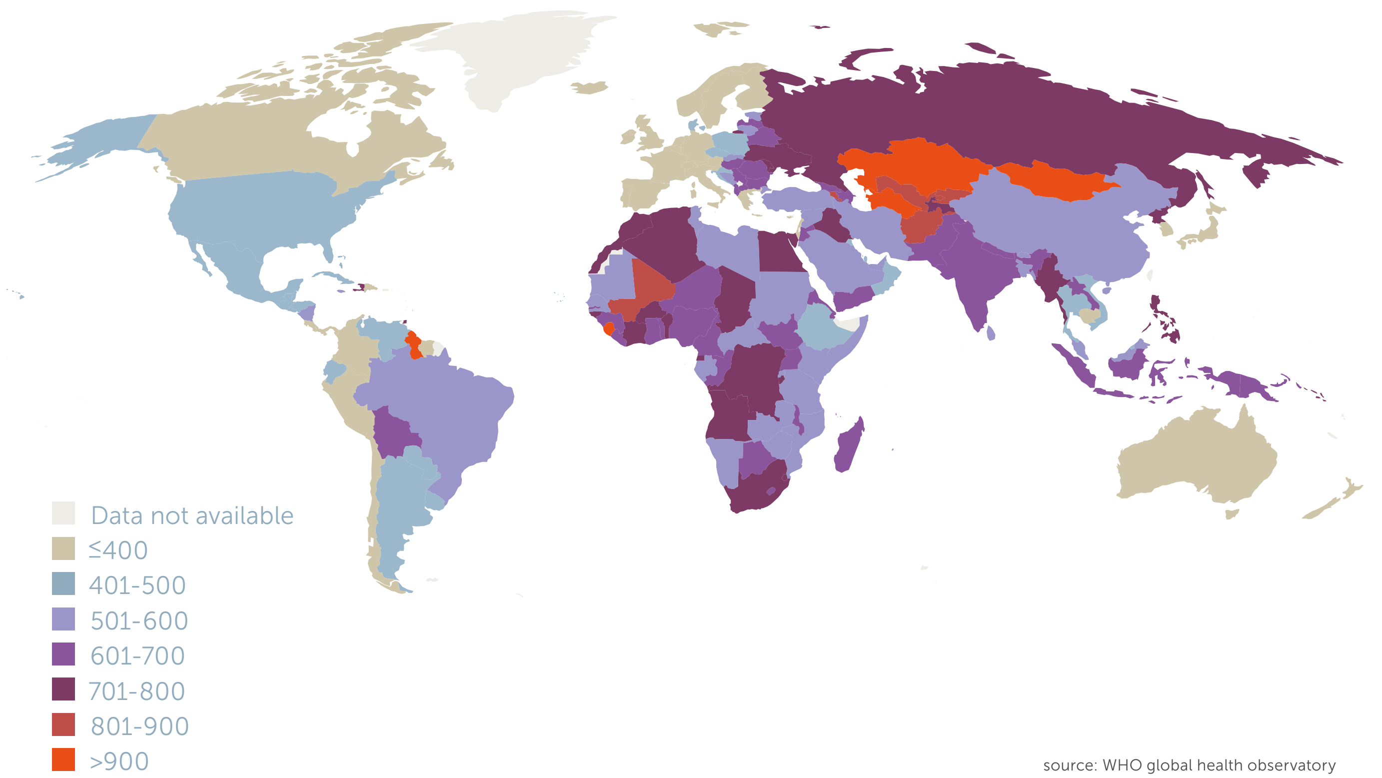
The most populous countries have the largest absolute number of people dying from non-communicable diseases (Table 3.2, Figure 3.2). In 2012, over 8 million people in China and over 5 million people in India were estimated to have died due to non-communicable diseases. Despite Japan's low age-standardised rate, over 947,000 people died from non-communicable diseases, due to both its large population (127 million people) and high median age (46.5 years). A similar pattern was seen in Germany.

Table 3.2
TOP 10 COUNTRIES BY TOTAL NON-COMMUNICABLE DISEASE (NCD) DEATHS IN 2012

source: WHO global health observatory

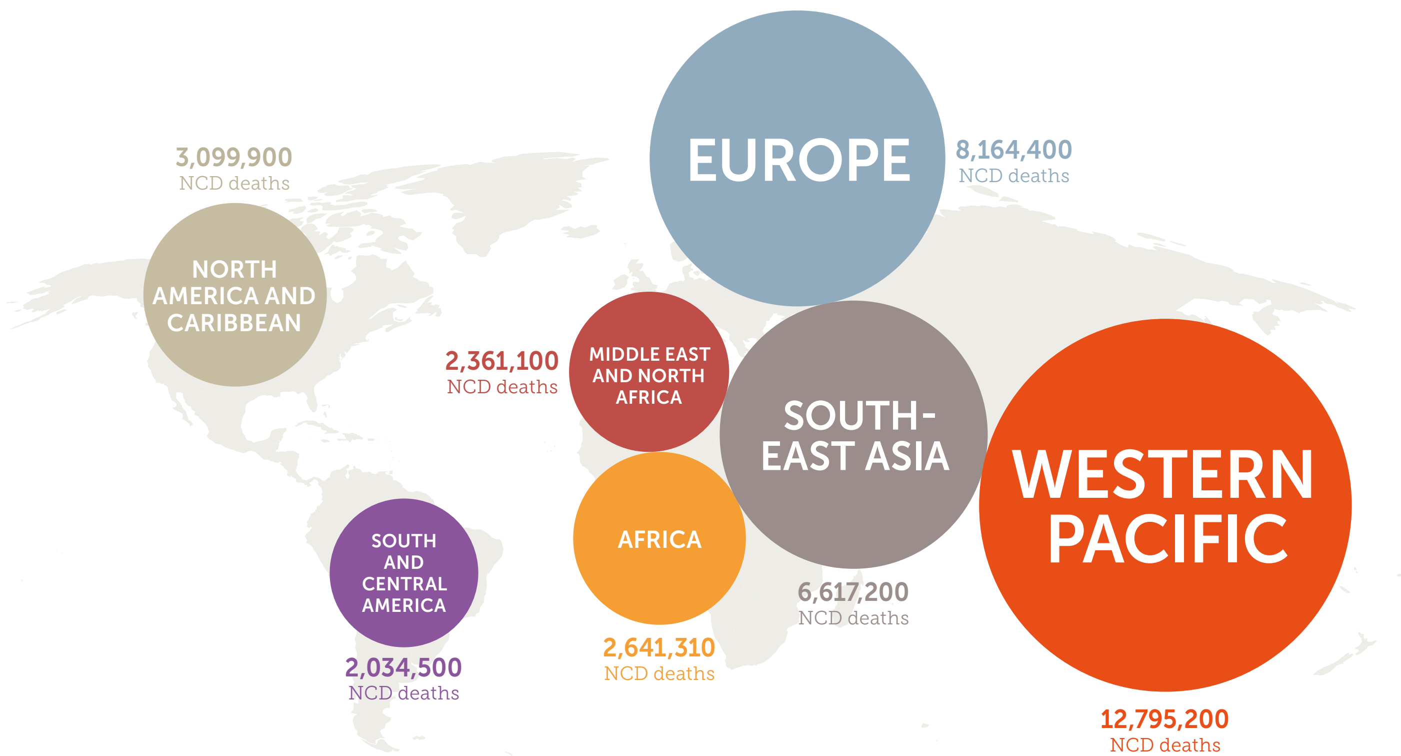
Rank	Country	Total NCD deaths in 2012
1	China	8,576,990
2	India	5,868,810
3	United States of America	2,334,060
4	Russian Federation	1,801,500
5	Indonesia	1,105,710
6	Brazil	978,220
7	Japan	947,580
8	Germany	790,540
9	Pakistan	672,530
10	Ukraine	614,410

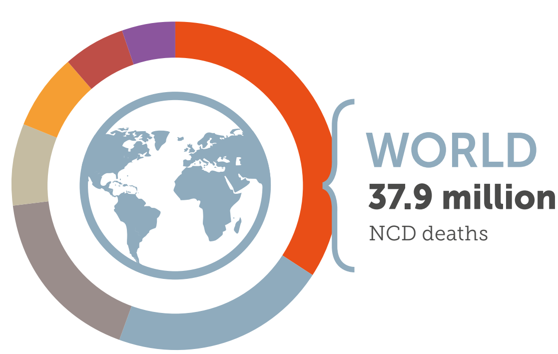
Figure 3.1
MAP OF AGE-STANDARDISED MORTALITY DUE TO NON-COMMUNICABLE DISEASES PER 100,000 IN 2012



source: WHO global health observatory

Figure 3.2.a
TOTAL NUMBER OF PEOPLE WHO DIED FROM NON-COMMUNICABLE DISEASES IN 2012, PER IDF REGION





source: WHO global health observatory

Figure 3.2.b
DEMERS CARTOGRAM OF PEOPLE WHO DIED FROM NON-COMMUNICABLE DISEASES IN 2012, PER COUNTRY

“37.9 million people die from non-communicable diseases each year.”

source: WHO global health observatory

Table of contents

Global patterns of cardiovascular disease mortality

Worldwide, over 46% of all non-communicable disease deaths are due to CVD, causing over 17.5 million deaths in 2012. CVD deaths primary consist of those caused by stroke and coronary artery disease (see Chapter 2). The countries with the highest age-standardised rates of CVD mortality are found in Central Asia and neighbouring Mongolia, Ukraine and the Russian Federation, as well as Guyana in South America (Figure 3.3). Countries with the lowest age-standardised rates of CVD mortality include Israel, France and Japan.

While CVD is responsible for a substantial number of deaths in all countries worldwide, the most populous countries have the largest absolute number of people dying from CVD (Table 3.3, Figure 3.6). Although China has the 70th highest rate of age-standardised CVD mortality (300 deaths per 100,000 per year), due to its large population it has the world's largest number of people dying from CVD (over 4 million deaths per year). Similarly, while India is ranked at number 67 in terms of age-standardised CVD mortality rate (306 deaths per 100,000 people per year), it has the second largest number of people dying from CVD (over 2 million deaths per year).

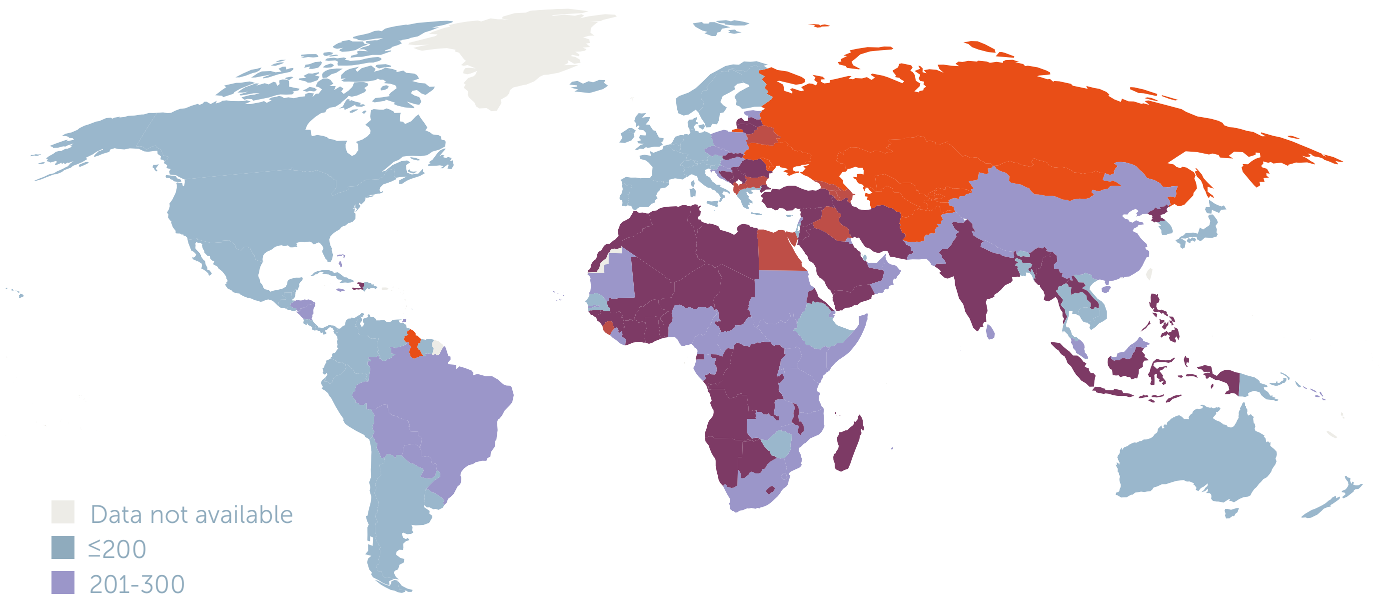
Table 3.3
TOP 10 COUNTRIES BY TOTAL CARDIOVASCULAR DISEASE (CVD) DEATHS IN 2012

source: WHO global health observatory

Rank	Country	Total CVD deaths in 2012
1	China	4,435,440
2	India	2,536,950
3	Russian Federation	1,252,380
4	United States of America	815,750
5	Indonesia	572,480
6	Ukraine	465,940
7	Brazil	408,190
8	Germany	349,550
9	Japan	349,200
10	Pakistan	249,000

> “The countries with the largest number of CVD-related deaths are the most populous countries, and include China, India and the Russian Federation.”

Figure 3.3
MAP OF AGE-STANDARDISED CARDIOVASCULAR DISEASE (CVD) MORTALITY PER 100,000 PEOPLE IN 2012



Data not available
≤200
201-300
301-400
401-500
>500

source: WHO global health observatory

> “CVD caused 17.5 million deaths worldwide in 2012.”

Global patterns of diabetes mortality

Estimating the number of deaths attributable to diabetes is challenging because many countries do not have any data on diabetes-related mortality and routine health statistics and death certificates underestimate the number of deaths due to diabetes[7]. To provide a more realistic estimate of mortality, the IDF Diabetes Atlas uses a modelling approach to estimate the number of deaths that can be attributed to diabetes, based on regional estimates of the relative risk a person with diabetes has of dying, compared to those without diabetes, rather than relying on the cause of death written on death certificates[8].

Approximately 5.0 million people aged between 20 and 79 years are estimated to have died from diabetes in 2015. These diabetes-attributable deaths were responsible for 13.1% of all non-communicable deaths of people of all ages, and include deaths from CVD related complications in people with diabetes. Close to half (46.6%) of deaths due to diabetes are in people under the age of 60[2]. The countries with the highest rates of diabetes-attributable mortality include Mauritius and Pacific Islands in the Western Pacific Region (Figure 3.4). These countries are estimated to have national diabetes prevalence rates of over 12 percent.

The countries with the lowest rates of diabetes-attributable mortality are low and lower-middle-income countries in Western Africa, including Ghana, Senegal, and Benin. These countries are estimated to have national diabetes prevalence rates of less than 3 percent.

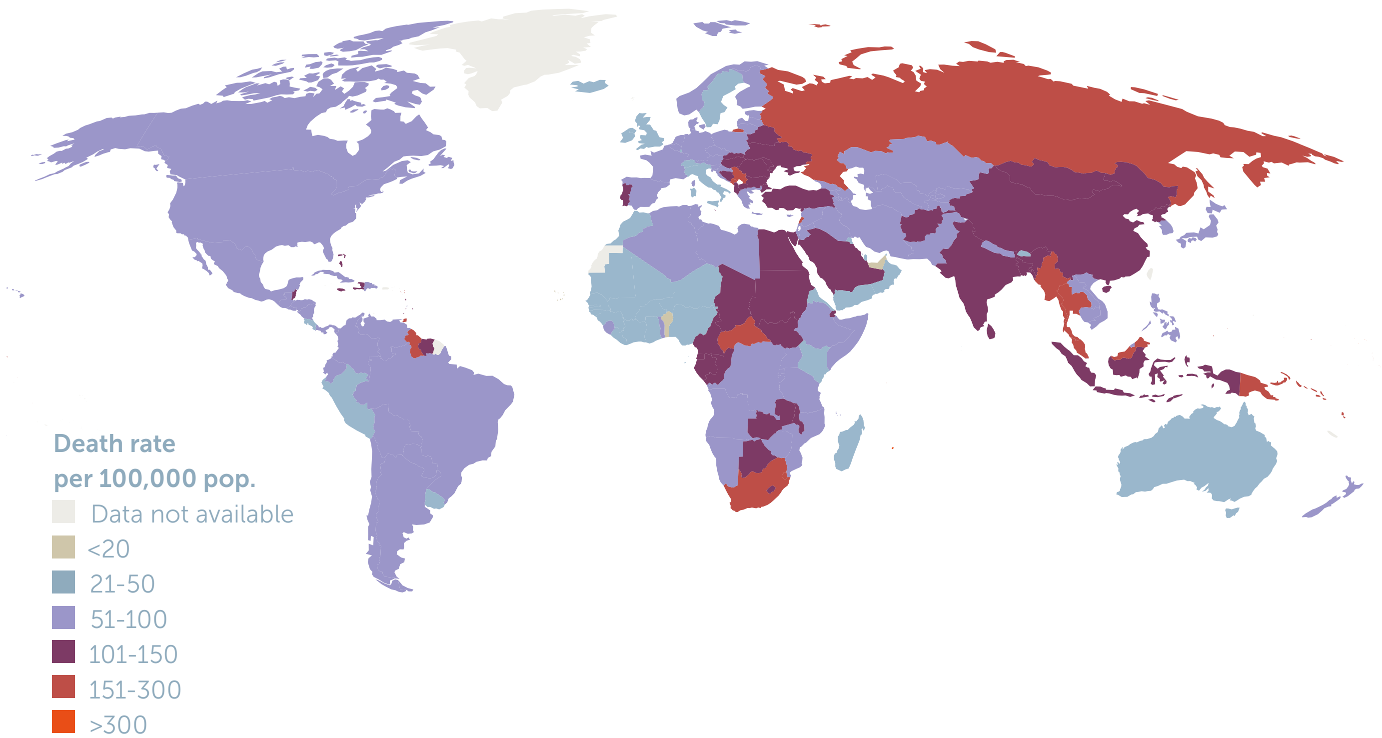
The most populous countries have the highest absolute number of people dying from diabetes (Table 3.4). In 2015, over 1 million people in China and an additional 1 million people in India were estimated to have died due to diabetes.

Table 3.4
TOP 10 COUNTRIES BY TOTAL DIABETES-ATTRIBUTABLE DEATH IN 2015

source: IDF Diabetes Atlas

Rank	Country	Deaths
1	China	1,299,700
2	India	1,027,900
3	United States of America	219,400
4	Russian Federation	186,100
5	Indonesia	185,000
6	Brazil	130,700
7	Bangladesh	129,300
8	Pakistan	86,400
9	Egypt	78,200
10	Mexico	76,300

Figure 3.4
MAP OF DIABETES-ATTRIBUTABLE MORTALITY PER 100,000 PEOPLE IN 2015



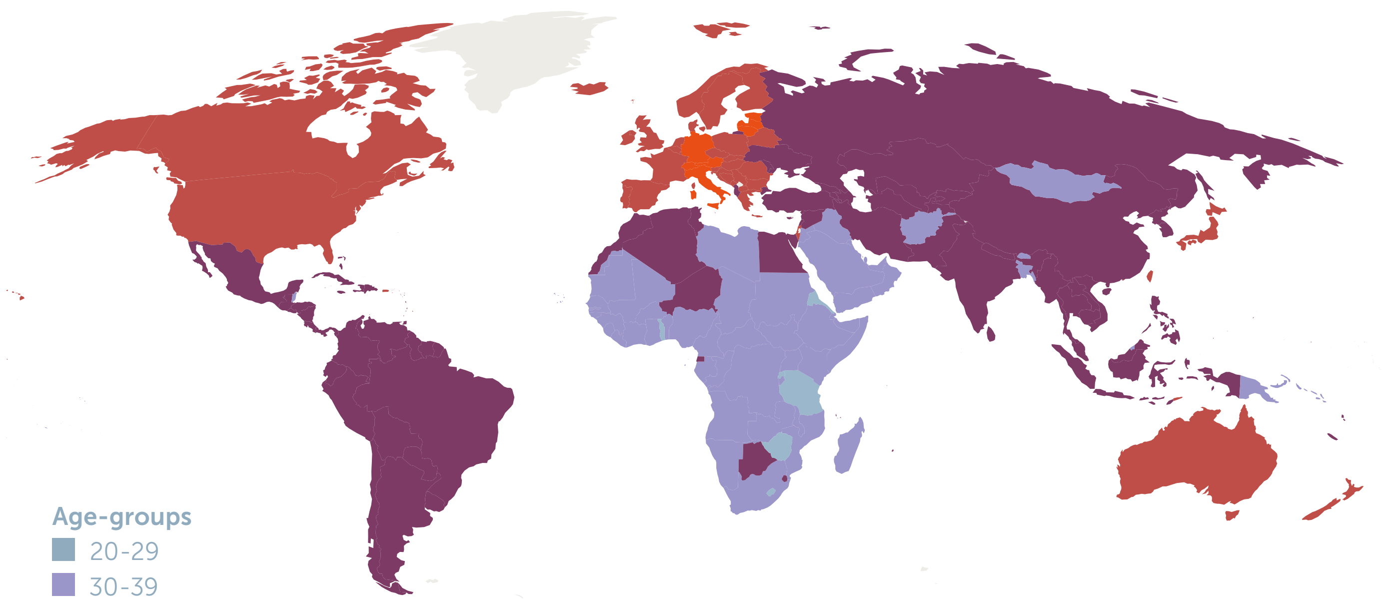
source: IDF Diabetes Atlas

In Africa and the Gulf region, most people with diabetes are aged below 40 (Figure 3.5). However, in Australia, North America, Western Europe and Japan, most people with diabetes are over 50 years of age. As age is a major risk factor for CVD, older people living with diabetes are at additional risk of stroke or heart attack[9].

“In Australia, North America, Western Europe and Japan, most people with diabetes are over 50 years of age.”

As CVD is one of the leading causes of death among people with diabetes, there will be considerable overlap between deaths attributable to CVD and those attributed to diabetes (Figure 3.6).

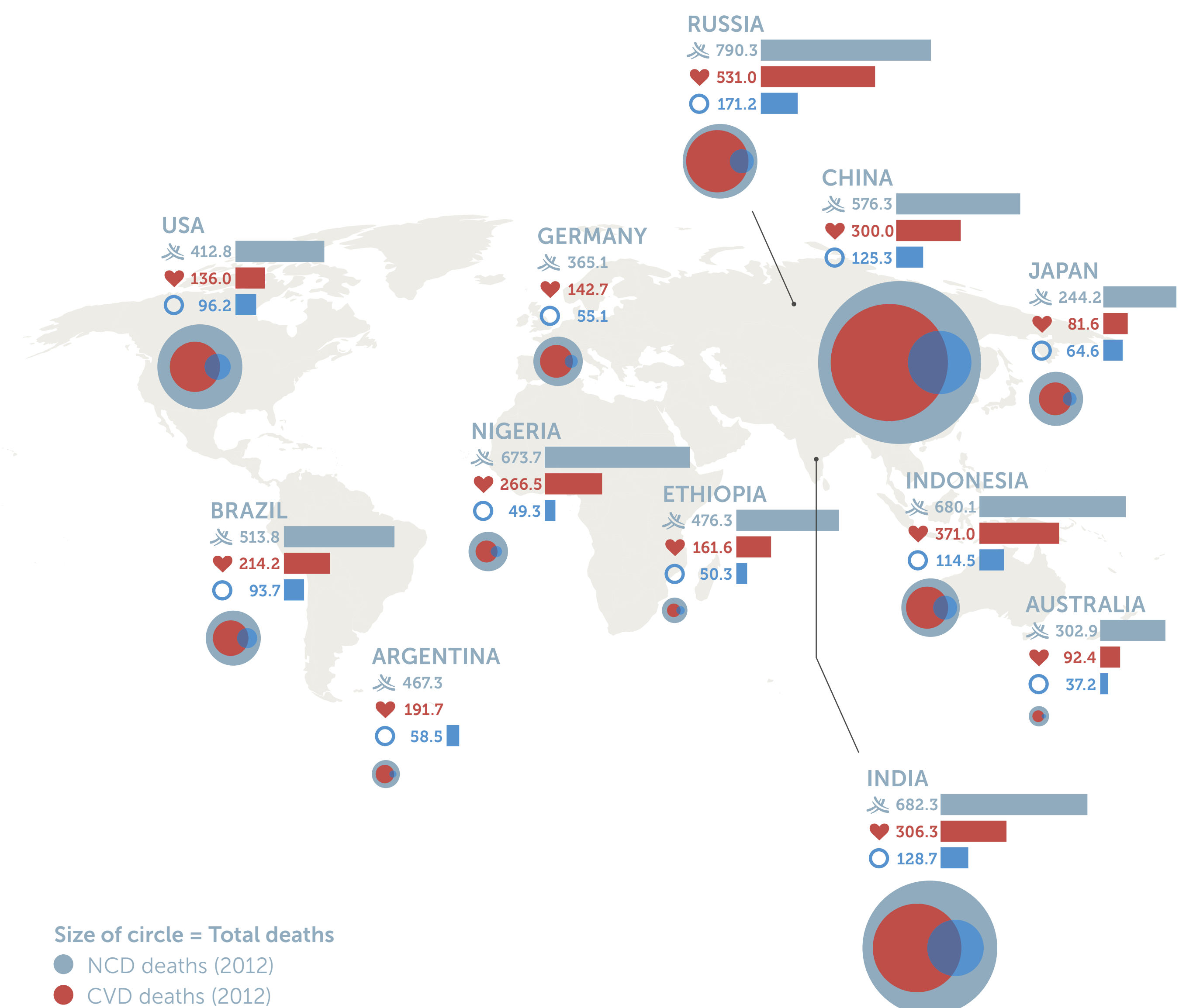
Figure 3.5
MAP OF THE AGE GROUP WITH THE LARGEST NUMBER OF PEOPLE LIVING WITH DIABETES IN 2015



Age-groups
- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- Data not available

source: IDF Diabetes Atlas

Figure 3.6
EXAMPLES OF MORTALITY RATES AND NUMBER OF DEATHS FROM NON-COMMUNICABLE DISEASES, CARDIOVASCULAR DISEASE AND DIABETES

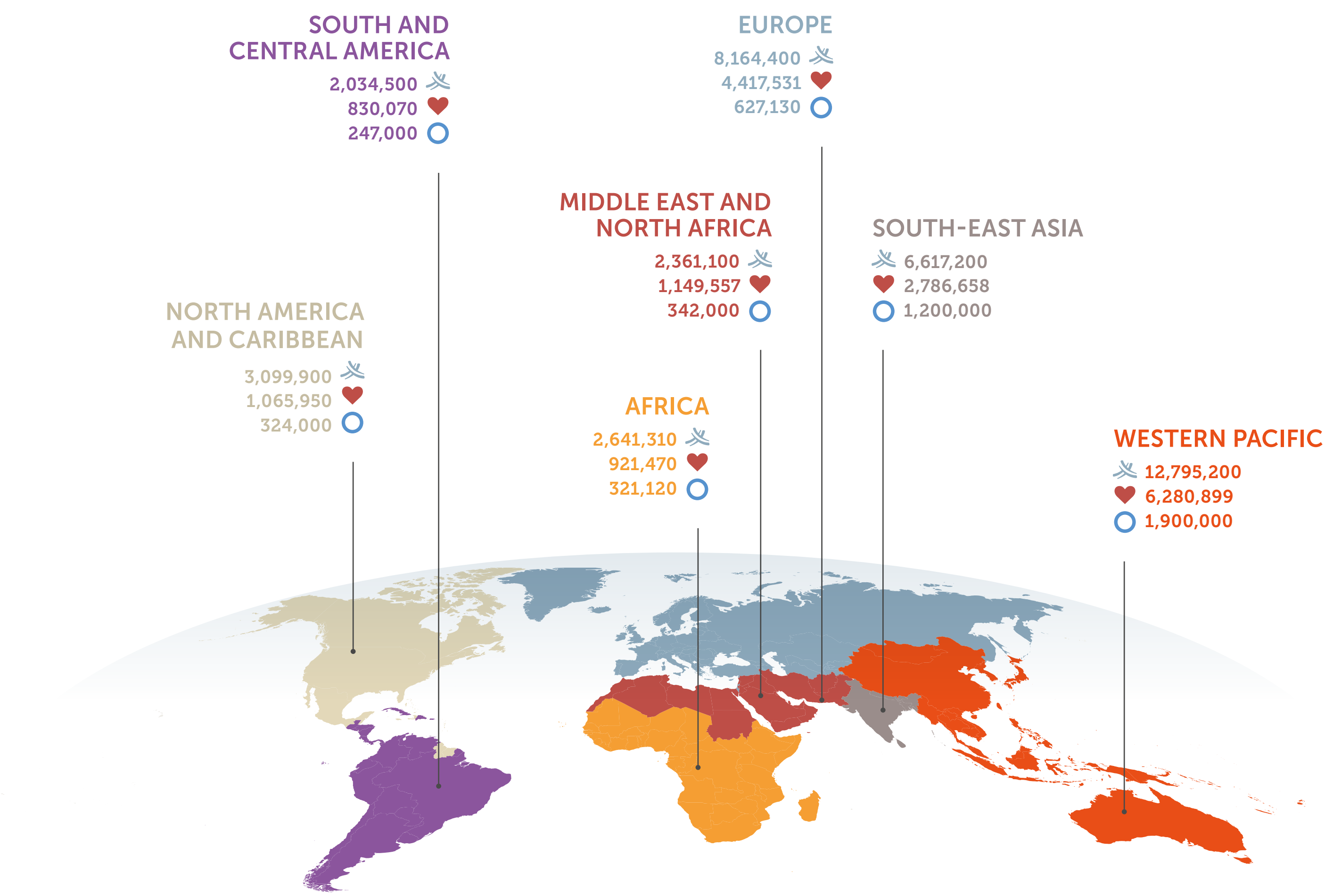


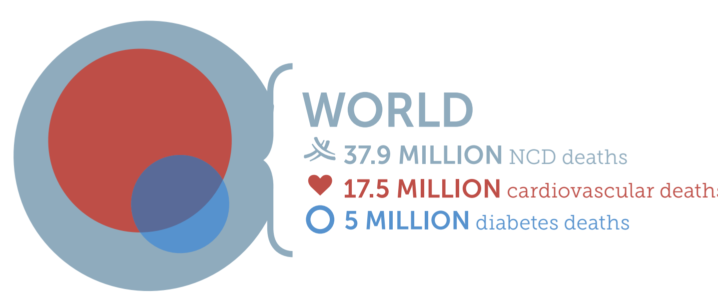
Size of circle = Total deaths
- NCD deaths (2012)
- CVD deaths (2012)
- Diabetes-attributable deaths (2015)

- NCD mortality per 100,000 people, age-standardised (2012)
- Cardiovascular mortality per 100,000 people, age-standardised (2012)
- Diabetes-attributable mortality per 100,000 people (2015)

source: WHO global health observatory and IDF Diabetes Atlas

Figure 3.7
NON-COMMUNICABLE DISEASE (NCD), CARDIOVASCULAR DISEASE (CVD) AND DIABETES ATTRIBUTABLE MORTALITY BY IDF REGION





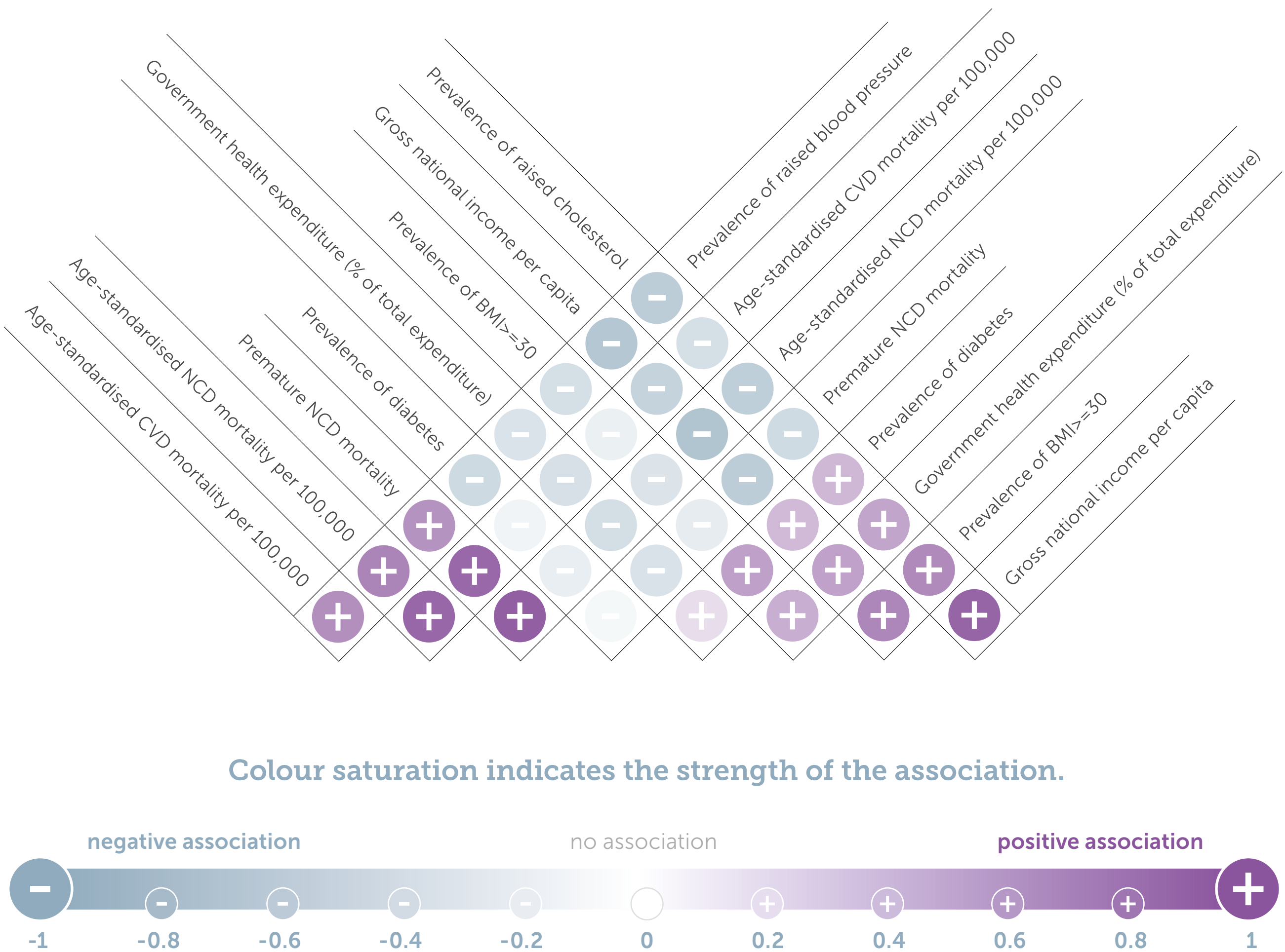
NCD total deaths (2012)
CVD total deaths (2012)
Diabetes-attributable total deaths (2015)

source: WHO and IDF Diabetes Atlas

A correlation matrix was produced to examine the associations between non-communicable disease mortality, CVD mortality, diabetes prevalence, health expenditures, gross national income, obesity prevalence, raised blood pressure prevalence and raised total cholesterol prevalence (Figure 3.8). There is a strong positive association between the gross national income and raised total cholesterol, meaning that the wealthier a country is, the more likely it is that the population will have a high prevalence of raised cholesterol levels. There are strong negative associations between gross national income and the non-communicable disease death rate, as well as between gross national income and the prevalence of raised blood pressure. This means that countries with a low gross national income are more likely to have a high non-communicable disease death rate and a high prevalence of raised blood pressure.

Figure 3.8

CORRELATION MATRIX ILLUSTRATING THE ASSOCIATIONS BETWEEN NON-COMMUNICABLE DISEASE (NCD) DEATH RATES, CARDIOVASCULAR DISEASE (CVD) DEATH RATES AND OTHER COUNTRY-LEVEL VARIABLES



sources: WHO global health observatory and IDF Diabetes Atlas

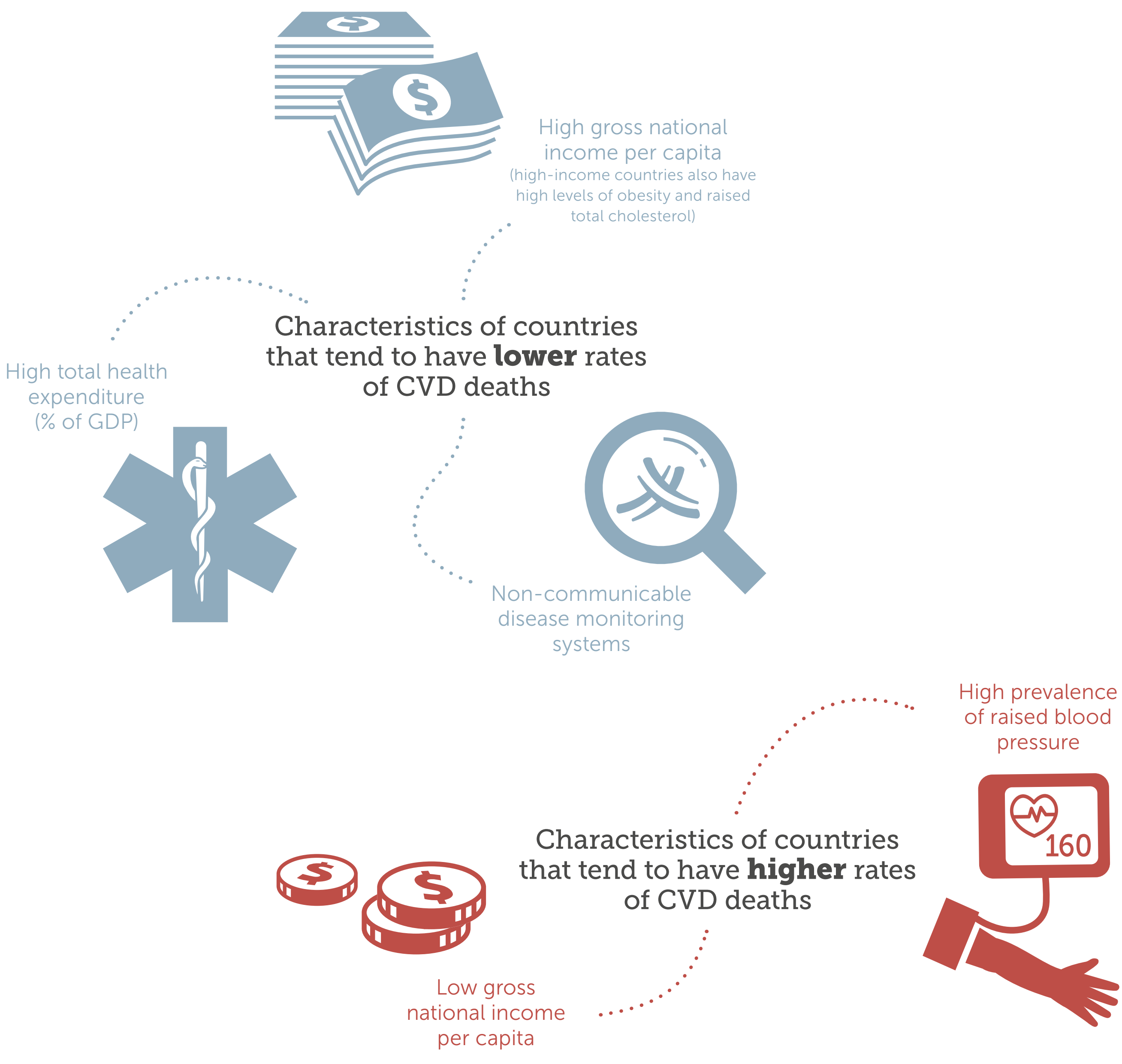
Characteristics of countries with high and low cardiovascular disease mortality rates

The regression coefficients from the principal components analysis (see Appendix for methodology) identified several variables that were significant (confidence intervals did not include zero) and strongly associated (value more 0.05 for positive associations or less than -0.05 for negative associations) with a country having a high or low rate of aged-standardised CVD deaths per 100,000 people.

Countries with low rates of CVD mortality were more likely to have a high per capita gross national income, high health expenditure as a percentage of gross domestic product and have non-communicable surveillance and monitoring systems. These countries were also likely to have high levels of obesity and high levels of raised cholesterol (Figure 3.9).

Countries with high rates of CVD mortality (per 100,000 people) were more likely to have a low per capita gross national income and high prevalence of raised blood pressure (Figure 3.9).

Figure 3.9
CHARACTERISTICS OF COUNTRIES WITH HIGH AND LOW RATES OF AGE-STANDARDISED CARDIOVASCULAR DISEASE (CVD) MORTALITY



source: WHO global health observatory

National income

Gross national income is a measure of the size of a country's economy. It is the sum of the products produced by enterprises owned by a country's citizens, excluding products produced by foreign-owned enterprises. A high-income country is defined by the World Bank to have a gross national income per capita of $12,736 or more (Figure 3.10). A middle-income country has a gross national income per capita of more than $1,045 and less than $12,736 and a low-income country has a gross national income per capita of $1,045 or less.

Countries with high national incomes are more likely to have low rates of CVD mortality (Figure 3.11). High-income countries in Europe, the Middle East, Western Pacific and North America have the lowest rates of CVD mortality. Low- and middle-income countries in Europe, Western Pacific, Caribbean and North Africa have the highest rates of CVD mortality.

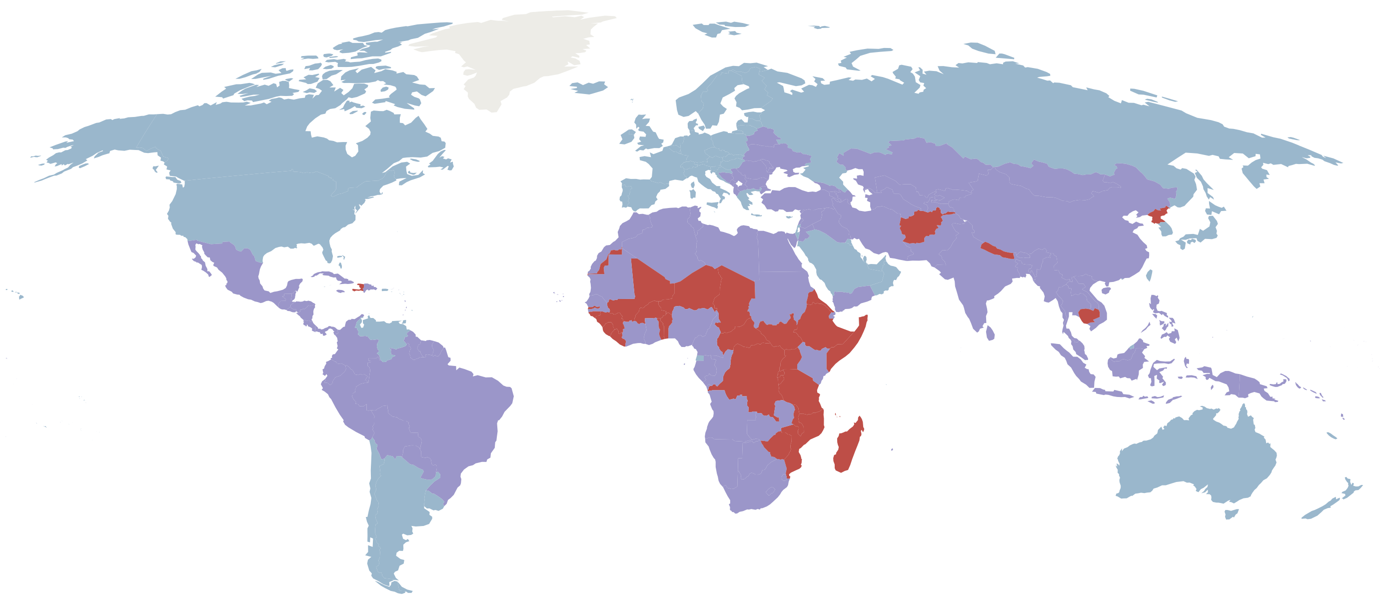
While obesity prevalence, diabetes prevalence and raised total cholesterol are also associated with low rates of CVD deaths, a negative binomial regression analysis indicated that these were not significant predictors of CVD deaths, once gross national income was included in the model. When controlling for gross national income, only the prevalence of raised blood pressure shows significant positive association with CVD mortality. A relatively high prevalence of diabetes is a characteristic of a country with a developed economy, and is not an independent risk factor CVD mortality at the population level. A high national income is associated with both low CVD mortality and to high diabetes prevalence in countries with strong economies (Figure 3.11).

In general, high income countries are able to provide better access to treatments, which in turn reduce CVD mortality. A high national income has been associated with increased infrastructure, investments in health and more efficient allocations of government spending[10]. Access to CVD medications and heart surgery is significantly better in high-income countries compared to middle- and low-income countries[11].

Countries with a higher per-capita gross national income have lower rates of age-standardised non-communicable disease mortality and CVD mortality. However, when the raw, non-age-standardised mortality rates are examined, the mean rate of CVD mortality is 107.8 per 100,000 people in low-and middle-income countries, compared to 252.0 per 100,000 people in high income countries. This is because in low-income countries more than a third of the population is under age 15, compared with less than a fifth in high-income countries.

Table of contents

Figure 3.10
MAP OF HIGH-, MIDDLE- AND LOW-INCOME COUNTRIES IN 2015



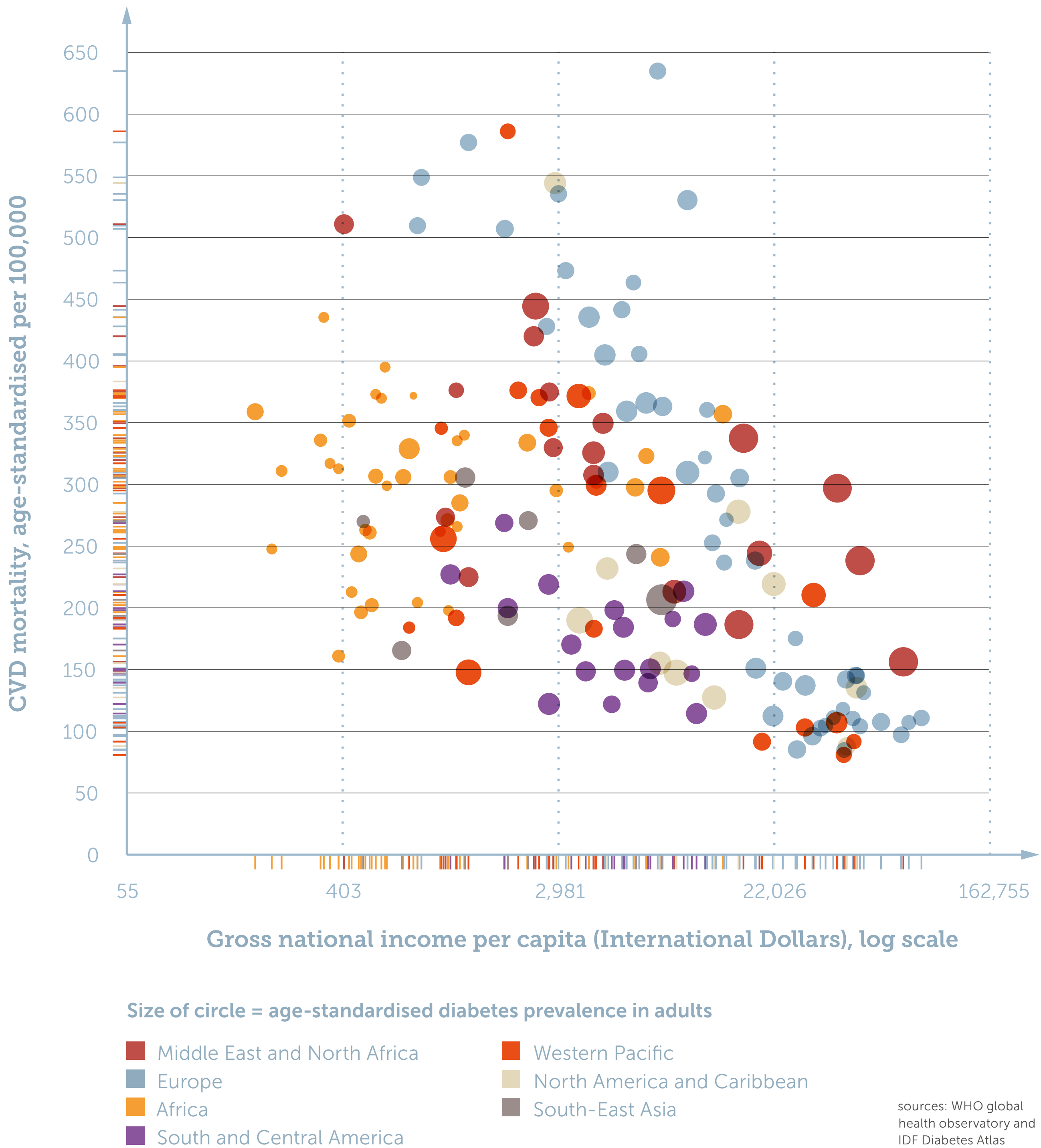
Data not available
Low-income countries
Middle-income countries
High-income countries

source: World Bank

> “Despite a high prevalence of risk factors, high-income countries have relatively low age-standardised CVD mortality due to their investment in access to healthcare.”

Table of contents

Figure 3.11
NATIONAL CVD DEATH RATE, NATIONAL INCOME AND REGION



sources: WHO global health observatory and IDF Diabetes Atlas

Spending on health

The proportion of gross domestic product spent on health is the sum of public and private health expenditure, as a percentage of gross domestic product. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities and emergency aid designated for health but does not include provision of water and sanitation.

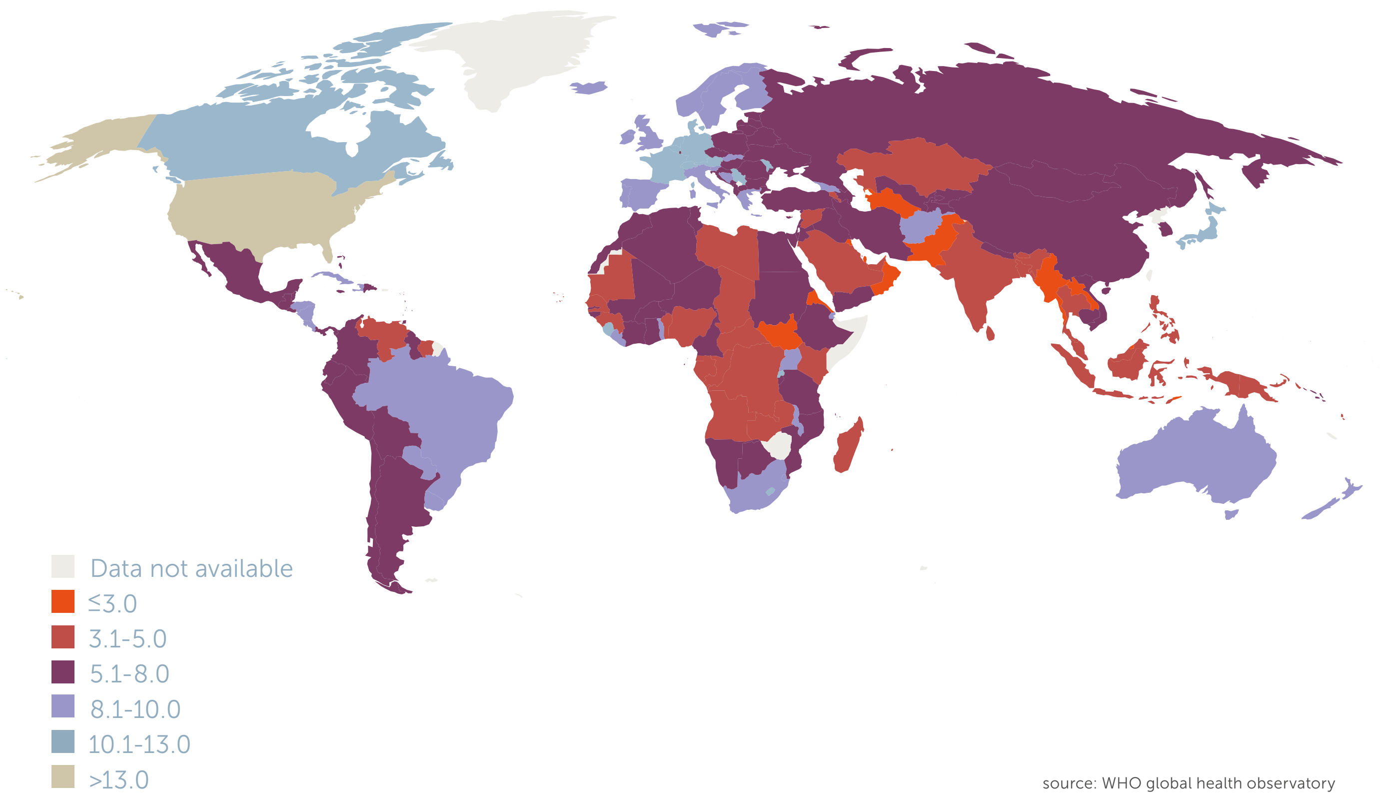
Although there has been a slight global increase in the proportion of gross domestic product spent on health over the past decade, there remain some substantial inequalities in the spending on health across countries. In 2013, total spending on health ranged from around 17% of gross domestic product in Tuvalu, the USA and Marshall Islands to less than 3% in Timor-Leste, Myanmar and Turkmenistan (Figure 3.12). On average, high-income countries spend 11.9% of their gross domestic product on health, middle-income countries spend 5.8% of their gross domestic product on health, and low-income countries spend 6.4% of their gross domestic product on health.

> “In general, countries with the lowest age-standardised CVD mortality rates were high-and middle-income countries with a high spending on health.”

In general, countries with the lowest age-standardised CVD mortality rates were high-and middle-income countries with a high spending on health as a percent of gross domestic product (Figure 3.13). Countries with the highest age-standardised non-communicable disease mortality rates were high-, middle- and low-income countries with a lower spending on health as a percentage of gross domestic product.

Figure 3.12

MAP OF TOTAL EXPENDITURE ON HEALTH AS A PERCENTAGE OF THE GROSS DOMESTIC PRODUCT IN 2013



source: WHO global health observatory

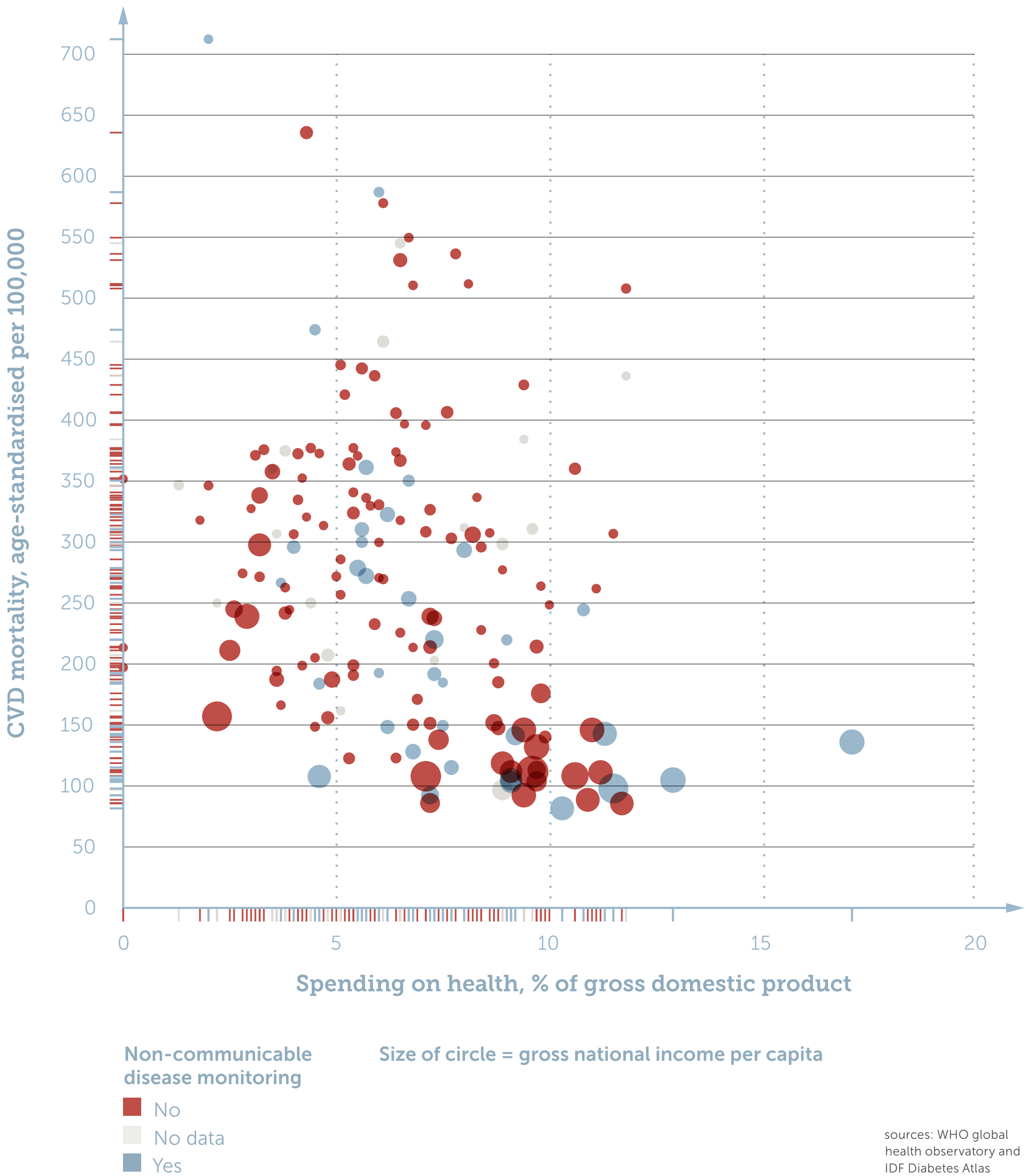
There was a negative association between the proportion of gross domestic product spent on health and the national CVD mortality rate (Figure 3.13). Countries with low CVD mortality rates were more likely to be high income countries that spent a high proportion of their GDP on health. For example, USA spends the largest share of GDP on health (17.1%), and has one of the lowest CVD mortality rates (Figure 3.13).

Whereas Turkmenistan, with one of the highest levels of non-communicable disease mortality rates (1025.1 deaths per 100,000), has a very low percentage spending on health (2%). Countries with high CVD mortality rates were more likely to be low- and middle-income countries that spent less than 8% of their gross domestic product on health, and did not have a non-communicable disease monitoring programme in place.

Table of contents

Figure 3.13

NATIONAL CARDIOVASCULAR DISEASE (CVD) MORTALITY RATE AND SPENDING ON HEALTH IN COUNTRIES WITH AND WITHOUT NON-COMMUNICABLE DISEASES MONITORING



sources: WHO global health observatory and IDF Diabetes Atlas

Non-communicable disease monitoring

Countries with non-communicable disease monitoring programmes have lower CVD disease mortality rates compared to countries without non-communicable disease monitoring programmes (Figure 3.14). A non-communicable disease surveillance and monitoring system includes regular data collection on mortality by cause and risk factor surveillance of harmful alcohol use, physical inactivity, tobacco use, raised blood glucose, raised blood pressure, overweight/obesity and salt/sodium intake. Only 20% of countries worldwide have reported the implementation of such a system, though data are missing from sub-Saharan Africa and the Caribbean. High-income countries are more likely to have non-communicable disease monitoring systems.

> “Countries with non-communicable disease monitoring programmes have lower CVD mortality rates compared to countries without non-communicable disease monitoring programmes.”

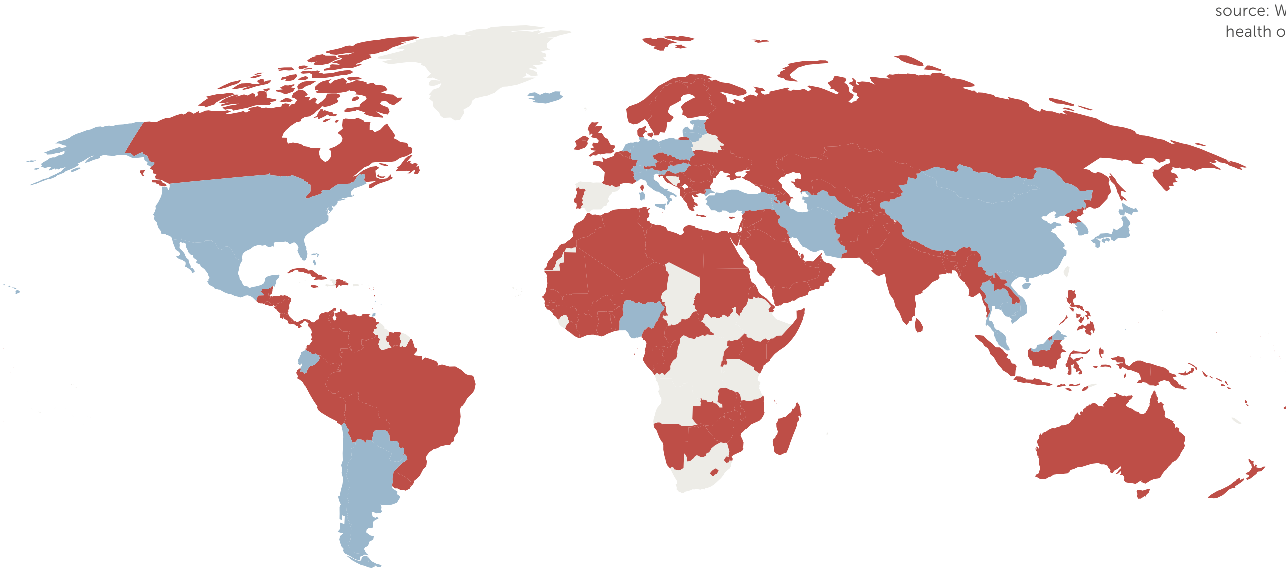
In countries with non-communicable disease monitoring, there was a median rate of 192.6 deaths per 100,000 due to CVDs, compared to a median of 271.0 deaths per 100,000 in countries without non-communicable disease monitoring (Figure 3.14). Among countries with non-communicable disease monitoring, two middle-income courtiers, Turkmenistan and Mongolia, had very high age-standardised CVD mortality levels (712.1 and 583.7 deaths per 100,000) and were outliers in this group.

Japan, Switzerland, the Netherlands and Germany have implemented non-communicable disease monitoring systems. They also have comparable per capita gross national income levels, spending on health and low CVD mortality. Similar countries such as Austria, France, Canada, Belgium and Denmark have yet to implement non-communicable disease monitoring systems (although the age-standardised CVD mortality rates are not significantly different between these two groups).

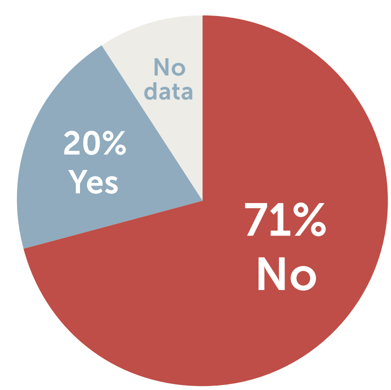
It is difficult to determine the causative effect of surveillance systems on non-communicable disease mortality. It is possible that their introduction may also be associated with the stage of the epidemiological transition in which CVD mortality begins to decline, despite increasing obesity and diabetes prevalence. Alternatively, such systems may be associated with better provision of treatments that are effective in preventing CVD deaths.

Figure 3.14
EXISTENCE OF A NON-COMMUNICABLE DISEASE (NCD) SURVEILLANCE AND MONITORING SYSTEM, 2013

source: WHO global health observatory



Existence of a surveillance and monitoring system in place to enable reporting against the nine global NCD targets



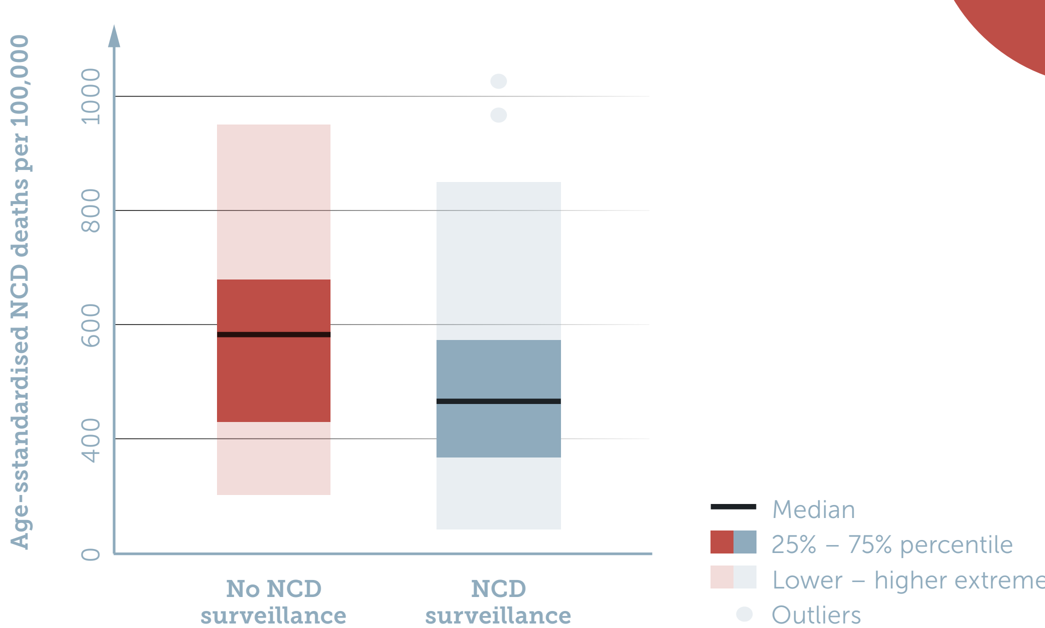


Table of contents

Raised blood pressure

Raised blood pressure is defined as a systolic blood pressure greater than or equal to 140 mmHg or a diastolic blood pressure greater than or equal to 90 mmHg, and is most prevalent in low- and middle-income countries in Central Asia, the Middle East and Africa (Figure 3.15).

There is a very strong association between the prevalence of raised blood pressure prevalence and the national CVD mortality rate (Figure 3.16). High- and middle-income countries with a low prevalence of raised blood pressure have the lowest rates of age-standardised CVD mortality rates (Figures 3.16 and 3.17). Countries with the highest CVD mortality rates had a high prevalence of raised blood pressure. These countries mostly consisted of low- and middle-income economies, although the high-income countries of Russian Federation and Estonia can also be found in this cluster.

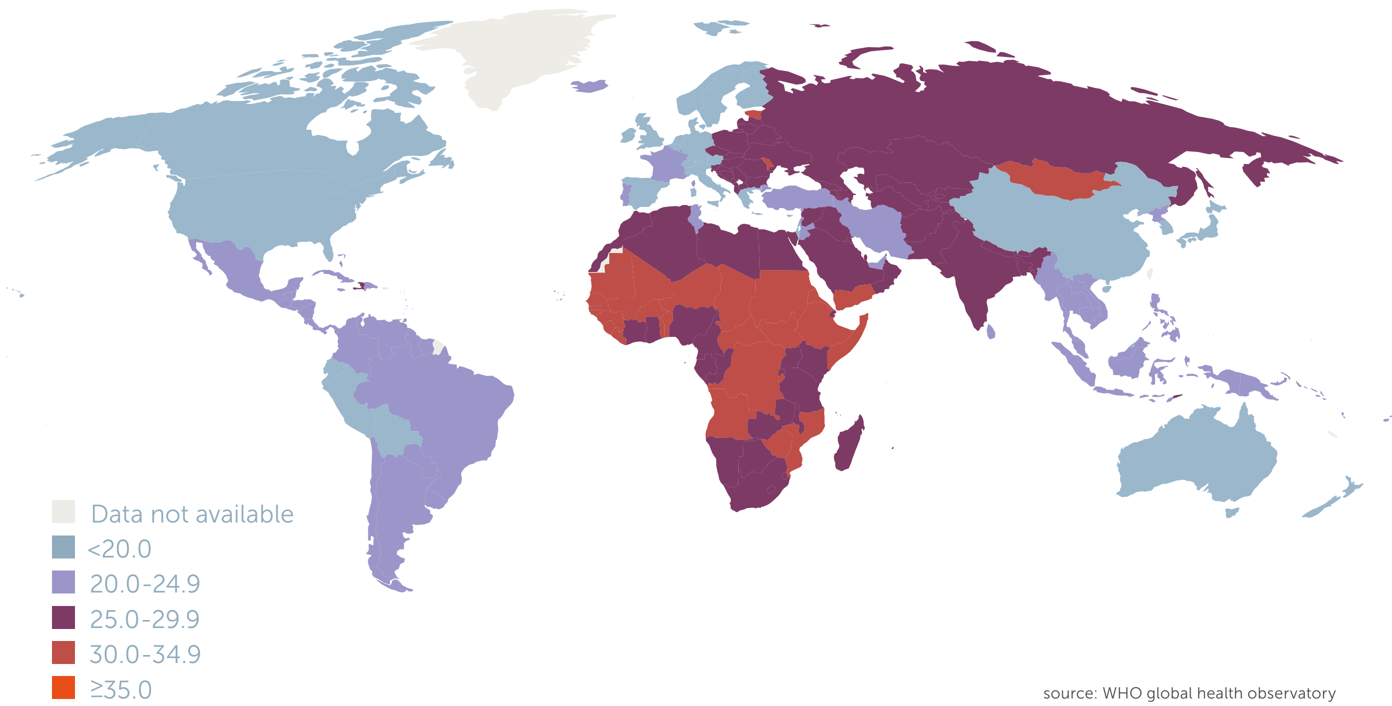
When examined at a country level, there is no correlation between national diabetes prevalence and national age-standardised CVD mortality (Figure 3.17). Countries with the highest rates of age-standardised CVD mortality have age-standardised national diabetes prevalence rates of 5-12%.

> “The regions with the highest rates of age-standardised CVD disease mortality also have a large proportion of people with high blood pressure, and are situated in Central Asia, the Middle East and Africa.”

Table of contents

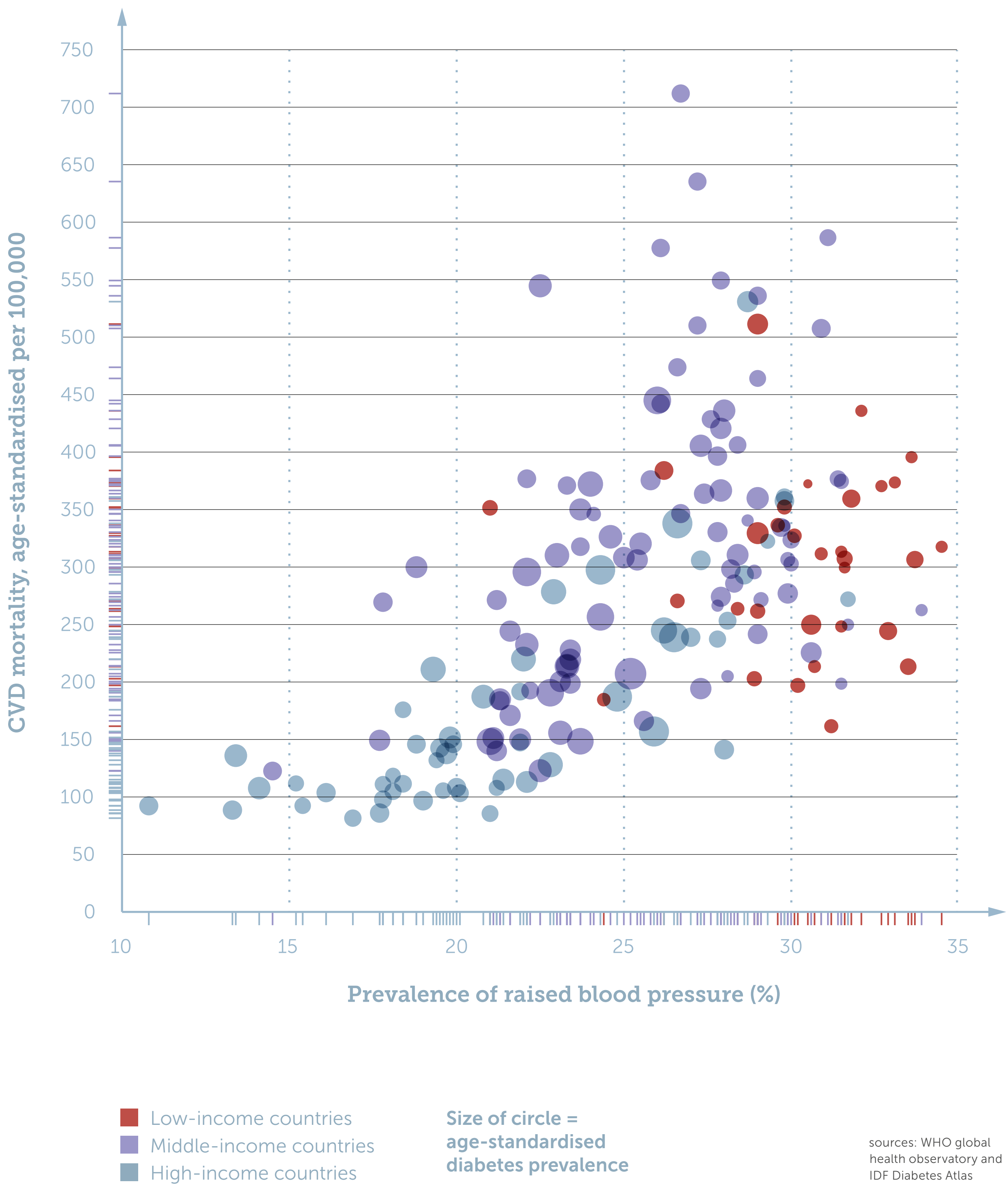
Figure 3.15

AGE-STANDARDISED PREVALENCE OF RAISED BLOOD PRESSURE, AGES 18+ IN 2014



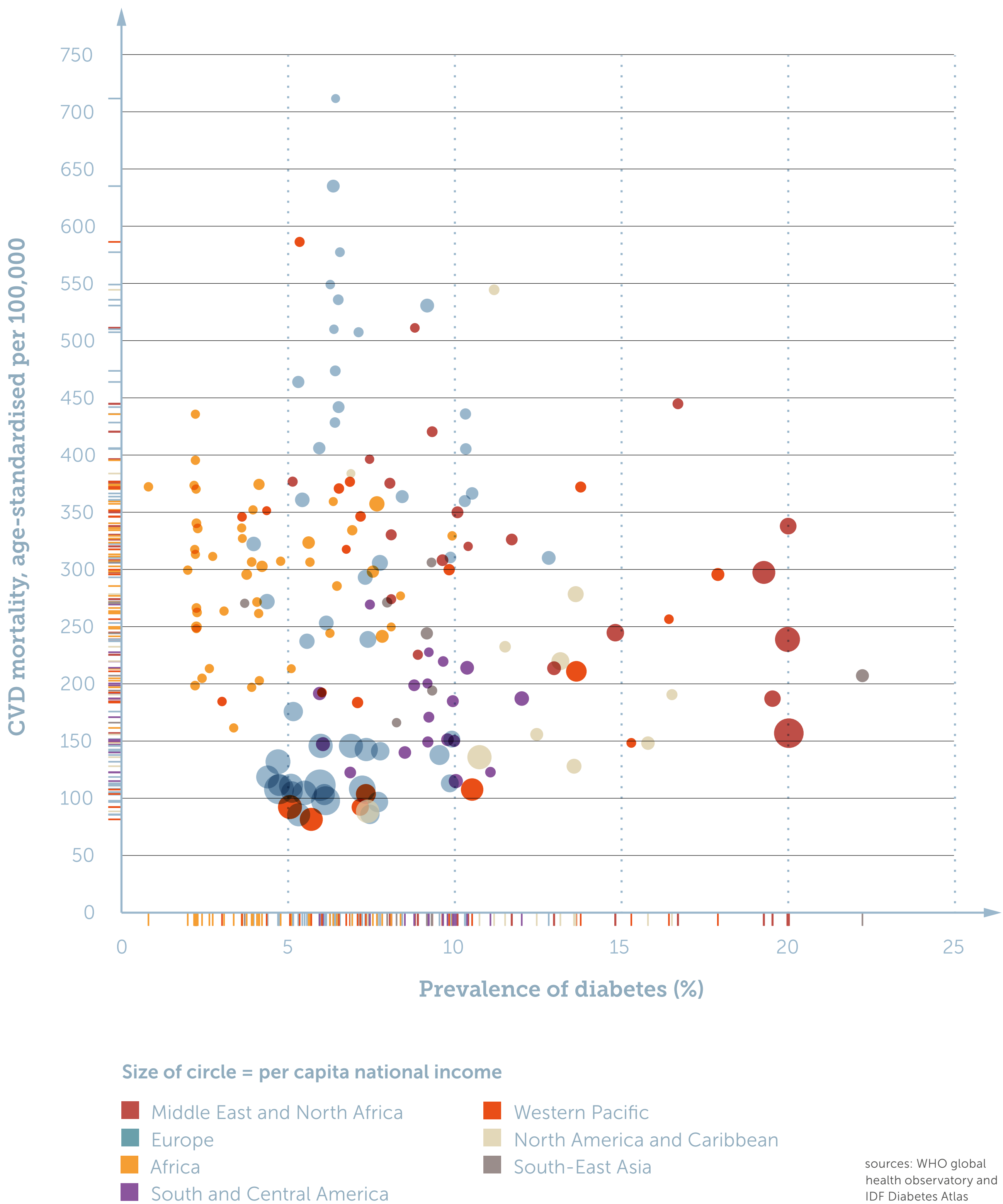
source: WHO global health observatory

Figure 3.16
CVD DEATH RATES AND PREVALENCE OF RAISED BLOOD PRESSURE



sources: WHO global health observatory and IDF Diabetes Atlas

Figure 3.17
CVD DEATH RATES AND PREVALENCE OF DIABETES



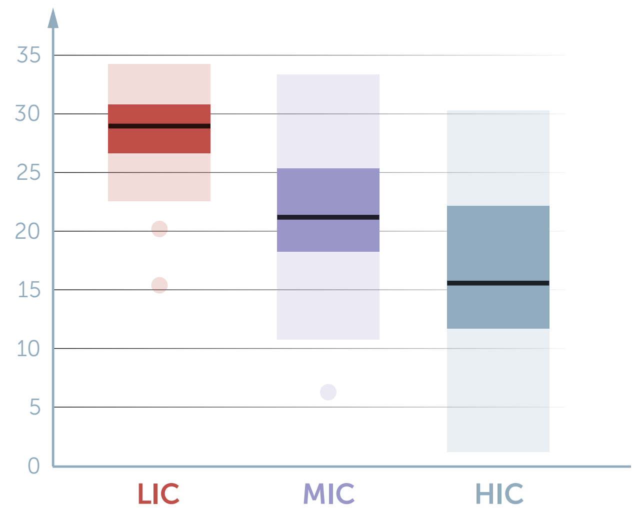
sources: WHO global health observatory and IDF Diabetes Atlas

Table of contents

Cholesterol and obesity

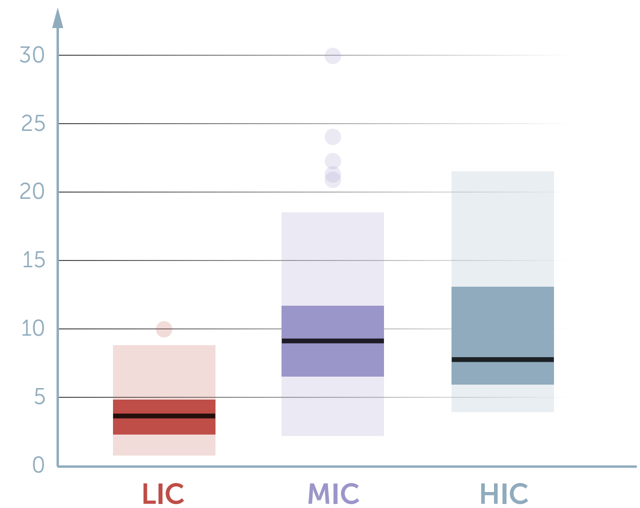
In contrast to the findings regarding high blood pressure, rates of raised total cholesterol are much higher in high-income countries (Figure 3.18). As countries increase their economic output, they are faced with a combined burden of obesity and increasing prevalence of raised cholesterol. The Europe Region has relatively high cholesterol, while the Middle East and North Africa region has very high obesity rates (Figure 3.19). Conversely, the Africa Region has very low rates of both high cholesterol and obesity.

Figure 3.18.a
RAISED BLOOD PRESSURE PREVALENCE IN LOW-, MIDDLE- AND HIGH INCOME COUNTRIES



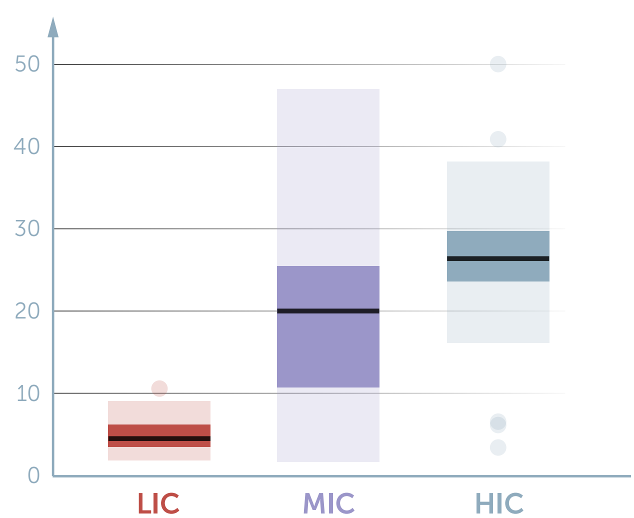
source: WHO global health observatory

Figure 3.18.b
AGE-STANDARDISED DIABETES PREVALENCE IN LOW-, MIDDLE- AND HIGH INCOME COUNTRIES



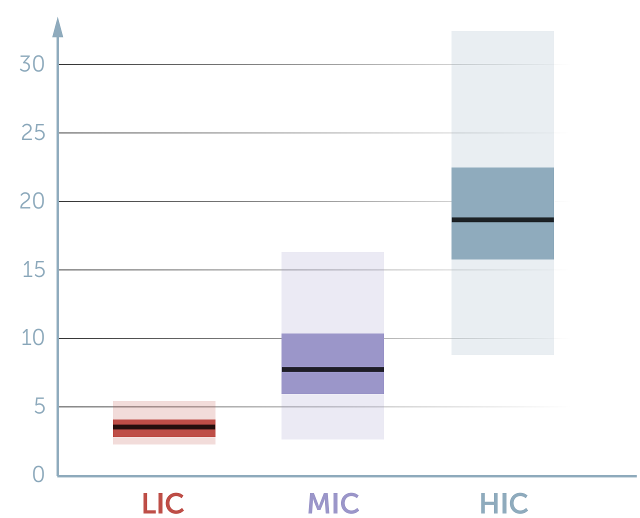
source: IDF Diabetes Atlas

Figure 3.18.c
OBESITY PREVALENCE IN LOW-, MIDDLE- AND HIGH INCOME COUNTRIES



source: WHO global health observatory

Figure 3.18.d
RAISED CHOLESTEROL PREVALENCE IN LOW-, MIDDLE- AND HIGH INCOME COUNTRIES



source: WHO global health observatory

Median — 25% – 75% percentile — Lower – higher extreme — Outliers

Figure 3.19

NATIONAL PREVALENCE OF OBESITY AND RAISED CHOLESTEROL

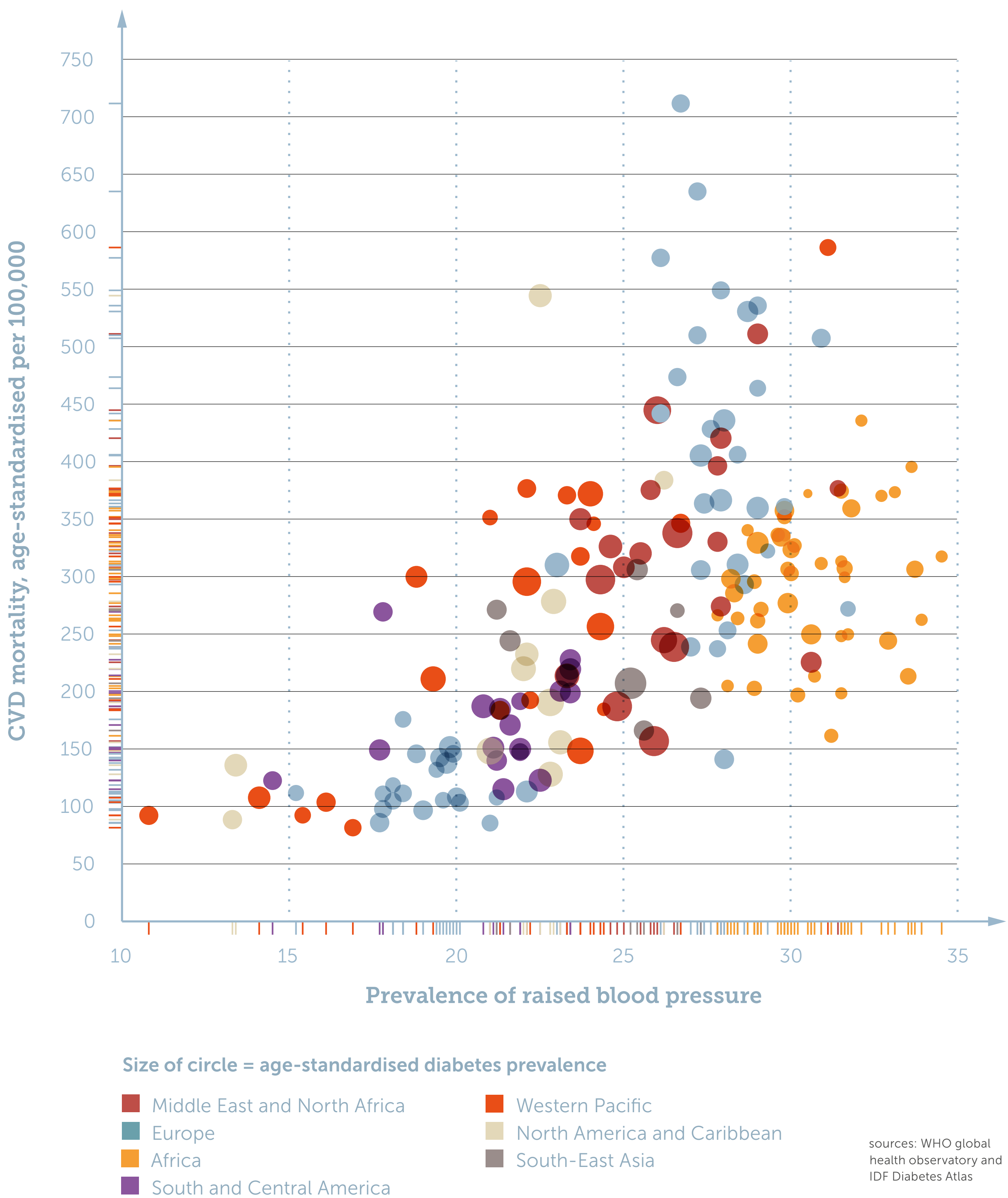
sources: WHO global health observatory and IDF Diabetes Atlas

Geographic region

Countries with the lowest rates of CVD mortality are more likely to have low national prevalence rates of raised blood pressure and be located in the IDF regions of Europe, North American and Caribbean and the Western Pacific (Figure 3.20). While most countries within a region have a wide range of CVD mortality rates, South and Central America has a very tight cluster of low rates of non-CVD mortality, regardless of the gross national income per capita. The relatively low rates of age-standardised CVD mortality in the South and Central America region may be related to the higher proportion of people living in rural areas who tend to have lower rates of CVD risk factors. The region of Europe contains countries with both some of the lowest (France) and highest (Turkmenistan) rates of CVD mortality.

The highest rates of CVD mortality are observed in middle-income countries in the European Region (such as Turkmenistan, Kazakhstan and Uzbekistan) and middle-income countries in the Middle East and North Africa Region (such as Afghanistan, Egypt and Iraq). Middle- and high-income countries have the highest diabetes prevalence rates.

Figure 3.20
NATIONAL CARDIOVASCULAR DISEASE (CVD) MORTALITY RATE, PREVALENCE OF RAISED BLOOD PRESSURE AND DIABETES PREVALENCE



sources: WHO global health observatory and IDF Diabetes Atlas

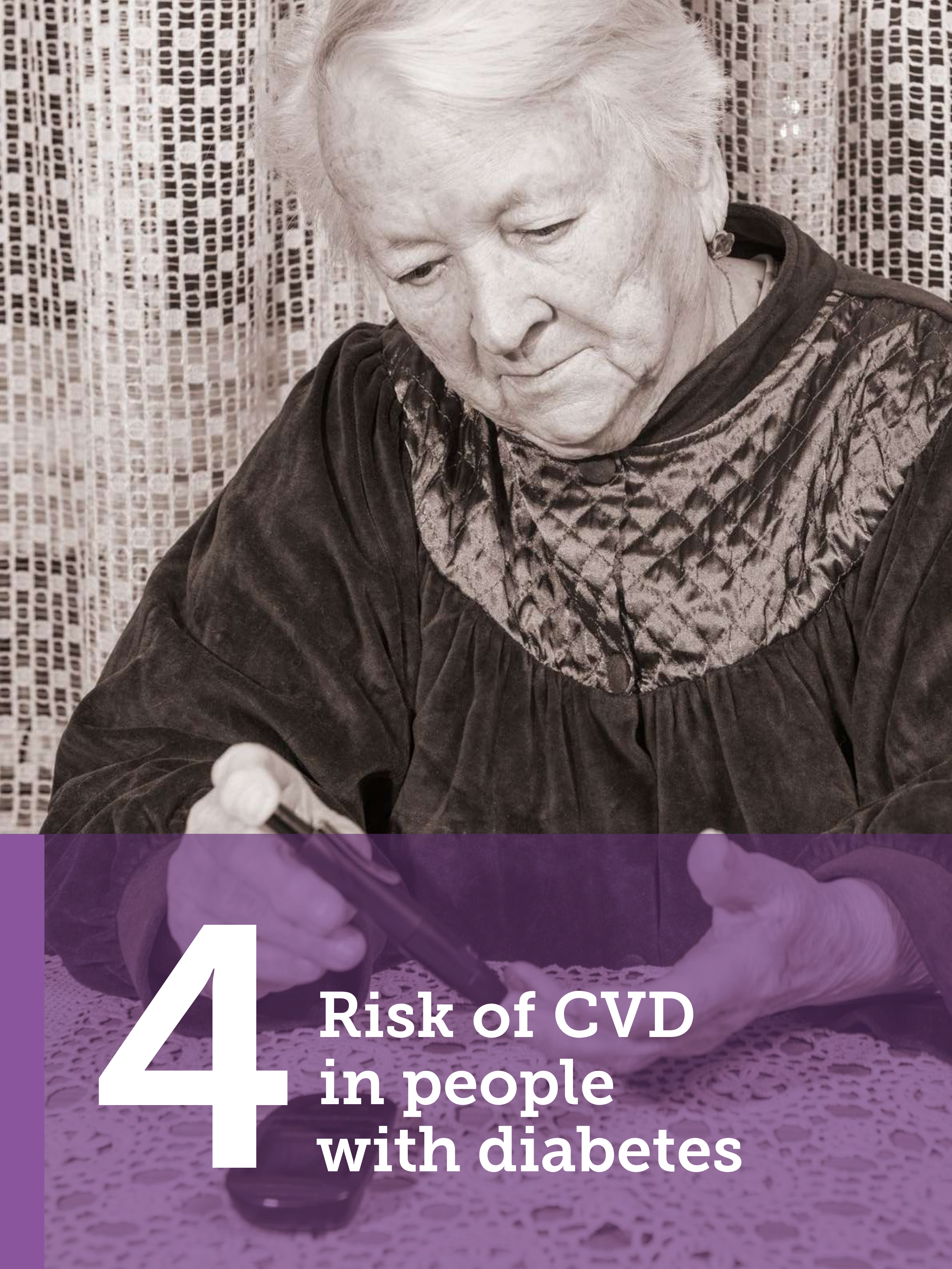
Conclusions

The prevalence of CVD is very high in many countries that also have high rates of diabetes. The association between CVD and diabetes varies at the country level, partly related to economic development, access to health care and life expectancy.

The regions with the highest rates of age-standardised CVD disease mortality have elevated rates of high blood pressure, and are situated in Central Asia, the Middle East and Africa. The countries of Russia, Egypt, Afghanistan and Albania are of particular concern, due to their high mortality rates from CVD and diabetes. Countries with increasing economic growth are predicted to experience higher prevalence rates of diabetes, obesity and raised cholesterol in the future.

Despite a high prevalence of risk factors such as diabetes, obesity and raised cholesterol, high-income countries have relatively low age-standardised CVD mortality rates due to their strong investment in the prevention, treatment and management of these diseases. Regardless of income level, countries with non-communicable disease monitoring systems to measure mortality and the prevalence of risk factors have lower rates of age-standardised CVD mortality.

“Countries with increasing economic growth will experience higher rates of diabetes, obesity and raised cholesterol.”



4 Risk of CVD in people with diabetes

Introduction

People with diabetes have a substantially increased risk of CVD compared to people without diabetes[1]. Furthermore, CVD events in people with diabetes generally occur at an earlier age[2].

Research on the association between diabetes and CVD has only been conducted in some high- and middle-income countries. However, in all studies conducted, people with diabetes have a higher risk of CVD than people without diabetes (Table 4.1). This has been observed in both people with type 1 and type 2 diabetes, and for stroke, coronary artery disease and CVD-related mortality. The highest risks have been observed in a study from Finland between 1982 and 1996, where women with type 2 diabetes were 9.5-fold more likely to have coronary artery disease, compared to women without type 2 diabetes. The effect of diabetes on CVD risk has not been investigated in any low-income country, nor in the majority of middle-income studies.

The sex of the person also influences the risk of CVD in people with diabetes (Table 4.1)[3]. The relative risk of coronary artery disease mortality in people with diabetes is 2.58 (95% CI 2.05-3.26) for women and 1.85 (95% CI 1.47-2.33) for men[4], compared to women and men without diabetes. The relative risk of coronary artery disease events is 2.82 (95% CI 2.35-3.38) in women with diabetes and 2.16 (95% CI 1.82-2.56) in men with diabetes, compared to women and men without diabetes[5]. However, the absolute CVD risk in men with diabetes is often higher than in women with diabetes.

> “CVD events in people with diabetes generally occur at an earlier age compared to people without diabetes.”

Table 4.1

RELATIVE RISK OF CVD IN PEOPLE WITH DIABETES COMPARED TO PEOPLE WITHOUT DIABETES

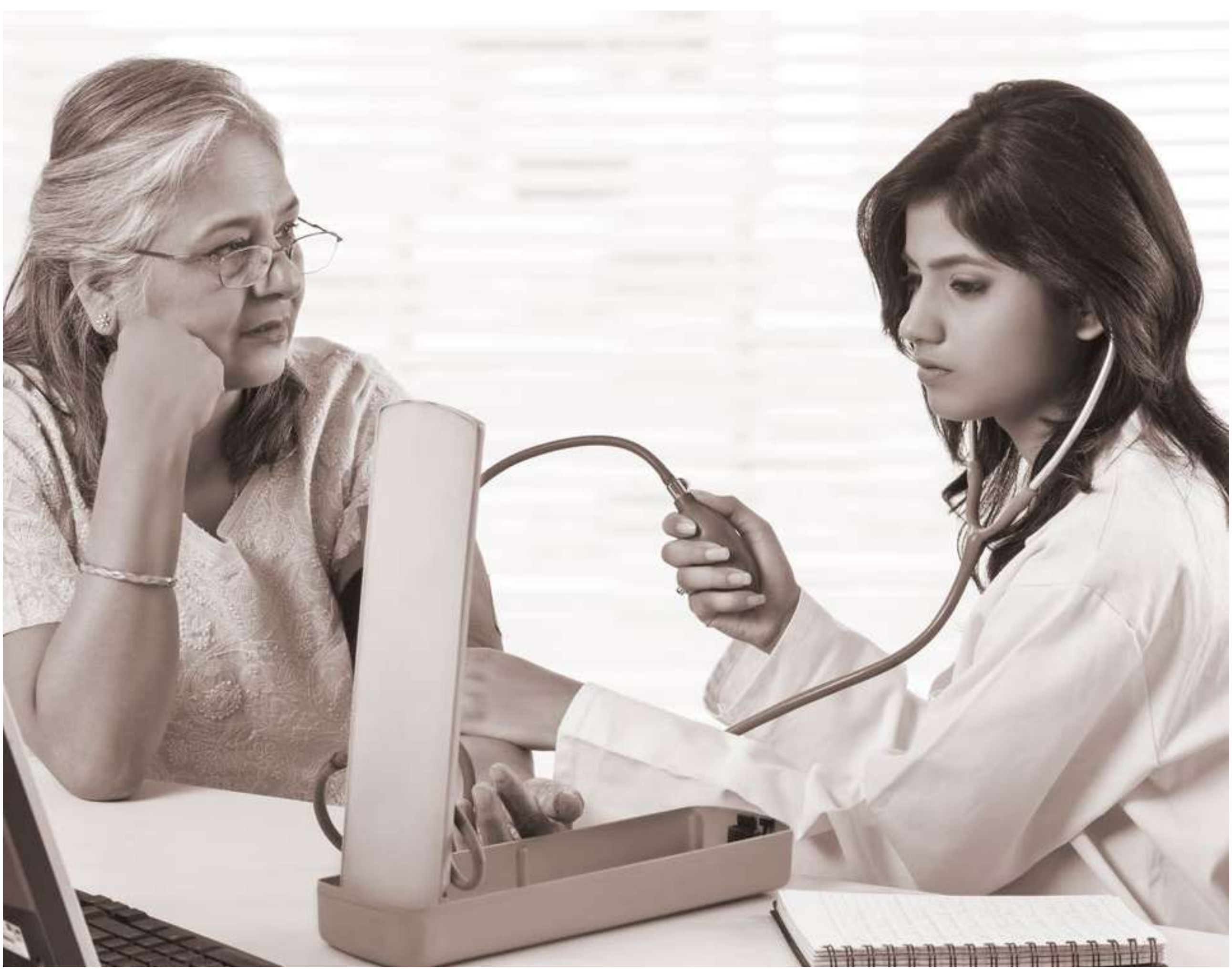
Study period	Country	Type of diabetes	Type of CVD	Type of risk ratio	Result (95% CI)	Ref.
1972-2000	United Kingdom	Unspecified	Fatal coronary artery disease	Standardised mortality ratio	**Men: 4.5 (3.9-5.1)* Women: 8.8 (7.4-10.3)***	(6)
1976-2002	USA	Type 1	Stroke	Relative risk	**Women: 4.7 (3.3-6.6)**	(7)
1976-2002	USA	Type 2	Stroke	Relative risk	**Women: 1.8 (1.7-2.0)**	(7)
1982-1996	Finland	Type 2	Fatal coronary artery disease, non-fatal heart attack	Hazard ratio	**Men: 2.8 (2.0-3.7) Women: 9.5 (5.5-16.9)**	(8)
1984-2004	New Zealand	Unspecified	Fatal CVD	Standardised mortality ratio	**Men: 3.27 (2.76-3.78) Women: 3.73 (3.16-4.30)**	(9)
1986-2009	China	Unspecified	Fatal CVD	Hazard ratio	**Men: 2.7 (1.7-4.2) Women: 5.9 (2.8-12.5)**	(10)
1998-2010	United Kingdom	Type 2	Stroke	Hazard ratio	**Both sexes: 1.7 (1.5-2.0)**	(11)
1992-1999	United Kingdom	Type 1	Stroke, heart attack, fatal acute coronary artery disease, coronary revascularizations	Incidence rate ratio	**Men: 3.6 (2.9-4.5)* Women: 7.7 (5.5-10.7)***	(12)
1997-2002	USA	Type 2	Congestive heart failure	Incidence rate ratio	**Both sexes: 2.5 (2.3-2.7)**	(13)
1999-2000	Australia	Unspecified	Fatal CVD	Hazard ratio	**Both sexes: 2.6 (1.4-4.7)**	(14)
2000-2002	Norway	Unspecified	Stroke, angina pectoris, heart attack	Odds ratio	**Both sexes: 4.4 (2.9-6.6)**	(15)
2001-2007	Scotland	Type 2	Fatal coronary artery disease	Risk ratio	**Men: 1.7 (1.5-2.0)* Women: 2.2 (2.0-2.9)***	(16)
2005-2008	Scotland	Type 1	Stroke, coronary artery disease	Incidence rate ratio	**Men: 2.3 (2.0-2.7) Women: 3.0 (2.4-3.8)**	(17)
2006	Netherlands	Unspecified	Stroke, transient ischemic attack and heart attack	Odds ratio	**Both sexes: 1.8 (1.6-1.9)**	(18)

*significant difference between sexes

The risk of CVD also increased with age. Only 6% of people aged between 15 and 25 living with type 1 diabetes have CVD, yet this increased to over 25% in people aged between 45 and 59 years old[19].

In high-income countries, the absolute rates of CVD mortality increase as socio-economic status decreases.[16] There is a need for sustained efforts to prevent and reduce cardiovascular risk in populations living in more deprived areas, in both people with and without diabetes.

“People with diabetes have two to three times the relative risk of CVD compared to people without diabetes.”



Incidence of CVD in people with diabetes

A systematic literature review was conducted to identify studies that observed groups of people with diabetes over time to see how many of them experienced CVD events (see Methodology section in the Appendix). Some studies only observed people with type 2 diabetes, while other studies observed people with both type 1 and type 2 diabetes. There were not enough data to examine the risks for men and women separately, so only the results for both sexes combined are presented below.

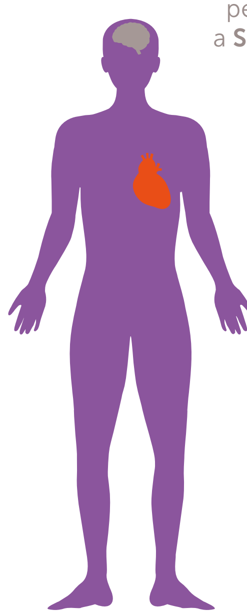
Global estimates of the incidence of CVD in people with diabetes could not be produced, due to the heterogeneity of the data. There were substantial differences in the methodologies used in the studies on CVD in people with diabetes. Often, the most recent version of the International Classification of Diseases classification system was not used to classify CVDs, and as a result a variety of terms were used to describe CVD events. Some of the studies only observed a few hundred people, which is likely to be unrepresentative of the national population and lead to less precise estimates. The diverse age groups further compound these differences. Due to these limitations, it is impossible to say whether differences observed between countries are due to true difference in national CVD risks, or just differences in study methodology. There is a need for future studies to utilise standardised classification and methodology, to enable better comparability across countries and more accurate meta-analyses.

Overall, of studies of middle-aged people with diabetes living in high- and middle-income countries, 14 to 47 per 1,000 had a CVD event each year, of which 2 to 26 per 1,000 were a coronary artery disease event each year and 2 to 18 per 1,000 were a stroke each year (Figure 4.1). The mean age of the study population ranged from 50 to 69 years. The incidence of CVD increased with age, and the data suggested regional variation. There was a lack of data for people with diabetes living in low-income countries.

Figure 4.1

INCIDENCE OF CARDIOVASCULAR DISEASE IN MIDDLE-AGED PEOPLE WITH DIABETES

In studies of middle-aged people with diabetes living in high- and middle-income countries:



Mean age of study population: 50 to 69 years

Incidence of all CVDs in people with diabetes

CVD events include coronary artery disease and stroke (see Chapter 2). Data on the incidence of all CVDs in people with diabetes was available for Europe, Western Pacific, and South and Central America (Figure 4.2). This incidence ranged from 14.3 CVD events per 1,000 people per year in a study from Hong Kong to 46.9 CVD events per 1,000 people per year in a study from Brazil. The mean age of the populations studied ranged from 57 to 64 years.

Figure 4.2
THE INCIDENCE OF ALL CARDIOVASCULAR DISEASES IN PEOPLE WITH TYPE 2 DIABETES, PER 1,000 PEOPLE PER YEAR

source: see appendix

Country	Mean age	Age range	Number of participants	Incidence per 1,000 people per year	95% confidence interval
Sweden	64	30-79	18,334	37.24	36.07-38.43
Sweden	64	35-	34,009	41.45	40.45-42.49
United Kingdom	63	30-	34,198	32.63	31.82-33.45
Brazil	60	41-81	471	46.89	38.76-56.72
Australia	64	15-90	1,240	33.15	28.70-38.29
Hong Kong	56	.. – ..	7,835	14.30	13.36-15.31
New Zealand	57	.. – ..	1,829	25.70	22.61-29.20

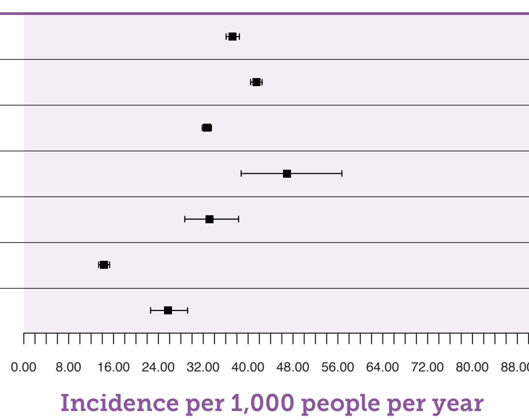


Table of contents

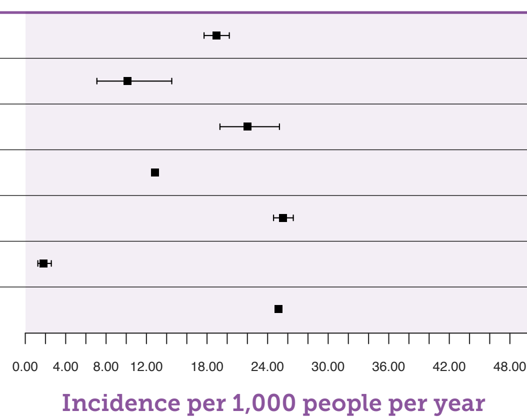
Incidence of coronary artery disease in people with type 2 diabetes

The only studies that specifically examined coronary artery disease separately were conducted in high-income countries. Coronary artery disease includes heart attack, angina pectoris and heart failure (see Chapter 2). In Europe and the Western Pacific, the incidence ranged from 1.8 coronary artery disease events per 1,000 people per year in a study in Japan to 25.6 coronary artery disease events per 1,000 people per year in a study in Sweden (Figure 4.3). Incidence was influenced by which CVD events were included in the definition of coronary artery disease and the age range of the population studied, which ranged from 30 to 79 at the beginning of the studies, with the mean age of the study population ranging from 62 to 69 years.

Figure 4.3
THE INCIDENCE OF CORONARY ARTERY DISEASE IN PEOPLE WITH TYPE 2 DIABETES, PER 1,000 PEOPLE PER YEAR

source: see appendix

Country	Mean age	Age range	Number of participants	Incidence per 1,000 people per year	95% confidence interval
Italy		39-	11,644	18.92	17.71-20.21
Netherlands		20-76	175	10.14	7.09-14.51
Spain	69		3,268	22.03	19.28-25.17
Sweden	62	30-75	53,553	12.85	12.57-13.13
Sweden	64	30-79	18,334	25.55	24.59-26.54
Japan	57	40-69	1,256	1.79	1.24-2.58
Taiwan	60		500,868	25.06	24.88-25.24



Incidence of heart attack in people with type 1 and type 2 diabetes

In Europe, the Western Pacific, and North America, the incidence of heart attack among people with diabetes ranged from 3.3 heart attacks per 1,000 people per year in people aged over 20 in a study from the USA to 17.8 heart attacks per 1,000 people per year aged over 35 in a study from Sweden (Figure 4.4). In these studies, the people with diabetes were aged over 16 at the beginning of the observation period, with the mean age of the study population ranging from 50 to 69 years.

Figure 4.4
THE INCIDENCE OF HEART ATTACK IN PEOPLE WITH DIABETES, PER 1,000 PEOPLE PER YEAR

source: see appendix

Country	Mean age	Age range	Number of participants	Incidence per 1,000 people per year	95% confidence interval
Denmark	57	16-	129,659	7.81	7.57-8.05
France	65		1,088	8.53	6.24-11.68
Germany	50	35-	1,257	4.32	2.92-6.40
Italy		39-	11,644	5.41	4.78-6.12
Netherlands		20-76	175	6.76	4.36-10.48
Spain	69		3,268	7.65	6.10-9.59
Sweden	64	35-	34,009	17.77	17.12-18.45
United Kingdom	63	30-	34,198	3.75	3.49-4.04
Canada	62	20-	606,051	8.35	8.26-8.45
United States of America		20-	20,676,427	3.28	3.27-3.30
Taiwan	60		500,868	3.93	3.86-4.01

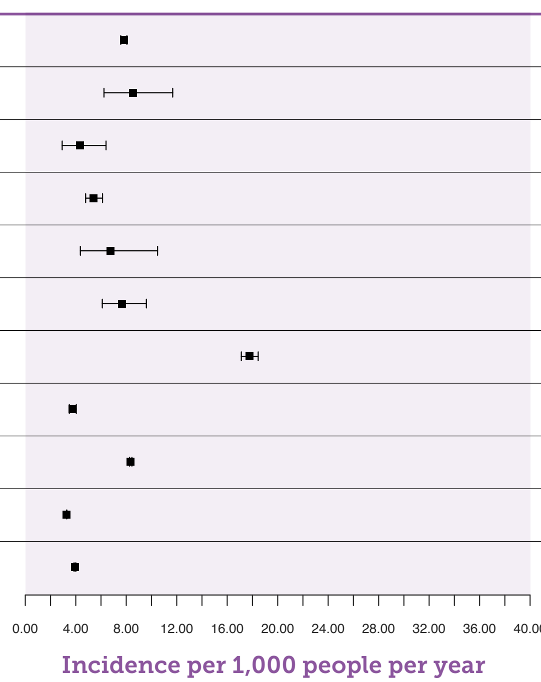


Table of contents

Incidence of stroke in people with diabetes

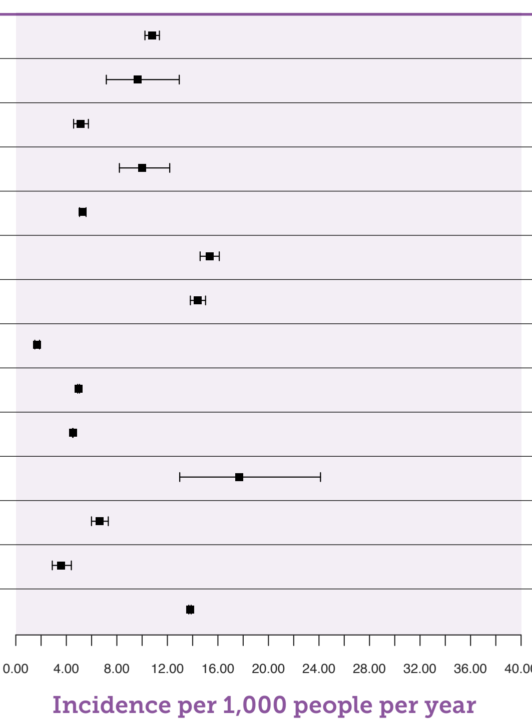
In Europe, Western Pacific and the Americas, the incidence of heart attack among people with type 2 diabetes ranged from 1.7 stroke events per 1,000 people per year in people aged over 30 in a study from the United Kingdom to 17.7 stroke events per 1,000 people per year in people aged over 41 in a study from Brazil (Figure 4.5). The mean age of the populations studied ranged from 56 to 66 years.

Figure 4.5

THE INCIDENCE OF STROKE IN PEOPLE WITH DIABETES, PER 1,000 PEOPLE PER YEAR

source: see appendix

Country	Mean age	Age range	Number of participants	Incidence per 1,000 people per year	95% confidence interval
Finland		25-80	126,530	10.78	10.22-11.37
France	65		1,088	9.63	7.17-12.94
Italy	66	40-97	14,432	5.13	4.58-5.75
Spain	69		3,268	10.00	8.20-12.18
Sweden	62	30-75	53,553	5.30	5.05-5.56
Sweden	64	30-79	18,334	15.33	14.59-16.11
Sweden	64	35-	34,009	14.41	13.82-15.02
United Kingdom	63	30-	34,198	1.68	1.50-1.88
Canada	62	20-	606,051	4.97	4.90-5.04
USA		20-	20,676,427	4.52	4.49-4.54
Brazil	60	41-81	471	17.69	12.98-24.12
Hong Kong	56		7,835	6.62	5.99-7.32
Japan		40-69	2,035	3.56	2.89-4.40
Taiwan	60		500,868	13.79	13.69-13.88



Prevalence of CVD in people with diabetes

Prevalence is the percentage of a population that has a disease. A systematic literature review was conducted to identify studies of people with diabetes to see what percentage of them had a history of CVD (see Methodology in the Appendix). Some studies only observed people with type 1 diabetes, while other studies observed people with both type 1 and type 2 diabetes. There was not enough data to examine the risks for men and women separately, so only the results for both sexes combined are presented below. The studies of people with type 1 diabetes had a younger mean age than the studies of people with both type 1 and type 2 diabetes.

Global estimates of the prevalence of a prior CVD event in people with diabetes could not be produced, due to the heterogeneity of the data. In general, in younger people with type 1 diabetes living in high- and middle-income countries (mean age of study population 25 to 44 years), 7% had a prior CVD event. Up to 16% of younger people with type 1 diabetes had a history of CVD, which included stroke, coronary artery disease, and peripheral artery disease. Separate studies found that approximately 2% of younger people with type 1 diabetes had a history of stroke, and 1% had a history of heart attack (Figure 4.6). In middle-aged people with type 2 diabetes and unspecified diabetes living in high- and middle-income countries (mean age of study population 50 to 69 years), 41% had a prior CVD event (Figure 4.7). Approximately 20% of middle-aged people with diabetes had coronary artery disease and 6% had a history of stroke. The prevalence increased with age, and there was substantial variation between regions. There was a lack of data for people with diabetes living in low-income countries.

Figure 4.6
PREVALENCE OF CARDIOVASCULAR DISEASES (CVDs) IN YOUNGER PEOPLE WITH TYPE 1 DIABETES IN HIGH- AND MIDDLE- INCOME COUNTRIES

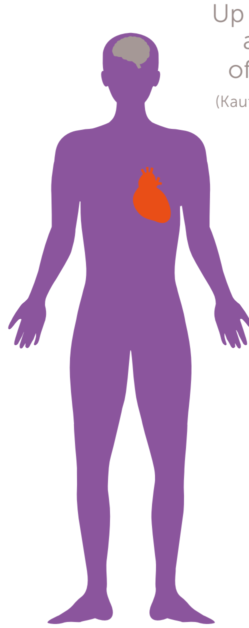
In studies of younger people with type 1 diabetes living in high- and middle-income countries:

Up to **16%** had a history of **CVD**

includes stroke, coronary artery disease, and peripheral artery disease

(David, 2010)

Mean age of study population: 28 to 44 years



Up to **2%** had a history of **STROKE**

(Kautzy-Willer, 2013)

Up to **1%** had a history of **HEART ATTACK**

(Koivisto, 1996)

Figure 4.7
PREVALENCE OF CARDIOVASCULAR DISEASES (CVDs) IN MIDDLE-AGED PEOPLE WITH DIABETES IN HIGH- AND MIDDLE- INCOME COUNTRIES

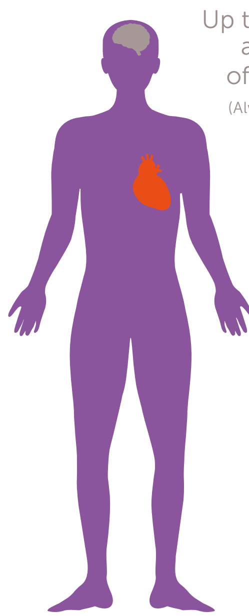
In studies of middle-aged people with diabetes living in high- and middle-income countries:

Up to **41%** had a history of **CVD**

includes stroke, coronary artery disease, and peripheral artery disease

(van Hateren, 2009)

Mean age of study population: 50 to 69 years



Up to **10%** had a history of **STROKE**

(Alwakeel, 2008)

Up to **14%** had a history of **HEART ATTACK**

(Alwakeel, 2008)

Prevalence of all CVDs in people with diabetes

In high-income countries, in studies where the mean age of the study population was between 28 and 44, the prevalence of all prior CVD events in people with type 1 diabetes ranged from 2.6% in a study from Sweden in people aged between 20 and 65 years, to 16.2% in a study from Australia in a population with a mean age of 44 years (Figure 4.8).

Figure 4.8
PREVALENCE OF ALL CARDIOVASCULAR DISEASES IN PEOPLE WITH TYPE 1 DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Prevalence (%)	95% confidence interval
Europe	28	15-60	1,215	7.98	6.59-9.65
Ireland	33	15-60	124	7.26	3.82-13.36
Spain	34		1,550	4.71	3.76-5.88
Sweden	37	20-65	7,454	2.60	2.26-2.99
USA	28	15-54	567	8.29	6.28-10.86
Australia	44		117	16.24	10.60-24.06

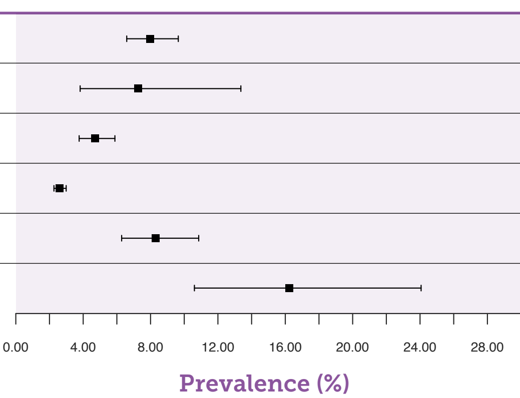
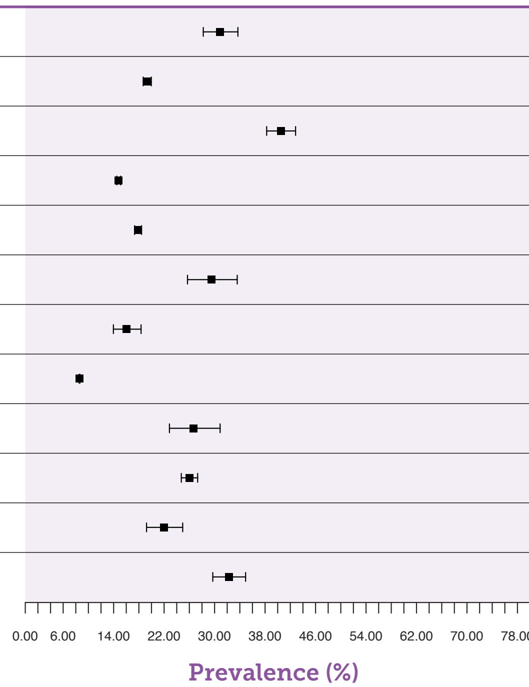


Figure 4.9
PREVALENCE OF ALL CARDIOVASCULAR DISEASES IN PEOPLE WITH TYPE 1 AND TYPE 2 DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Prevalence (%)	95% confidence interval
France	65		1,088	30.88	28-21-33.69
Italy	66	40-97	14,432	19.32	18.68-19.97
Netherlands		60+	881	40.52	38.25-42.83
Sweden	62	30-75	53,553	14.81	14.51-15.11
Sweden	64	30-79	18,334	17.87	17.32-18.43
United Arab Emirates	53		513	29.49	25.71-33.59
Iraq	56	26-94	1,079	16.03	13.96-18.35
Canada	62	20+	606,051	8.59	8.52-8.66
USA	58	18+	465	26.67	22.84-30.87
USA	60	18+	4,399	26.00	24.72-29.32
Australia	62	25+	802	21.95	19.22-24.94
Australia	64	15-90	1,240	32.26	29.71-34.91



In studies of people with type 1 and type 2 where the mean age of the study population was between 56 and 66 years, the prevalence of all prior CVD events ranged from 14.8% in a study from Sweden in people aged between 30 and 75 to 40.5% in people in a study from the Netherlands aged over 60 (Figure 4.9).

Prevalence of coronary artery disease in people with diabetes

Coronary artery disease includes angina pectoris and heart attack. In studies where the mean age of the study population was between 25 and 33 years, the prevalence of a history of coronary artery disease in people with type 1 diabetes ranged from 0.5% in a study from India where the mean age of the population was 25, to 20% in a study from Switzerland where the mean age of the study population was 43 (Figure 4.10).

Figure 4.10

PREVALENCE OF CORONARY ARTERY DISEASE IN PEOPLE WITH TYPE 1 DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Prevalence (%)	95% confidence interval
Austria	42	18-75	225	2.44	1.06-5.52
Switzerland	43	35-77	533	20.00	15.28-25.74
Brazil	33	16-72	573	1.22	0.58-2.54
India	25	10-50	617	0.49	0.16-1.50

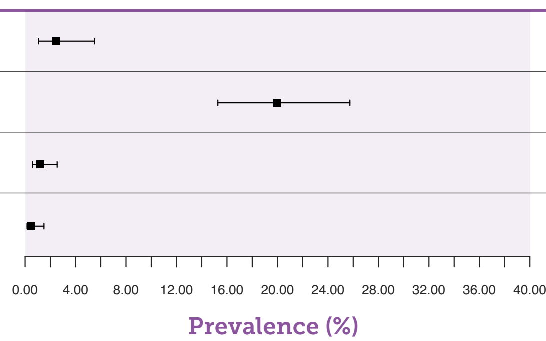


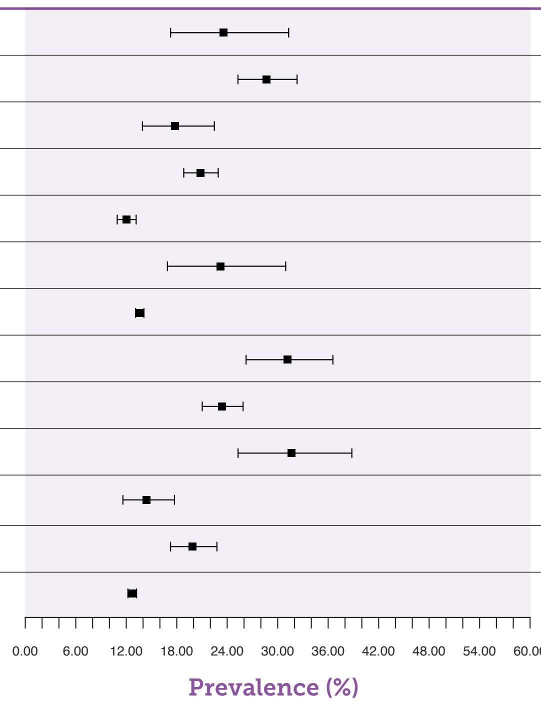
Table of contents

In studies where the mean age of the study population was between 51 and 69 years, the prevalence of a history of coronary artery disease in people with diabetes ranged from 12.0% in a study from Portugal in people aged between 18 and 96 to 31.7% in a study from Qatar in people aged between 25 and 65 (Figure 4.11).

Figure 4.11
PREVALENCE OF CORONARY ARTERY DISEASE IN PEOPLE WITH DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Prevalence (%)	95% confidence interval
Cameroon	55		140	23.57	17.27-31.30
Iceland		33-79	635	28.66	25.28-32.30
Ireland			309	17.80	13.93-22.47
Italy	69		1,509	20.81	18.83-22.93
Portugal	58	18-96	3,215	12.01	10.93-13.18
Slovenia	62	22-88	138	23.19	16.90-30.95
Sweden	64	30-79	18,334	13.60	13.11-14.10
Switzerland		35-77	533	31.17	26.24-36.56
Hungary	67	50-	1,168	23.37	21.03-25.89
Qatar	51	25-65	180	31.67	25.29-38.82
United Arab Emirates	53		513	14.40	11.60-17.73
Pakistan		0-	805	19.88	17.26-22.78
China		30-79	16,162	12.70	12.20-13.22



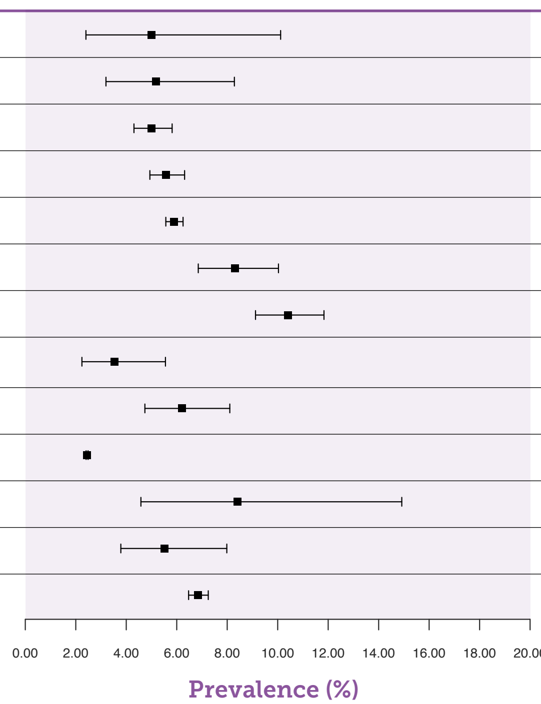
Prevalence of stroke in people with diabetes

In studies where the mean age of the study population was between 53 and 67 years, the prevalence of a history of stroke in people with diabetes ranged from 3.5% in a study from the United Arab Emirates with a mean age of 53 years to 10.4% in a study from Saudi Arabia with a mean age of 58 years (Figure 4.12).

Figure 4.12
PREVALENCE OF A HISTORY OF STROKE IN PEOPLE WITH DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Prevalence (%)	95% confidence interval
Cameroon	55		140	5.00	2.40-10.12
Ireland			309	5.18	3.20-8.28
Portugal	58	18-96	3,215	5.01	4.31-5.82
Spain			4,298	5.58	4.94-6.31
Sweden	64	30-79	18,334	5.90	5.57-6.25
Hungary	67	50-	1,168	8.30	6.85-10.03
Saudi Arabia	58	15-100	1,952	8.30	9.12-11.83
United Arab Emirates	53		513	3.54	2.24-5.55
Pakistan		0-	805	6.21	4.74-8.10
Canada	62	20-	606,051	2.45	2.41-2.49
Mexico		60-	119	8.40	4.58-14.92
Brazil	60	41-81	471	5.52	3.79-7.98
China		30-79	16,162	6.85	6.47-7.25



CVD mortality in people with diabetes

Mortality rates estimate the number of deaths that occur each year per 1,000 population. The most recent United Nations global all-cause crude mortality rate was estimated at 7.8 deaths per 1,000 people per year.

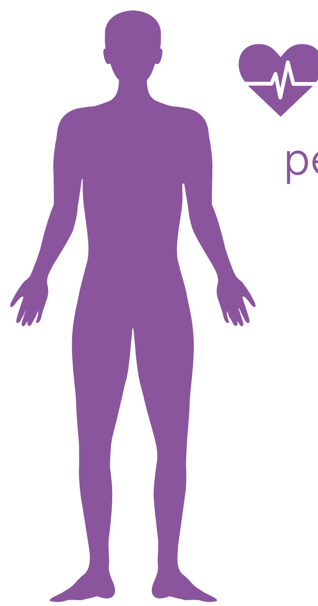
CVD is a major cause of death in people with diabetes. A systematic literature review was conducted to identify studies that examined the risk of CVD-related mortality in people with diabetes (see Methodology section in the Appendix). Some studies only observed people with type 1 diabetes, while other studies observed people with both type 1 and type 2 diabetes. There was not enough data to examine the risks for men and women separately, so only the results for both sexes combined are presented below. As the studies of people with type 1 diabetes had a younger mean age than the studies of people with type 2 diabetes and unspecified diabetes, the results are presented separately.

Global estimates of CVD mortality in people with diabetes could not be produced, due to the heterogeneity of the data. In studies of younger people with type 1 diabetes (mean age of study population 8 to 43 years), 0.3 to 5 people out of 1,000 died from CVD each year (Figure 4.13). In studies of middle-aged people with type 2 and unspecified diabetes (mean age of study population 49 to 69 years), 2 to 27 people out of 1,000 died from CVD each year. Of these, two to seven deaths were from coronary artery disease and one to nine deaths were from stroke (Figure 4.14). The mortality risk increased with age, and there was substantial variation between regions. There is a lack of data for people with diabetes living in low-income countries.

Figure 4.13
CARDIOVASCULAR DISEASES MORTALITY IN YOUNGER PEOPLE WITH TYPE 1 DIABETES

In studies of younger people with type 1 diabetes living in high- and middle-income countries:

Mean age of study population:
8 to 43 years



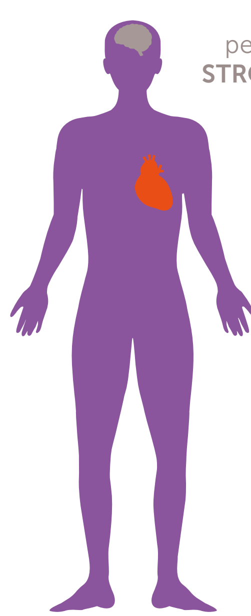
Up to **5**
per 1,000 died
from **CVD**
each year
(Davis, 2010)

Figure 4.14
CARDIOVASCULAR DISEASES MORTALITY IN MIDDLE-AGED PEOPLE WITH DIABETES

In studies of middle-aged people with diabetes living in high- and middle-income countries:

Up to **27**
per 1,000 died
from **CVD**
each year
(Miot, 2012)

Mean age of study population:
49 to 69 years



Up to **9**
per 1,000 died
STROKE each year
(Mlacak, 1999)

Up to **7** per
1,000 died from
CORONARY ARTERY DISEASE
each year
(Bidel, 2006)

Mortality from all CVDs in people with diabetes

Studies on the annual CVD mortality in people with type 1 diabetes were conducted in high- and middle-income countries where the mean age of the study population at the beginning of the study ranged from 8 to 44 years. The highest risk of 5.1 CVD deaths per 1,000 was seen in a study from Australia with a mean age of 44 and the lowest risk of 0.3 CVD deaths per 1,000 was observed in a study from Norway in people aged less than 44 years (Figure 4.15).

Figure 4.15
ALL CARDIOVASCULAR DISEASE MORTALITY IN PEOPLE WITH TYPE 1 DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Mortality per 1,000 people per year	95% confidence interval
Norway		0-44	1,906	0.30	0.18-0.51
Sweden	37	20-65	7,454	0.98	0.70-1.35
United Kingdom		1-84	23,751	1.33	1.22-1.44
USA	43		1,043	2.94	2.42-3.58
Cuba	8	0-14	504	0.73	0.40-1.37
Australia	44		117	5.13	1.65-15.90

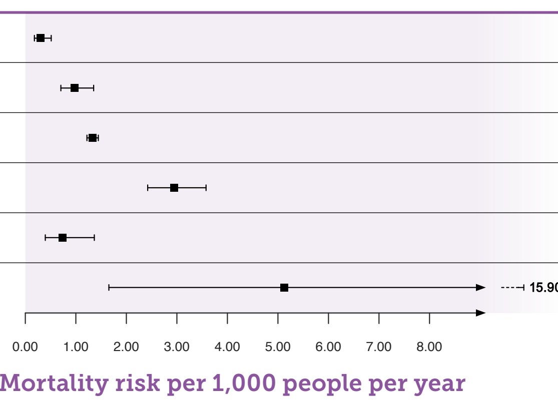


Table of contents

In studies of people with diabetes where the mean age ranged from 54 to 60 years, the lowest risk of 2.3 CVD deaths per 1,000 people per year was found in a study from Japan in a population with a mean age of 57 years, and the highest risk of 26.7 CVD deaths per 1,000 people was found in a study from France in a population with a mean age of 65 years (Figure 4.16).

Figure 4.16
ALL CARDIOVASCULAR DISEASE MORTALITY IN PEOPLE WITH DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Mortality per 1,000 people per year	95% confidence interval
Finland	49	25-74	3,837	11.39	10.67-12.15
France	65		1,088	26.70	22.36-31.88
Iceland		33-79	635	14.58	12.69-16.75
Italy	69		1,509	22.71	20.83-24.76
Netherlands		60-	881	22.82	20.67-25.19
Norway	60	20-	1,195	11.30	9.68-13.18
Sweden	64	30-79	18,334	14.18	13.47-14.93
Sweden	64	35-	34,009	26.29	25.49-27.11
Ukraine	65		89,443	13.75	13.29-14.22
USA	60	18-	4,399	10.61	8.99-12.52
Brazil	60	41-81	741	19.46	14.48-26.15
Australia	62	25-	802	9.60	7.41-12.45
Australia	64	15-90	1,240	18.10	14.89-22.00
Japan	54		507	2.32	1.32-4.09
Rep. of Korea	57	20-	1,712	3.11	2.35-4.12
New Zealand		1-	966	19.04	17.06-21.24
New Zealand	57		1,829	4.92	3.67-6.59
New Zealand	59		9,043	4.36	3.79-5.01

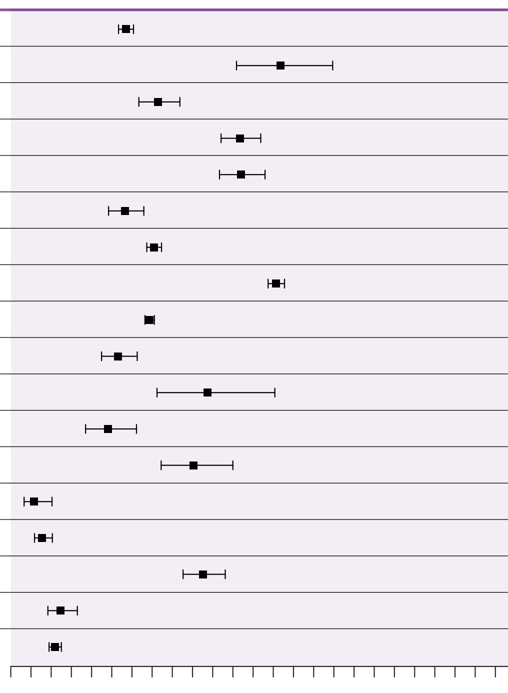


Table of contents

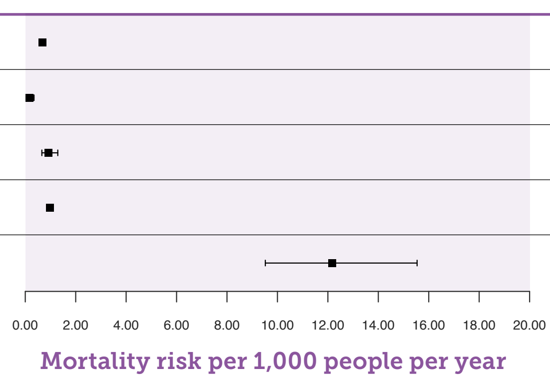
Mortality from coronary artery disease in people with diabetes

Studies on coronary artery disease in people with type 1 diabetes were carried out in high-income countries where the age of the participants ranged from 0 to 84. The highest risk of 12.2 coronary artery disease deaths per 1,000 was found in a study from the USA with a mean age of 29 years and the lowest risk of 0.2 coronary artery disease deaths per 1,000 was observed in a study from Norway in people aged between 0 and 44 (Figure 4.17).

Figure 4.17
CORONARY ARTERY DISEASE MORTALITY IN PEOPLE WITH TYPE 1 DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Mortality per 1,000 people per year	95% confidence interval
Finland		0-	17,306	0.67	0.62-0.74
Norway		0-44	1,906	0.17	0.09-0.35
Sweden	37	20-65	7,454	0.92	0.66-1.29
United Kingdom		1-84	23,751	0.98	0.92-1.05
USA	29		506	12.16	9.52-15.54



In studies of people with type 2 diabetes, the lowest mortality rate from coronary artery disease was 4.3 deaths per 1,000 people per year (in a population from Sweden with mean age of 62 years). The highest rate was 7.5 deaths per 1,000 people per year (in a population from Finland with mean age of 49 years) (Figure 4.18).

Figure 4.18
CORONARY ARTERY DISEASE MORTALITY IN PEOPLE WITH DIABETES

source: see appendix

Country	Mean age	Age range	Number of participants	Mortality per 1,000 people per year	95% confidence interval
Finland	49	25-74	3,837	7.49	6.92-8.12
Sweden	62	30-75	53,553	4.27	4.04-4.51
United Kingdom		40-	216,652	6.96	6.83-7.09
Japan	54		507	0.77	0.29-2.06
Japan	57	40-69	1,256	0.56	0.29-1.07
Repub. of Korea	57	20-	1,712	0.95	0.57-1.58

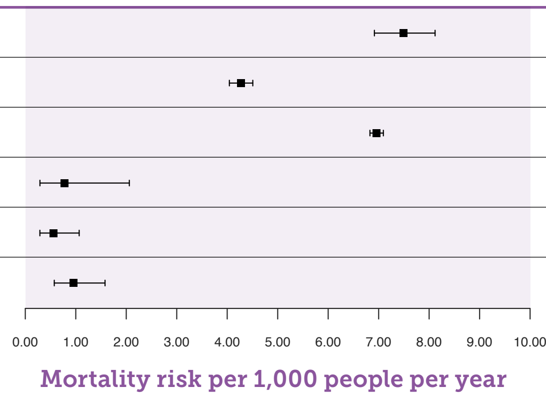


Table of contents

Conclusions

People with diabetes have a substantially increased risk of CVD compared to people without diabetes. Furthermore, CVD events in people with diabetes generally occur at an earlier age compared to people without diabetes[20].

Global estimates of the risk of CVD in people with diabetes could not be produced, due to the heterogeneity of the data.

In the studies reviewed, 3% to 16% of younger people with type 1 diabetes living in high- and middle-income countries had CVD (mean age of study population 25 to 44 years). Approximately 9% to 41% of middle-aged people with type 2 diabetes and unspecified diabetes living in high- and middle-income countries had CVD (mean age of study population 50 to 69).

In studies of younger people with type 1 diabetes (mean age of study population 8 to 43) living in high- and middle-income countries, 0.3 to 5 per 1,000 died from CVD each year. In studies of middle-aged people with type 2 diabetes and unspecified diabetes (mean age of study population 49 to 69 years), 2 to 27 people out of 1,000 died from CVD each year.

> “The risk of CVD increased with age.”

There is a lack of data for people with diabetes living in low-income countries. Research on the association between diabetes and CVD has been limited, with only high- and middle-income countries reporting findings on this important relationship. Each study examined populations with different types of CVD and different age ranges (Figure 4.19). This made it difficult to make comparisons between studies and to substantiate the known increased risk of CVD and CVD mortality with increased age.

Figure 4.19

CARDIOVASCULAR DISEASES IN DIABETES IS NOT REPORTED OR MEASURED CONSISTENTLY ACROSS THE GLOBE

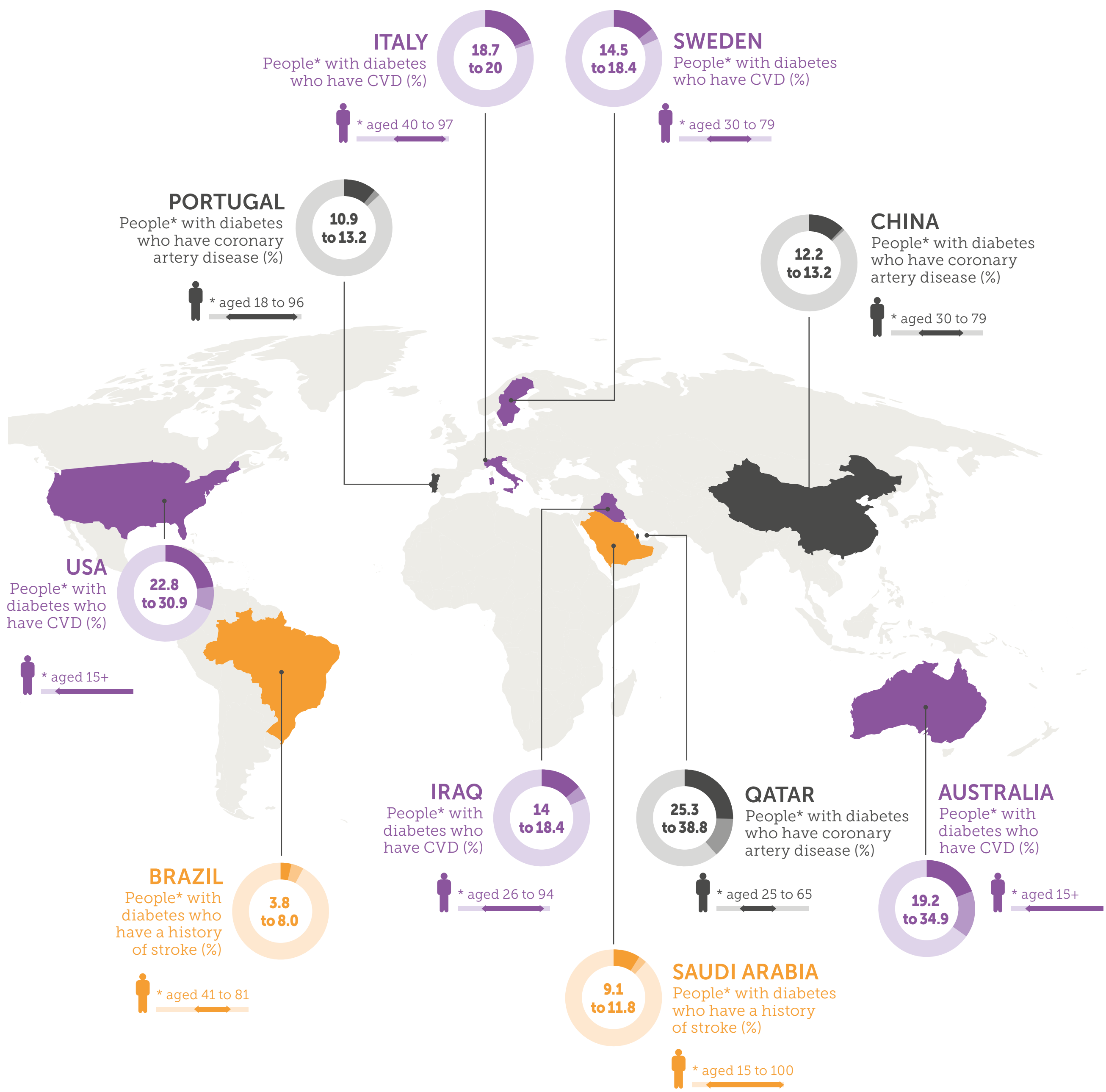


Table of contents

5 The way forward

This report confirms the huge impact of cardiovascular disease on people with diabetes. They have a 2-3-fold risk of CVD compared to people without diabetes. The risk of cardiovascular disease is also approximately six-fold higher in people with diabetes aged over 75 years, compared to younger people with diabetes[(1)].

CVDs are an important cause of mortality in people with diabetes. Of every thousand middle-aged people with diabetes, up to 27 will die each year as a result of cardiovascular disease. Overall, age-standardised CVD mortality rates are today higher in most low- and middle-income countries than in high-income countries.

The report identifies that high blood pressure is an important risk factor for CVD mortality, particularly in low-income countries. Raised cholesterol levels and obesity, seen particularly in middle and high income countries were less predictive of CVD mortality.

The report also demonstrates the important impact of non-communicable disease surveillance systems; countries with such systems have lower CVD mortality, regardless of national income level. The majority of countries however still need to implement national strategies that prioritise non-communicable disease surveillance.

In order to decrease the impact of diabetes and CVD, national governments should focus on:

1. **Implementing public health policies and lifestyle interventions to increase healthy eating and physical activity**

2. **Prioritising control of blood pressure and ensuring essential medicines are available to achieve blood pressure control**

3. **Implementing non-communicable disease monitoring systems**

4. **Legislating and implementing policies that reduce tobacco consumption**

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Prevent type 2 diabetes as part of an integrated non-communicable disease action plan

As type 2 diabetes, CVD, and other non-communicable diseases share modifiable risk factors, it is vital that policy makers develop a comprehensive and inclusive strategy to increase healthy eating and physical activity within the population.

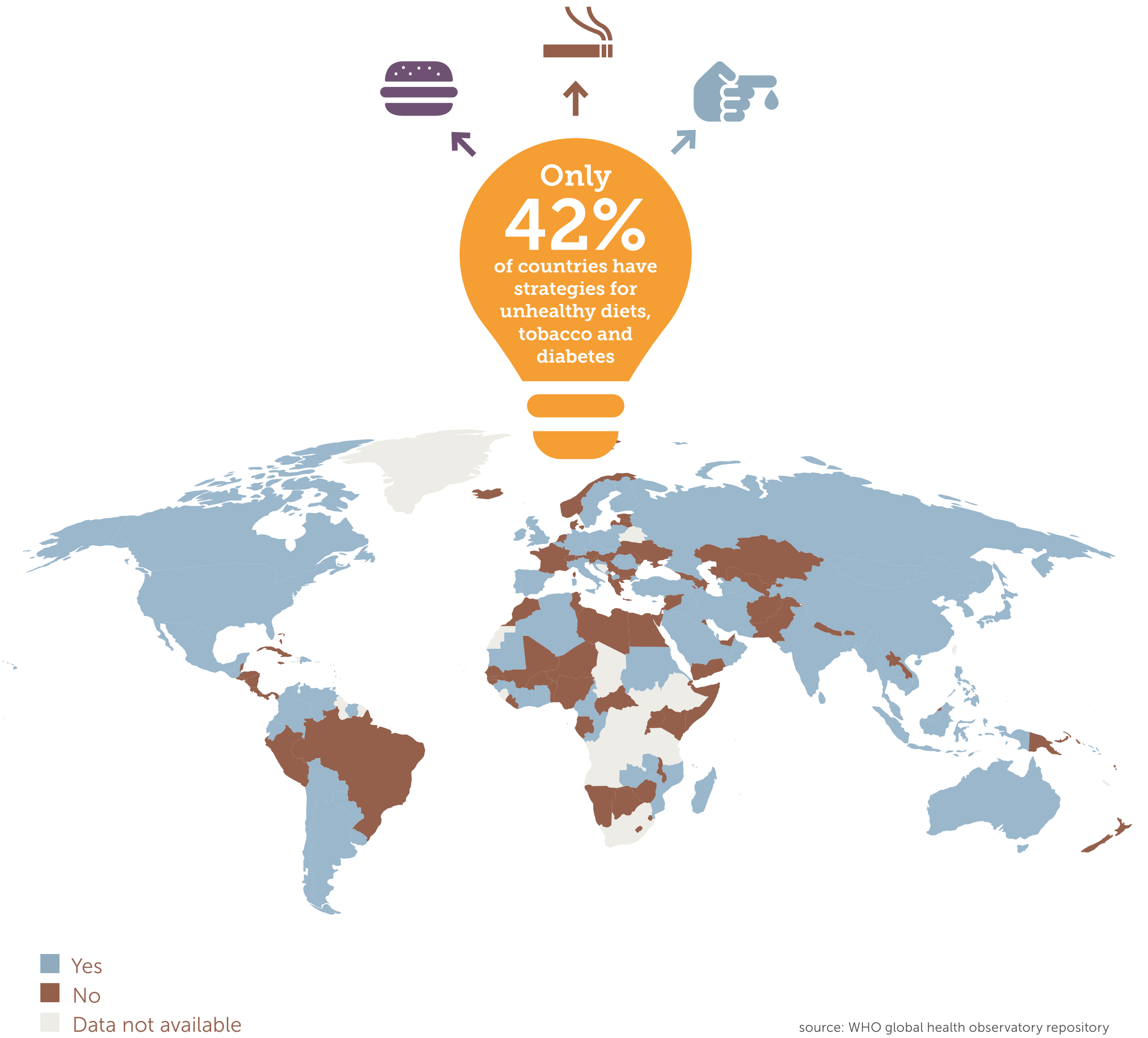
The threat of non-communicable diseases now confronts countries at all stages of development, and it is imperative that each country develops and implements an integrated plan to mitigate risk factors and promote screening and prevention. Combatting CVD and diabetes requires a balanced approach that incorporates both prevention and treatment. Successful prevention of type 2 diabetes and CVD will be required to reduce the incidence of non-communicable diseases, while better treatment can extend and improve the lives of people with the diseases. The value of cost-effective prevention interventions has been known for over a decade, but their uptake is still unacceptably low, particularly in low- and middle-income countries.

The majority of countries worldwide do not have action plans aimed at decreasing the impact of non-communicable diseases. Such a plan should include strategies for unhealthy diets, tobacco and diabetes. However, while 80% of countries have a strategy to address at least one of these issues, only 42% have a strategy for all three (Figure 5.1).

> “Combatting CVD and diabetes requires a balanced approach that incorporates both prevention and treatment.”

Figure 5.1

MAP INDICATING THE PRESENCE OF ACTION PLANS FOR UNHEALTHY DIET, TOBACCO AND DIABETES



source: WHO global health observatory repository

Both diabetes and CVD have emerged as a major threat to health globally, and particularly in low- and middle-income countries where access to health care is a major challenge. Effective approaches to reduce the impact of non-communicable diseases include a mixture of population-wide and individual interventions. There is a need to create environments that promote healthy lifestyle choices and help reduce the risk of non-communicable diseases, as well as to build health systems that can detect and manage diabetes and CVD.

Cost-effective interventions include early detection of non-communicable diseases using inexpensive technologies, non-pharmacological modification of risk factors and affordable medications for prevention and treatment of heart attacks, strokes and diabetes. These interventions, if effectively delivered, can reap future benefits such as reduced medical costs, improved quality of life and productivity. However, in many countries, the implementation of these interventions has been insufficient.

Population-wide strategies to combat non-communicable diseases should be conducted in partnership with local governments, civil societies, researchers and communities. They should maximise health system investments by aligning non-communicable disease prevention with existing global health efforts to strengthen health systems. Furthermore, priority should be given to research to determine what interventions will be most effective and feasible to implement in low- and middle-income countries[2].

Increase intersectoral collaboration

Non-communicable diseases, such as diabetes and CVD, are major barriers to sustainable development and the alleviation of poverty. Every person with diabetes who dies prematurely from CVD or other comorbidity has an impact on both their family and on their society. Premature death in people of working age places a strain on the economy through lost productivity, and on the family through lost wages and manpower[3].

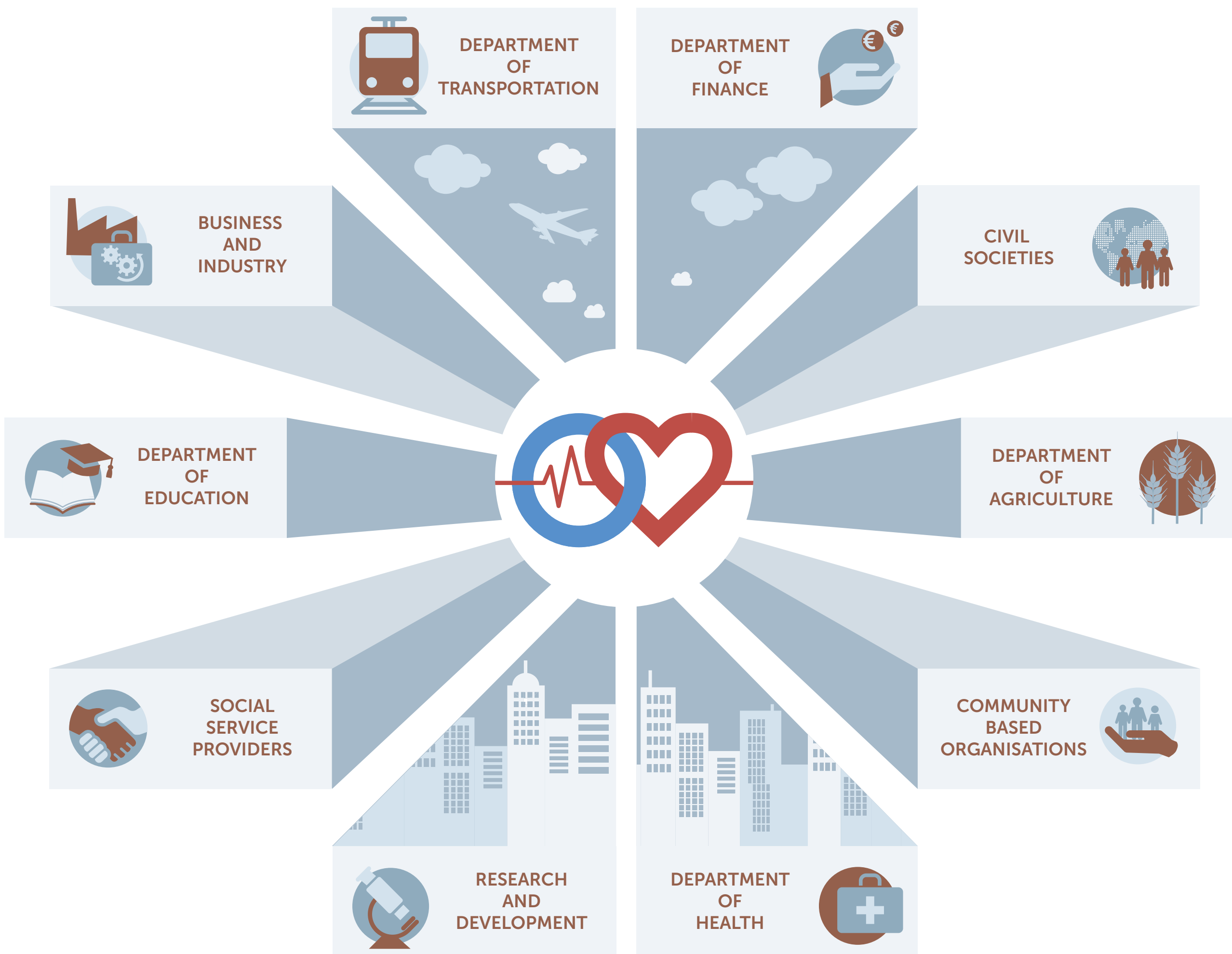
In September 2015, the United Nations Member States adopted the Sustainable Development Goals for 2030. Within the goal of health, there are several targets related to non-communicable diseases. Goal 3 of the Sustainable Development Goals is "Good Health and Well-Being", which includes the following targets:

- By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
- Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
- Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States
- Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks
- Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate

The greatest health challenges of the 21st century, such as non-communicable diseases, health inequalities, and increasing health care costs, are highly complex. These are often linked through the social determinants of health, such as the socio-economic circumstances in which people are born and raised, and influenced by economic policies, social norms, and political systems. Intersectoral collaboration is essential to address the social determinants of health that increase risk of non-communicable diseases and to ensure everyone has equal opportunity to achieve the highest level of health.

Intersectoral collaboration is a key component in the development and advocacy for population-wide cost-effective interventions to improve safe physical activity, encourage access to healthy foods, decrease tobacco use and improve access to clean water. At government level, multisectoral collaboration requires co-operation between different departments such as the Departments of Finance, Agriculture, Education and Transportation to ensure co-ordinated policy development and implementation. At the community level, intersectoral collaboration can involve civil societies, social service providers, businesses, community-based organisations and other stakeholders coming together to develop and coordinate service provision and advocacy initiatives (Figure 5.2).

Figure 5.2
INTERSECTORAL AND MULTISECTORAL COLLABORATION IS VITAL TO FIGHT DIABETES AND CARDIOVASCULAR DISEASE



NCD Alliance

In recent years, the major global non-governmental organisations focused on non-communicable diseases have aligned their efforts to advocate a global coordinated response in the form of the NCD Alliance. IDF is a founding member of the NCD Alliance, whose mission is to unite and strengthen civil society to stimulate collaborative advocacy, action and accountability for non-communicable disease prevention and control. The NCD Alliance uses targeted advocacy and outreach to ensure that non-communicable diseases are recognised as a major cause of poverty, a barrier to economic development and a global emergency.

NCD Alliance launched a successful campaign for a United Nations High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. In 2011, United Nations Member States acknowledged that the global burden and threat of non-communicable diseases constitutes one of the major challenges for development in the twenty-first century. Non-communicable diseases have since gained political traction on a global scale, with the adoption of the World Health Organization Global Monitoring Framework, Global Non-Communicable Disease Action Plan and the landmark inclusion of non-communicable diseases in the 2030 Agenda for Sustainable Development.

www.ncdalliance.org

Use the World Heart Federation roadmaps for reducing CVD mortality

The World Health Organization *Global Action Plan for the Prevention and Control of Non-Communicable Diseases* calls on governments to act to reduce premature mortality from cardiovascular disease and from diabetes by at least 25 percent, and to halt the rise in diabetes by 2025. Without urgent action to prevent CVD events in people with diabetes, these targets are unlikely to be met. Countries must therefore work quickly to implement high impact solutions.

The World Heart Federation roadmaps can serve as models to help countries meet their commitments to the targets. The roadmap structure aligns to the goal of reducing premature CVD mortality. They translate existing knowledge of best practices, barriers, and solutions into practical strategies for improved cardiovascular health, and focus on strategies to reduce premature mortality from cardiovascular disease by decreasing tobacco use, decreasing the prevalence of raised blood pressure and improving drug therapy.

www.cvdroadmaps.org

Increase tobacco control

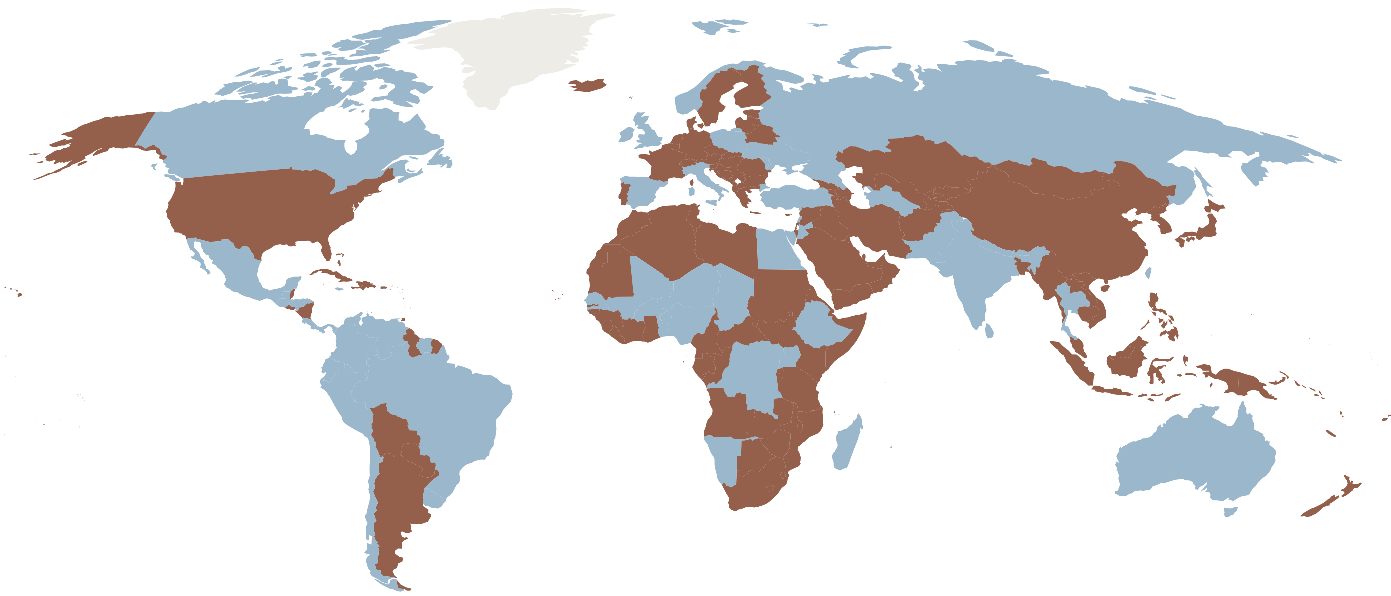
Tobacco kills up to half of its users, more than 5 million people per year. An additional 600,000 annual deaths are the result of non-smokers being exposed to second-hand smoke. Many of these deaths are due to CVDs such as heart attack or stroke. Nearly 80% of the world's smokers live in low- and middle-income countries. The amount of tobacco produced globally has nearly doubled since 1960, with tobacco farming shifting from high to low- and middle-income countries[(4)].

Smoking cessation has significant impacts on reducing CVD-related mortality. The *World Health Organization Global Action Plan for the Prevention and Control of Non-Communicable Diseases* includes a voluntary global target of a 30% relative reduction in prevalence of current tobacco use by 2020[(5)].

In order to achieve this, governments should implement the World Health Organization Framework Convention on Tobacco Control. Actions include raising tobacco taxes, comprehensive bans on tobacco advertising and sponsorship, placing large health warnings on packaging and legislating for smoke-free environments. However, currently only 57 countries have smoke-free environments in all indoor workplaces, public transport, and indoor public places (Figure 5.3)

Figure 5.3

MAP OF COUNTRIES WITH SMOKE-FREE INDOOR WORKPLACES, PUBLIC TRANSPORT AND INDOOR PUBLIC PLACES



- Yes
- No
- Data not available

"28% of countries have legislated for these policies."

source: tobaccocontrollaws.org

Increase blood pressure control

High blood pressure is the leading modifiable risk factor that contributes to the global burden of disease[5]. There is a very strong association between the prevalence of raised blood pressure and the national age-standardised CVD mortality rate (Chapter 3). Even when controlling for gross national income, the prevalence of raised blood pressure still shows a significant positive association with CVD mortality. Raised blood pressure is most prevalent in low- and middle-income countries in Central Asia, the Middle East and Africa (Chapter 3).

The *World Health Organization Global Action Plan for the Prevention and Control of Non-Communicable Diseases* includes the voluntary global target to reduce or contain the prevalence of raised blood pressure. Primary prevention of raised blood pressure should be focused on salt reduction, improved fruit and vegetable intake, increased physical activity, and avoidance of excessive alcohol[6]. Secondary prevention requires a concerted effort to provide education and treatment to people with raised blood pressure, with good access to essential medicines. In many countries, this will require strengthening of the health care system.

> “There is a very strong association between the prevalence of raised blood pressure and the national age-standardised CVD mortality rate.”

Strengthen and improve access to the health care system

Improving public health services is a short-term necessity, but also an investment in the long-term health and well-being of the population. Inequalities in the access, availability and affordability of medicines and health services, particularly at the primary care level, present hurdles to the delivery of health care for people living with CVD and diabetes. Health-system strengthening should be a major focus in the prevention and management of non-communicable diseases.

Community health workers and primary health professionals are often the first point of contact with the health system, especially in resource-constrained settings. The role of primary care in the management of CVDs should be strengthened, and should be integrated with the management of other chronic conditions, such as diabetes and HIV. Community health workers and traditional birth attendants should be trained how to measure blood pressure and blood glucose. Furthermore, there should be good access to primary health care facilities especially in rural areas.

Locally applicable guidelines that are simple and practical should be developed for both specialist and non-specialist health professionals. The education and ongoing training of health professionals should be a priority, with regular assessment and feedback from the medical community. Clinical support systems can improve the way that health professionals prescribe appropriate medications and promote cost-effective treatments.

The care of people with non-communicable disease should be integrated and patient centred. Co-operation and information sharing should be fostered between primary health professionals, diabetologists, and cardiologists. Diabetologists should routinely check the blood pressure in all their patients, and cardiologists should be aware that many of their patients are at increased risk of type 2 diabetes, and screen accordingly. As some diabetes and CVD medications can interact, the prescribing doctor should review with each patient their complete treatment regimen.

Improve education and empowerment of people with non-communicable diseases

People with diabetes should be empowered to manage their own disease, share decision-making with health professionals, and actively work to prevent the onset of complications. These efforts can be supported by m-health interventions such as the World Health Organization's Be He@lthy Be Mobile initiative.

Communication and information technology can be used to remind people with non-communicable diseases to fill their prescriptions and take their medicine at the appropriate time. Text-messages are one form of reminders that can be cost-effective even in low-resource settings. Family and friends can be requested to monitor treatment adherence, which may also be improved by using fixed-dose combinations of priority medicines.

Community health centres, antenatal clinics, and pharmacies should enable people at risk of CVDs to easily monitor their blood pressure status. People attending tuberculosis or HIV clinics should also have the opportunity to receive education about non-communicable diseases and be checked for diabetes and high blood pressure.

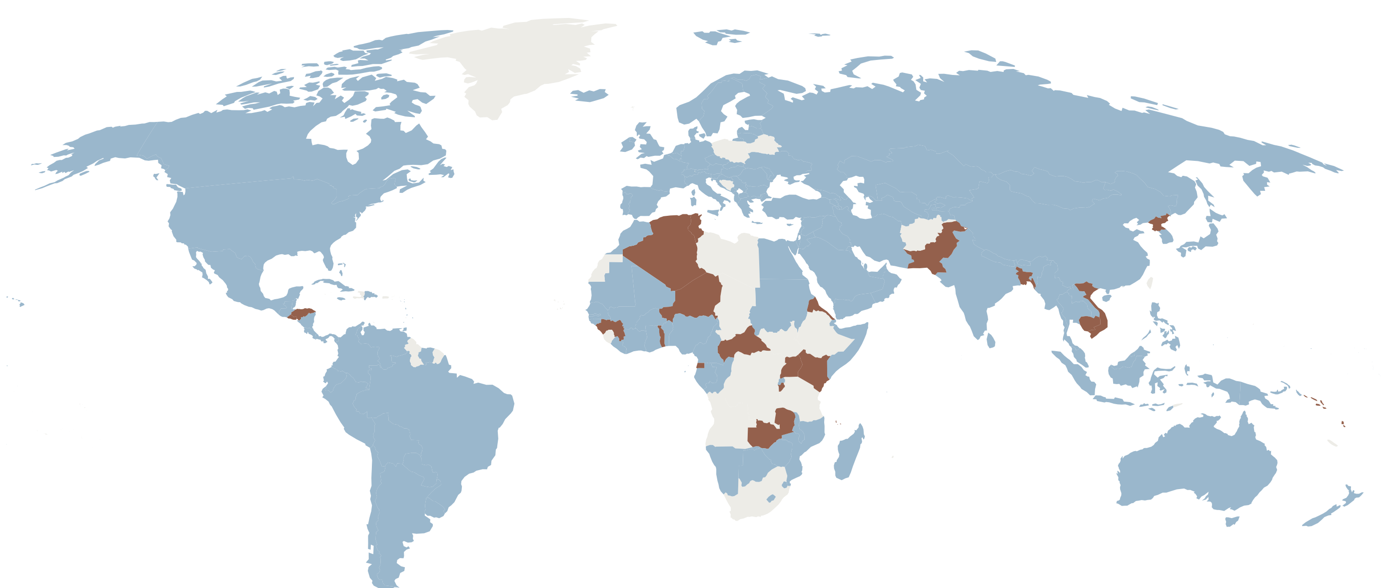
Improve access to medicines

In September 2015, the United Nations Member States adopted the Sustainable Development Goals for 2030. These targets include achieving access to safe, effective, quality and affordable essential medicines and vaccines for all.

Essential medicines for CVD include aspirin, ACE inhibitors, angiotensin receptor antagonists, beta-blockers, calcium channel antagonists, diuretics and statins. Essential medicines for diabetes include gliclazide (or a similar sulfonylurea), glucagon, insulin, and metformin. These medicines should be affordable, and widely available at community health facilities and pharmacies as well as in hospital settings.

Data from the World Health Organization suggest that one third of countries lack general public health sector availability of one of more essential cardiovascular or diabetes medicines (Figure 5.4). Many of these are in Africa, where the burden of diabetes and CVD mortality is already very high. Improving access, which may require more efficient procurement practices and distribution, must be prioritised in these countries.

Figure 5.4
MAP OF COUNTRIES WITH GENERAL AVAILABILITY OF ACE INHIBITORS AND METFORMIN IN THE PUBLIC HEALTH SECTOR, 2013



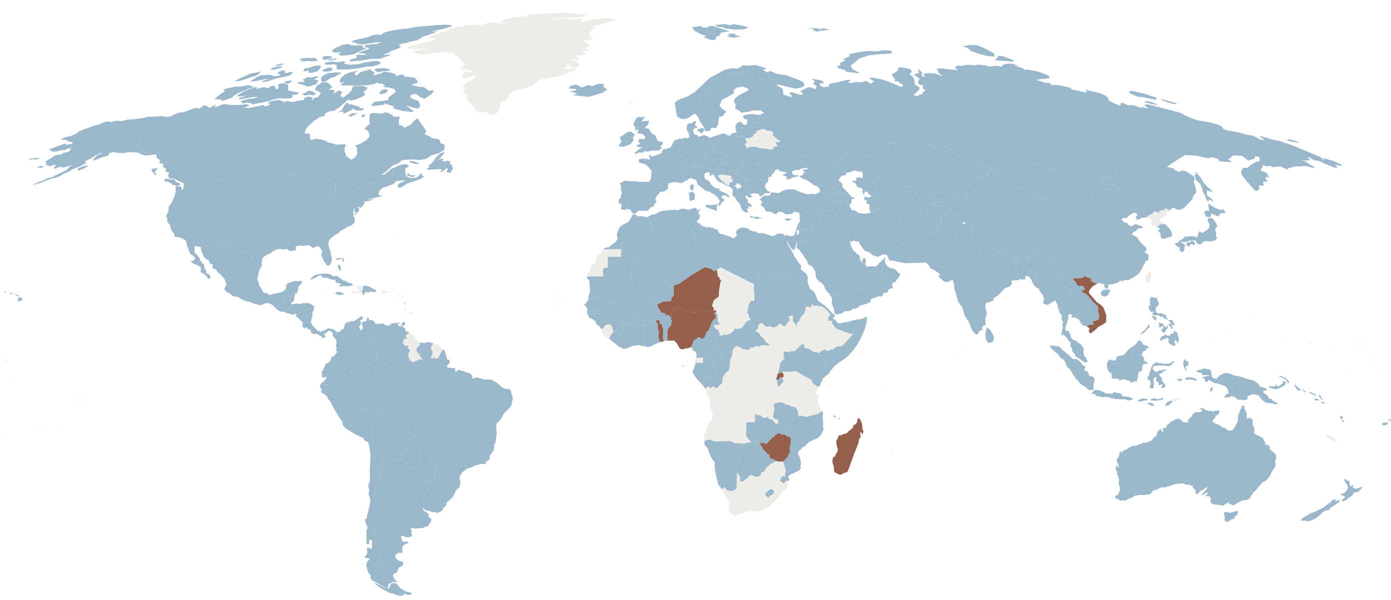
Yes
No
Data not available

"70% of countries have general availability."

source: WHO global health observatory

As approximately half of all cases of diabetes are undiagnosed globally, and in order to ensure appropriate lifestyle advice and correct prescribing practices, it is essential that all at-risk populations have access to diabetes testing. This service is currently available in 87% of countries (Figure 5.5).

Figure 5.5
MAP OF COUNTRIES WHERE DIABETES TESTING IS GENERALLY AVAILABLE AT THE PRIMARY HEALTH CARE LEVEL



Yes
No
Data not available

source: WHO global health observatory

Table of contents

Improve information systems

Accurate measurement of prevalence and mortality is the basis for determining the scale of the global impact of non-communicable diseases, and for understanding how best to intervene. Many low- and middle-income countries still lack sufficient local data to inform their decisions about how to prioritise actions to target diabetes and CVDs. Information systems should build upon current approaches used in monitoring and in order to take advantage of existing infrastructure and to avoid the inefficiencies of duplicate systems. In order to facilitate comparisons between countries, there also needs to be international agreement on what is to be measured, how it is classified, and how the information is shared.

> “Information systems should build upon current approaches used in monitoring and in order to take advantage of existing infrastructure and to avoid the inefficiencies of duplicate systems.”

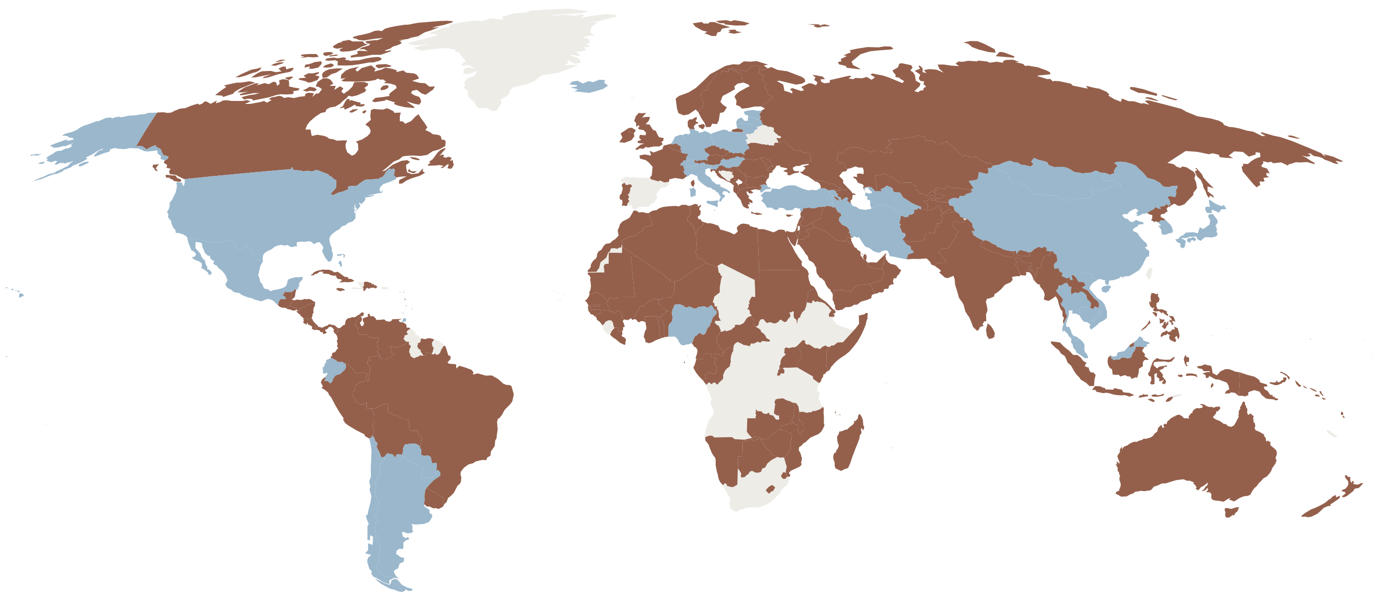
Increase non-communicable disease monitoring

Countries with non-communicable disease monitoring systems generally have lower rates of age-standardised CVD mortality, even when the income level of the country is taken into account.

Non-communicable disease surveillance and monitoring systems include regular data collection on mortality by cause, and risk factor surveillance of all harmful alcohol use, physical inactivity, tobacco use, raised blood glucose, raised blood pressure, overweight/obesity and salt/sodium intake. Only 20% of countries worldwide have reported the implementation of such a system, and they are very rare in low-income countries (Figure 5.6). Even in the countries with monitoring systems, the quality of the data collected varies substantially. In many countries, especially in low resource areas, health statistics are often based on monitoring that does not cover all areas of the country, or is collected by under-trained staff.

The IDF recommends that all countries with appropriate resources move towards implementing a comprehensive non-communicable disease surveillance and monitoring system in order to understand population health, identify salient risk factors and plan for risk factor reduction. Appropriate data should also be made available and accessible to researchers.

Figure 5.6
MAP OF EXISTENCE OF A NON-COMMUNICABLE DISEASE MONITORING SYSTEM, 2013



Yes
No
Data not available

source: WHO NCD country capacity survey

Use international standards for conducting epidemiological studies

To monitor the impact of diabetes and CVD and measure the efficacy of interventions, it is critical to be able to gather data and make comparisons across countries, sectors, systems and evaluations. Therefore, measurement strategies would benefit enormously from standardization and global co-ordination.

The World Health Organization has developed the International Statistical Classification of Diseases and Related Health Problems medical classification list. It is a health care classification system, providing a system of diagnostic codes for classifying diseases, symptoms, social circumstances and external causes of injury or disease. This classification list is the international standard diagnostic tool for epidemiology, health management and clinical purposes, and should be used on all medical records and in all epidemiological studies to allow better comparability or studies and meta-analyses.

Conclusions

CVD is a major cause of death and disability in people living with diabetes, and a barrier to sustainable development. There is a need to create environments that promote healthy lifestyle choices and reduce the risk of non-communicable diseases, as well as to build health systems that can detect and manage diabetes and CVD.

In order to reduce premature mortality from non-communicable diseases, an integrated action plan is needed in each country to strengthen health systems and implement cost-effective interventions.

The incidence of CVD and diabetes can be decreased through individual-level interventions such as reduction in intake of sugar, salt and fat, improved fruit and vegetable intake, increased physical activity, smoking cessation and avoidance of excessive alcohol. At a population level, the health care system should be strengthened, the education of people with non-communicable diseases should be improved, and access to priority medicines should be increased.

Progress and efficacy of these interventions can be measured through internationally standardised surveillance and monitoring systems, as well as increased funding of high quality epidemiological assessments.

The IDF is committed to advocating for improved health for all people living with diabetes. It endorses the recommendations included in this report, and encourages all countries to work towards good health and well-being for all people living with diabetes.

“Progress and efficacy of these interventions can be measured through internationally standardised surveillance and monitoring systems, as well as increased funding of high quality epidemiological assessments.”

6 Abbreviations, glossary, methodology and references

Abbreviations

ACE	Angiotensin-converting enzyme
BMI	Body mass index
CAD	Coronary artery disease
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
GDP	Gross domestic product
GNI	Gross national income
HbA1c	Glycated haemoglobin
HDL	High-density lipoproteins
IDF	International Diabetes Federation
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
LDL	Low-density lipoproteins
NA	Not available
NCD	Non-communicable disease
NGO	Non-governmental organisation
OGTT	Oral glucose tolerance test
SBP	Systolic blood pressure
USA	United States of America
WHO	World Health Organization

Table of contents

Glossary

Age-standardised prevalence: See prevalence.

Angina pectoris: The sensation of chest pain, pressure, or squeezing, caused by an inadequate supply of blood to the heart.

Angiotensin converting enzyme (ACE) inhibitor: A type of medication used for blood pressure control and heart failure.

Artery: A vessel carrying blood from the heart to various parts of the body.

Atherosclerosis: Narrowing, hardening and thickening of the walls of the arteries.

Beta blocker: A type of medication that is used to manage irregular heartbeat and reduce the risk of heart attacks in people who have already had one.

Blood pressure: A measure of the force of the blood being pushed by the heart through the arteries. Blood pressure is written as two numbers. The higher number (systolic) shows the pressure created by the heart contracting or pumping out the blood. The lower number (diastolic) indicates the pressure when the heart is relaxing between beats.

Blood vessel: An artery, vein or capillary.

Body mass index (BMI): A key index for assessing body weight in relation to height. The BMI is a person's weight in kilograms (kg) divided by their height in metres (m) squared.

Cardiovascular disease: Diseases and injuries of the circulatory system: the heart, the blood vessels of the heart and the system of blood vessels throughout the body.

Cerebrovascular disease: Damage to the blood vessels in the brain, which may result in a stroke.

Cholesterol: A waxy, fat-like substance that is used to form cell membranes and to produce some hormones. When total cholesterol is measured in the blood, it includes cholesterol carried by low-density lipoproteins (LDL) and high-density lipoproteins (HDL).

Coronary artery: The coronary arteries are blood vessels that deliver oxygenated blood to the muscle of the heart.

Coronary artery disease: A group of diseases related to damage to the blood vessels supplying blood to the heart. Includes angina pectoris, heart attack (myocardial infarction), and sudden coronary death.

Diabetes: A condition that arises when the pancreas does not produce enough insulin or when the body cannot effectively use insulin. The three most common forms are: type 1 diabetes, type 2 diabetes, and gestational diabetes.

Gestational diabetes:
Hyperglycaemia that is first detected at any time during pregnancy is classified as either:
- Gestational diabetes mellitus
- Diabetes mellitus in pregnancy

Women with slightly elevated blood glucose levels are classified as having gestational diabetes, whilst women with substantially elevated blood glucose levels are classified as having diabetes mellitus in pregnancy.

Glycated haemoglobin A1c (HbA1c): Haemoglobin to which glucose is bound. Glycated haemoglobin is tested to determine the average level of blood glucose over the past two to three months.

Heart attack: Also called myocardial infarction. Results from permanent damage to an area of the heart muscle, after the blood supply to the area of the heart is interrupted because of narrowed or blocked blood vessels.

Heart failure: Occurs when damage to the heart muscle is severe enough to prevent it from functioning adequately as a pump.

High-density lipoproteins (HDL): High-density lipoproteins (HDL) are sometimes referred to as "good cholesterol" because they transport cholesterol out of the circulation and reduce the risk of atherosclerosis.

High-income country: A country defined by the World Bank to have a gross national income per capita of $12,736 or more in 2014.

Hyperglycaemia: A raised level of glucose in the blood.

Hypertension: Persistently elevated blood pressure.

Impaired fasting glycaemia (IFG): A person can be diagnosed as having impaired fasting glucose if they have an abnormally high level of blood glucose after fasting, but that level is not high enough to be diagnosed as diabetes.

Impaired glucose tolerance (IGT): A person can be diagnosed as having impaired glucose tolerance if they have an abnormally high level of blood glucose after drinking a standard amount of glucose diluted in water, but that level is not high enough to be diagnosed as diabetes.

Incidence: The number of new cases of a disease among a certain group of people for a certain period of time. For example, the number of strokes in people with diabetes in one year.

Insulin: A hormone produced in the pancreas. If blood glucose levels increase, it enables cells to take up glucose from the blood stream and convert it to energy, and the liver to take up glucose from the blood stream and store it as glycogen.

Insulin resistance : A state in which a given level of insulin produces a less than expected biological effect.

Intermittent claudication: Pain, usually in the calves, due to an impaired blood supply to the calf muscle.

Ischaemia: A shortage of oxygen in a part of the body.

Low-density lipoprotein (LDL): Low-density lipoprotein particles are sometimes referred to as “bad cholesterol” because they transport cholesterol into the circulation and increase the risk of atherosclerosis..

Low-income country: A country defined by the World Bank to have a gross national income per capita of $1,045 or less in 2014.

Metformin: An oral medicine that is used for the treatment of type 2 diabetes.

Middle-income country: A country defined by the World Bank to have a gross national income per capita of more than $1,045 and less than $12,736 in 2014.

Myocardial infarction: See heart attack.

Obesity: People are generally considered obese when their body mass index is over 30 kg/m^2. A lower threshold is used in some Asian populations.

Pancreas: The pancreas is an organ situated behind the lower part of the stomach which produces hormones such as insulin and glucagon.

Peripheral vascular disease: Disease of blood vessels other than those that supply blood to the brain or the heart.

Prevalence: The proportion or number of individuals in a population that has a disease or condition at a particular time (be it a point in time or time period). For example, the proportion of adults with raised blood pressure. Prevalence is a proportion or number and not a rate.

Age-standardised prevalence: Calculated by assuming that every country has the same age profile. This reduces the effect of different age distributions between countries, and makes this estimate appropriate for making comparisons.

Raw Prevalence: The number or percentage of a population that has a disease.

Relative risk : The ratio of the probability of an event occurring (for example, a stroke) in one group (for example, people with diabetes) to the probability of the event occurring in a comparison group (for example, people without diabetes).

Statins: A class of lipid-lowering medications.

Stroke: A sudden loss of function in part of the brain as a result of the interruption of its blood supply.

Type 1 diabetes: Type 1 diabetes is caused by an autoimmune reaction, in which the body's defence system attacks the insulin-producing beta cells in the pancreas. As a result, the body can no longer produce the insulin it needs.
People with this form of diabetes need to inject insulin every day in order to control the levels of glucose in their blood. Without insulin, a person with type 1 diabetes will die.

Type 2 diabetes: In type 2 diabetes, there is a combination of inadequate production of insulin and an inability of the body to respond fully to insulin (insulin resistance).

Vein: A vessel carrying blood back from various parts of the body to the heart.

Methodology

Chapter 3

Because the measurements collected from WHO repository are over correlated with each other and in order to identify correctly characteristics of countries with high and low age-standardised non-communicable death rates, modelling was conducted using principal component analysis. The principal component analysis returned linear combinations of the covariates that were uncorrelated between each other and helped to describe the main traits and tendencies in the data. The variables listed below were used in the analysis:

Variables from IDF Diabetes Atlas

- Average diabetes-related health expenditure per person with diabetes (aged 20-79)
- Age-standardised diabetes prevalence (aged 20-79)
- Proportion of diabetes-attributable deaths that occur under 60
- Diabetes deaths as a proportion of all-cause deaths (aged 20-79)
- IDF Geographic Region (Europe, Africa, North America and Caribbean, Middle East and North Africa, Western Pacific, South-East Asia, South America and Central America)

Variables from World Health Organization global health observatory repository

- Existence of evidence-based national guidelines/protocols/standards for the management of major NCDs through a primary care approach
- Existence of operational policy/strategy/action plan to decrease tobacco use
- Existence of operational policy/strategy/action plan to reduce unhealthy diet related to NCDs
- General availability of metformin in the public health sector
- Existence of an NCD surveillance and monitoring system in place to enable reporting against global NCD targets
- Existence of operational policy/strategy/action plan for diabetes
- General availability of ACE inhibitors in the public health sector
- General availability of diabetes testing (by blood glucose measurement, OGTT, or HbA1c) at the primary health care level
- Gross national income per capita

- General government expenditure on health as a percentage of total government expenditure
- Prevalence of raised total cholesterol (>= 5.0 mmol/L)
- Prevalence of BMI >= 30
- Prevalence of raised blood pressure (SBP>=140 OR DBP>=90)

Main outcomes

- Cardiovascular diseases, age-standardised deaths per 100,000
- Premature NCD mortality
- Age-standardised NCD mortality per 100,000

Principal component analysis employed both Box-Cox transformation for rescaling covariates that were presented in different units and magnitudes, and the complete Pearson correlation matrix that allowed mixing categorical (operated with "Yes"/"No" types of response) and numerical (prevalence, measurements, mortality) covariates together.* After taking in consideration correlation and covariation of the different variables, it was observed that the first eight principal components accounted for roughly 77% of the total variation.

The negative binomial model was selected as an appropriate tool that allowed handling the presence of high variability in outcome variables: for example, mortality from NCDs ranged from 1025.1 people per 100,000 in Turkmenistan to 244.2 people per 100,000 in Japan.

The regression coefficients from the model were used later to present the results. The coefficients showed how strong and directed the association between principal components and outcomes. Extracting effects of particular elements from components and regression coefficients were obtained in the backward transformation. The confidence intervals of coefficients were derived from the model dispersion matrix.

The analysis was conducted in R, a free software environment for statistical computing and graphics, and the functions "princomp"(package "stats"), "mixed.cor" (package "psych"), "glm.nb" (package "MASS") were used in the analysis.

The analysis was repeated on sex-specific data. As the patterns were similar to the results for both sexes combined, only the results for both sexes combined are presented in this report.

* - G. E. P. Box and D. R. Cox Journal of the Royal Statistical Society. Series B (Methodological) Vol. 26, No. 2 (1964), pp. 211-252

- W.Revelle, J.Wilt, and A.Rosenthal. Personality and cognition: The personality-cognition link. In A.Gruszka, G. Matthews, and B. Szymura, editors, Handbook of Individual Differences in Cognition: Attention, Memory and Executive Control, chapter 2, pages 27-49. Springer, 2010

Chapter 4

A systematic literature review in Ovid MEDLINE was conducted in 2014 to identify the prevalence, incidence and CVD-related mortality of CVD in people with diabetes. It was restricted to observational studies on human subjects published in 1993 or later.

All references were reviewed by a single reviewer based on their abstracts and titles against a set of pre-defined eligibility criteria. Papers based on the same study data or clinical trial were identified and the appropriate papers were selected for data extraction.

All publications where there was uncertainty about inclusion were reviewed by two people, and any disagreement was resolved either through "reconciliation" (discussion between the two reviewers) or through "arbitration" by a third independent reviewer. The "majority view" determined inclusion or exclusion.

Publications included after abstract review underwent a full review of the text. All papers included after completion of the full text review were retained for quality assessment and data extraction into a MySQL database.

In cases of duplication of study data, only the paper reporting the most complete data or the most recent paper were used. All references identified through the searches were exported the MySQL database.

Once all duplicates were removed, the quality of each study was assessed, based on relevance, study variables, sample size, study population and the date of study. The highest quality studies for each country were selected for inclusion into the final sample.

#	Searches	Results
1	Diabetes mellitus/ or diabetes mellitus, type 1/or diabetes mellitus, type 2	**218579**
2	Diabetes Complications	**34545**
3	1 or 2	**240298**
4	Cardiovascular diseases/ or exp heart diseases/ or exp vascular diseases	**1855146**
5	3 and 4	**59774**
6	Epidemiology/ or mortality/ or "cause of death"/ or fatal outcome/ or mortality, premature	**126867**
7	Incidence/ or prevalence	**346350**
8	6 or 7	**467287**
9	5 and 8	**7665**
10	Diabetes mellitus/ ep, mo or diabetes mellitus, type 1/ ep, mo or diabetes mellitus, type 2/ ep, mo or diabetes complications/ ep, mo	**31982**
11	Cardiovascular diseases/ ep, mo or exp heart diseases/ ep, mo or exp vascular diseases/ ep, mo	**214426**
12	10 and 11	**11703**
13	9 or 12	**14800**
14	Randomized controlled trial. pt.	**372317**
15	Controlled clinical trial. pt.	**88255**
16	Controlled clinical trial./ or randomized controlled trial.	**455672**
17	Epidemiologic studies/ or exp case-control studies/ or exp cohort studies/ or cross-sectional studies	**1621612**
18	Observational Study	**2099**
19	14 or 15 or 16 or 17 or 18	**1962662**
20	13 and 19	**7128**
21	Limit 20 to (humans and yr="1993-2014")	**6809**

25,804
titles were identified

↓

1,606
papers were included for a full text review

↓

409
papers were included for data extraction

↓

116
papers were entered into the CVD database

↓

72
papers were used in the analysis

After the data cleaning process, the database was transformed using the SAS 9.4 statistical package and R statistical software. Where possible, incidence and mortality risks were transformed using a standard unit of 1,000 persons per year. In cases where a prevalence rate was not provided, these were derived using the number of subjects and CVD events, when this information was available.

If the follow up time, number of subjects and number of CVD events were available, rates were derived per 1,000 person years using the following formula:

$$\text{Rate} = \frac{\text{Number of CVD events}}{\text{Number of subjects x mean follow up time x 1,000}}$$

Table M.1
CVD GROUPS

CVD Group	Diseases
All CVDs	Any combination of cardiovascular diseases that includes both stroke and coronary artery disease
MI	Acute Myocardial Infarction, Infarctas Myocardii
Other	Acute Coronary Syndrome, Angina, Angina Pectoris, Ischemic Myocardiopathy, Arrhythmia Or Sudden Cardiac Death, Chronic Heart Failure, Heart Failure
Stroke	Stroke, Cerebrovascular Disease, Transient Ischaemic Attack, Hemorrhagic And Nonhemorrhagic Stroke
Vascular CVD	Lower-Extremity Arterial Disease, Peripheral Arterial Disease, Peripheral Arterial Occlusive Disease, Peripheral Vascular Disease
CAD	All Heart Disease, Coronary Artery Disease, Coronary Heart Disease, Ischaemic Heart Disease

Meta-analysis was performed on the 3 measures of interest, namely incidence, prevalence and mortality. Each measure was examined overall i.e. all studies included and by subgroups. Subgroups included countries, IDF regions, income groups and CVD event. Further subgrouping of CVD event, examining in particular CAD, All CVDs and stroke by geographical region and by GDP.

The Metafor package in R was utilised to generate forest plots. As incidence and mortality were standardised into 1,000 persons per year, the data were transformed using logs before applying a random effects model with restricted maximum likelihood estimation (REML). Rates and 95% CI were generated and back transformed to the original scale. For prevalence, the more appropriate logit transformation was applied first. To overcome instances where the number of events was recorded as 0, a correction of adding a small constant to zero counts (in this case 0.5) was applied. The model adjusts for this correction during estimation.

For each meta-analysis the between-study heterogeneity was also examined. For all subgroups, the tests showed a significant level of heterogeneity. A sensitivity analysis was also conducted to verify that there was minimal impact on the approximations of incidence and mortality rates.

A total of 40 countries with original studies were included in the analysis. Also, one study was chosen with multiple countries (16 countries in Europe). In total, 46 countries were covered. However, Table M.2 only includes the studies where one country was represented.

The USA had the highest number of studies (6). There were 5 studies based in the UK. Finland, Italy, Sweden had 4 studies each. Four countries had 3 studies per country; six countries had 2 studies per country; and 26 countries had only 1 study.

Table M.2

THE REPRESENTATION OF DISEASES, REGIONS AND INCOME GROUPS IN THE STUDIES SELECTED

Disease	**# of studies**
All CVDs	42
Stroke	40
Coronary artery disease	36
Myocardial infarction	20

IDF Regions	**# of countries**	**# of studies**
Africa	1	1
Europe	19	38
NAC	3	7
MENA	6	6
SACA	2	3
SEA	1	1
WP	9	16

Income group	**# of countries**	**# of studies**
Middle-income countries	13	14
High-income countries	28	58

Table M.3
COUNTRY SUMMARY TABLE

Source: WHO global health observatory and IDF Diabetes Atlas

Country	Total NCD related deaths (2012)	Age-standardised NCD mortality rate per 100,000 population (2012)	Total CVD related deaths (2012)	Age-standardized CVD mortality rate per 100,000 population (2012)	Total diabetes related deaths 20-79 years (2015)
Africa Region					
Angola	72,400	768.4	26,000	374.6	6,500
Benin	32,400	761.5	13,100	372.5	600
Botswana	6,000	612.2	2,900	323.7	1,500
Burkina Faso	51,500	784.0	18,900	373.7	3,400
Burundi	32,200	729.5	11,000	311.6	2,900
Cabo Verde	1,800	482.1	900	249.9	100
Cameroon	74,100	675.2	25,300	285.7	15,000
Central African Republic	13,200	550.8	5,100	244.4	3,700
Chad	36,600	712.6	12,400	306.6	7,200
Comoros	2,200	695.5	900	329.6	300
Congo	13,500	632.3	6,100	334.5	2,800
Côte d'Ivoire	77,500	794.0	27,000	336.1	4,600
Dem. Rep. of the Congo	215,700	724.4	84,600	359.6	32,400
Djibouti	2,900	631.1	1,100	277.1	600
Equatorial Guinea	2,700	729.0	1,100	357.6	600
Eritrea	14,900	671.9	5,900	327.3	1,200
Ethiopia	210,500	476.3	59,400	161.6	23,100
Gabon	5,500	504.6	2,500	241.7	1,000
Gambia	4,800	629.6	1,700	299.6	200
Ghana	87,300	669.9	38,000	340.6	4,800
Guinea	36,700	681.1	14,300	313.4	1,900
Guinea-Bissau	5,800	764.7	2,300	370.5	400
Kenya	98,400	514.7	31,600	205.0	8,700
Lesotho	7,700	671.8	3,400	306.7	1,500
Liberia	11,700	656.9	3,700	248.4	800
Madagascar	62,900	648.6	29,500	352.3	5,600
Malawi	41,900	655.0	18,000	336.5	8,200
Mali	52,900	866.1	19,200	395.7	2,400
Mauritania	9,500	555.1	3,700	262.6	600
Mozambique	72,600	593.7	21,000	213.5	9,700
Namibia	6,100	580.2	2,900	302.9	1,000
Niger	44,600	649.1	17,000	317.7	3,300
Nigeria	503,600	673.7	156,100	266.5	40,800
Rwanda	27,700	585.3	10,000	261.7	4,500
Senegal	33,600	558.1	9,600	198.6	1,900
Sierra Leone	26,500	963.5	9,000	436.0	1,600
Somalia	26,700	550.7	8,000	213.4	4,100
South Africa	264,000	710.9	107,000	298.3	57,300
South Sudan	33,300	623.4	11,000	249.9	6,400
Swaziland	4,000	702.4	1,500	295.8	1,100

Country	Total NCD related deaths (2012)	Age-standardised NCD mortality rate per 100,000 population (2012)	Total CVD related deaths (2012)	Age-standardized CVD mortality rate per 100,000 population (2012)	Total diabetes related deaths 20-79 years (2015)
Togo	19,300	679.0	6,900	307.4	2,400
Uganda	95,900	664.4	30,300	263.8	11,300
United Republic of Tanzania	123,000	569.8	36,600	202.9	17,700
Zambia	33,200	587.4	12,300	271.7	8,300
Zimbabwe	42,200	598.9	13,000	197.1	7,000
Europe Region					
Albania	26,400	671.6	17,400	436.2	2,900
Armenia	33,900	847.5	20,000	473.9	2,200
Austria	72,200	359.5	34,000	145.9	4,500
Azerbaijan	48,600	664.3	31,100	442.2	5,000
Belarus	108,500	682.5	77,100	464.2	7,700
Belgium	94,200	356.8	32,900	111.1	4,300
Bosnia and Herzegovina	32,300	512.5	19,900	310.7	3,500
Bulgaria	99,500	638.2	67,400	406.3	7,000
Croatia	46,300	495.8	23,900	237.4	2,100
Cyprus	5,600	333.0	2,400	137.9	500
Czech Republic	96,100	460.7	53,300	239.0	7,900
Denmark	48,000	406.1	14,200	108.3	3,600
Estonia	13,600	510.7	8,100	272.1	800
Finland	46,700	366.6	20,300	145.9	2,900
France	483,400	313.2	157,700	85.6	26,400
Georgia	46,700	615.2	34,300	428.7	2,800
Germany	790,500	365.1	349,600	142.7	55,100
Greece	101,200	365.0	53,300	175.9	4,900
Hungary	120,000	602.8	63,900	293.3	9,100
Iceland	1,800	311.7	700	103.3	100
Ireland	23,800	343.9	8,800	118.7	1,200
Israel	35,100	311.2	10,500	86.0	2,800
Italy	528,300	303.6	213,400	105.5	22,200
Kazakhstan	132,300	949.7	85,800	635.5	10,600
Kyrgyzstan	29,200	835.4	18,000	549.4	2,600
Latvia	27,100	623.7	16,800	361.1	1,300
Lithuania	31,100	580.6	18,800	322.5	1,700
Luxembourg	3,100	317.8	1,200	107.9	200
Macedonia. FYRO	18,700	636.5	11,900	405.6	2,000
Malta	2,700	364.5	1,200	151.8	300
Montenegro	5,400	571.5	3,500	366.7	700
Netherlands	124,800	355.2	39,800	104.8	7,600
Norway	36,300	336.6	13,600	111.5	2,000
Poland	337,100	494.5	184,400	253.4	21,500
Portugal	83,000	343.3	31,100	113.1	7,900
Rep. of Moldova	38,300	787.6	25,200	507.7	3,700
Romania	234,000	612.2	149,000	363.9	18,900
Russian Federation	1,801,500	790.3	1,252,400	531.0	186,100
Serbia	107,100	657.7	61,000	360.0	10,600
Slovakia	45,800	532.5	27,500	305.9	5,000
Slovenia	16,300	369.2	7,000	141.2	1,500

Country	Total NCD related deaths (2012)	Age-standardised NCD mortality rate per 100,000 population (2012)	Total CVD related deaths (2012)	Age-standardized CVD mortality rate per 100,000 population (2012)	Total diabetes related deaths 20-79 years (2015)
Spain	365,400	323.1	123,100	96.8	22,300
Sweden	82,000	333.5	36,800	132.0	3,100
Switzerland	55,800	291.6	21,400	97.9	2,700
Tajikistan	30,000	752.6	18,200	510.3	2,400
Turkey	362,500	555.2	198,900	310.3	52,100
Turkmenistan	34,400	1,025.1	22,500	712.1	2,800
Ukraine	614,400	749.0	465,900	536.1	42,900
United Kingdom	497,400	358.8	169,900	111.8	22,800
Uzbekistan	146,000	810.9	98,800	577.7	12,300
Middle East and North Africa Region					
Afghanistan	91,300	846.3	46,400	511.5	19,700
Algeria	168,900	710.4	89,200	396.6	14,100
Bahrain	2,200	505.7	800	187.2	800
Egypt	443,500	781.7	241,900	445.1	78,200
Iran (Islamic Republic of)	302,000	569.3	180,800	350.2	37,100
Iraq	102,900	715.5	55,500	420.7	16,900
Jordan	19,600	640.3	9,000	326.4	3,100
Kuwait	4,500	406.3	2,500	239.0	1,100
Lebanon	17,500	384.6	9,700	213.8	5,700
Libya	20,000	550.0	11,100	320.4	2,700
Morocco	155,400	707.7	69,300	330.5	9,500
Oman	6,400	478.2	3,100	244.9	1,200
Pakistan	672,500	669.3	249,000	274.2	86,400
Qatar	1,900	407.0	700	157.0	600
Saudi Arabia	70,400	549.4	41,200	338.1	23,400
Sudan	100,700	551.0	34,400	225.6	22,400
Syrian Arab Republic	61,900	572.7	38,200	375.6	7,000
Tunisia	49,400	509.3	29,500	308.3	5,100
United Arab Emirates	6,400	546.8	2,900	297.6	1,400
Yemen	63,700	626.9	34,400	377.0	5,600
North America and Caribbean Region					
Bahamas	1,600	465.2	800	220.0	300
Barbados	1,500	404.5	500	128.1	300
Belize	800	470.7	300	190.7	300
Canada	219,500	318.0	66,100	88.6	15,700
Guyana	4,200	1,024.2	2,100	544.8	900
Haiti	42,900	724.6	21,000	384.1	6,300
Jamaica	15,400	519.1	7,300	232.6	2,000
Mexico	468,100	468.3	147,600	148.3	76,300
Suriname	1,700	374.8	700	155.9	500
Trinidad and Tobago	10,100	705.3	4,000	278.6	1,600
United States of America	2,334,100	412.8	815,700	136.0	219,400
South and Central America Region					
Argentina	255,400	467.3	110,200	191.7	16,300
Bolivia (Plurinational State of)	42,500	635.3	17,000	269.5	4,600
Brazil	978,200	513.8	408,200	214.2	130,700

Country	Total NCD related deaths (2012)	Age-standardised NCD mortality rate per 100,000 population (2012)	Total CVD related deaths (2012)	Age-standardized CVD mortality rate per 100,000 population (2012)	Total diabetes related deaths 20-79 years (2015)
Chile	79,100	366.5	25,600	115.1	8,500
Colombia	143,300	377.3	55,600	150.2	19,800
Costa Rica	17,600	391.8	6,300	140.1	1,600
Cuba	75,900	421.8	34,800	185.0	8,000
Dominican Republic	34,500	396.0	17,200	198.9	6,000
Ecuador	54,600	409.7	20,000	149.3	7,300
El Salvador	26,400	474.9	9,700	171.0	2,900
Guatemala	37,600	409.4	10,700	122.9	8,000
Honduras	21,800	441.5	9,500	200.5	2,300
Nicaragua	21,300	546.6	8,600	227.8	2,400
Panama	13,400	372.9	5,500	151.3	1,500
Paraguay	23,000	485.5	10,100	219.7	3,100
Peru	87,700	363.5	29,100	122.6	7,800
Uruguay	26,200	446.0	9,400	147.4	1,100
Venezuela (Bolivarian Rep. of)	96,000	410.6	42,500	187.3	15,600
South-East Asia Region					
Bangladesh	522,300	548.9	148,800	166.2	129,300
Bhutan	2,800	572.8	900	194.3	200
India	5,868,800	682.3	2,536,900	306.3	1,027,900
Maldives	1,000	487.2	500	244.3	100
Mauritius	7,700	576.5	2,800	207.3	2,900
Nepal	110,800	678.1	41,400	270.6	11,700
Sri Lanka	103,800	501.2	55,400	271.4	16,300
Western Pacific Region					
Australia	133,000	302.9	45,100	92.4	6,300
Brunei Darussalam	1,100	475.3	500	211.1	300
Cambodia	43,900	394.0	20,100	184.7	5,400
China	8,577,000	576.3	4,435,400	300.0	1,299,700
Dem. People's Rep. of Korea	180,400	751.4	82,100	351.6	19,500
Fiji	4,800	804.0	2,000	372.3	1,200
Indonesia	1,105,800	680.1	572,500	371.0	185,000
Japan	947,600	244.2	349,200	81.6	61,100
Lao People's Democr. Rep.	22,300	680.0	10,400	346.2	2,800
Malaysia	106,800	563.2	53,100	295.8	34,600
Mongolia	14,900	966.5	8,100	586.7	2,300
Myanmar	258,800	708.7	108,600	317.8	63,000
New Zealand	24,900	313.6	9,000	103.8	1,800
Papua New Guinea	23,500	693.2	4,400	148.5	9,200
Philippines	383,500	720.0	187,100	376.9	51,100
Republic of Korea	210,800	302.1	65,200	92.3	31,900
Singapore	17,900	264.8	7,400	107.7	3,800
Solomon Islands	1,800	709.7	600	256.7	500
Thailand	354,400	449.1	145,500	183.8	76,000
Timor-Leste	3,000	670.5	1,400	346.6	600
Viet Nam	379,000	435.4	173,300	192.6	53,500

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Chapter 5

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