

GLOBAL REPORT ON DIABETES



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PREFACE



Diabetes is on the rise. No longer a disease of predominantly rich nations, the prevalence of diabetes is steadily increasing everywhere, most markedly in the world's middle-income countries.

Unfortunately, in many settings the lack of effective policies to create supportive environments for healthy lifestyles and the lack of access to quality health care means that the prevention and treatment of diabetes, particularly for people of modest means, are not being pursued.

When diabetes is uncontrolled, it has dire consequences for health and well-being.

In addition, diabetes and its complications impact harshly on the finances of individuals and their families, and the economies of nations. People with diabetes who depend on life-saving insulin pay the ultimate price when access to affordable insulin is lacking.

In an effort to address this growing health challenge, since early this decade world leaders have committed to reducing the burden of diabetes as one of four priority noncommunicable diseases (NCDs).

As part of the 2030 Agenda for Sustainable Development, Member States have set an ambitious target to reduce premature mortality from NCDs – including diabetes – by one third; achieve universal health coverage; and provide access to affordable essential medicines – all by 2030.

We have an enormous task at hand, which is why I welcome this first WHO *Global report on diabetes*. The report makes an important contribution to our understanding of diabetes and its consequences.

It advances our understanding of trends in diabetes prevalence, of the contribution of high blood glucose (including diabetes) to premature mortality, and of what action governments are taking to prevent and control diabetes.

From the analysis it is clear we need stronger responses not only from different sectors of government, but also from civil society and people with diabetes themselves, and also producers of food and manufacturers of medicines and medical technologies.

The report reminds us that effectively addressing diabetes does not just happen: it is the result of collective consensus and public investment in interventions that are affordable, cost-effective and based on the best available science.

Please join me in ensuring that the findings of this report are used and its recommendations implemented so that we may indeed halt the rise in diabetes.

Dr Margaret Chan
Director-General
WHO

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EXECUTIVE SUMMARY

Diabetes is a serious, chronic disease that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood sugar, or glucose), or when the body cannot effectively use the insulin it produces. Diabetes is an important public health problem, one of four priority noncommunicable diseases (NCDs) targeted for action by world leaders. Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades.

GLOBAL BURDEN

Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population. This reflects an increase in associated risk factors such as being overweight or obese. Over the past decade, diabetes prevalence has risen faster in low- and middle-income countries than in high-income countries.

Diabetes caused 1.5 million deaths in 2012. Higher-than-optimal blood glucose caused an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases. Forty-three percent of these 3.7 million deaths occur before the age of 70 years. The percentage of deaths attributable to high blood glucose or diabetes that occurs prior to age 70 is higher in low- and middle-income countries than in high-income countries.

Because sophisticated laboratory tests are usually required to distinguish between type 1 diabetes (which requires insulin injections for survival) and type 2 diabetes (where the body cannot properly use the insulin it produces), separate global estimates of diabetes prevalence for type 1 and type 2 do not exist. The majority of people with diabetes are affected by type 2 diabetes. This used to occur nearly entirely among adults, but now occurs in children too.

COMPLICATIONS

Diabetes of all types can lead to complications in many parts of the body and can increase the overall risk of dying prematurely. Possible complications include heart attack, stroke, kidney failure, leg amputation, vision loss and nerve damage. In pregnancy, poorly controlled diabetes increases the risk of fetal death and other complications.

ECONOMIC IMPACT

Diabetes and its complications bring about substantial economic loss to people with diabetes and their families, and to health systems and national economies through direct medical costs and loss of work and wages. While the major cost drivers are hospital and outpatient care, a contributing factor is the rise in cost for analogue insulins¹ which are increasingly prescribed despite little evidence that they provide significant advantages over cheaper human insulins.

1. These are insulins derived from human insulin by modifying its structure to change the pharmacokinetic profile.

PREVENTING DIABETES

Type 1 diabetes cannot be prevented with current knowledge. Effective approaches are available to prevent type 2 diabetes and to prevent the complications and premature death that can result from all types of diabetes. These include policies and practices across whole populations and within specific settings (school, home, workplace) that contribute to good health for everyone, regardless of whether they have diabetes, such as exercising regularly, eating healthily, avoiding smoking, and controlling blood pressure and lipids.

Taking a life-course perspective is essential for preventing type 2 diabetes, as it is for many health conditions. Early in life, when eating and physical activity habits are formed and when the long-term regulation of energy balance may be programmed, there is a critical window for intervention to mitigate the risk of obesity and type 2 diabetes later in life.

No single policy or intervention can ensure this happens. It calls for a whole-of-government and whole-of-society approach, in which all sectors systematically consider the health impact of policies in trade, agriculture, finance, transport, education and urban planning – recognizing that health is enhanced or obstructed as a result of policies in these and other areas.

MANAGING DIABETES

The starting point for living well with diabetes is an early diagnosis – the longer a person lives with undiagnosed and untreated diabetes, the worse their health outcomes are likely to be. Easy access to basic diagnostics, such as blood glucose testing, should therefore be available in primary health-care settings. Established systems for referral and back-referral are needed, as patients will need periodic specialist assessment or treatment for complications.

For those who are diagnosed with diabetes, a series of cost-effective interventions can improve their outcomes, regardless of what type of diabetes they may have. These interventions include blood glucose control, through a combination of diet, physical activity and, if necessary, medication; control of blood pressure and lipids to reduce cardiovascular risk and other complications; and regular screening for damage to the eyes, kidneys and feet, to facilitate early treatment. Diabetes management can be strengthened through the use of standards and protocols.

Efforts to improve capacity for diagnosis and treatment of diabetes should occur in the context of integrated noncommunicable disease (NCD) management to yield better outcomes. At a minimum, diabetes and cardiovascular disease management can be combined. Integrated management of diabetes and tuberculosis and/or HIV/AIDS can be considered where there is high prevalence of these diseases.

NATIONAL CAPACITY FOR PREVENTION AND CONTROL OF DIABETES

National capacity to prevent and control diabetes as assessed in the 2015 NCD Country Capacity Survey varies widely by region and country-income level. Most countries report having national diabetes policies, as well as national policies to reduce key risk factors and national guidelines or protocols to improve management of diabetes. In some regions and among lower-income countries, however, these policies and guidelines lack funding and implementation.

In general, primary health-care practitioners in low-income countries do not have access to the basic technologies needed to help people with diabetes properly manage their disease. Only one in three low- and

middle-income countries report that the most basic technologies for diabetes diagnosis and management are generally available in primary health-care facilities.

Many countries have conducted national population-based surveys of the prevalence of physical inactivity and overweight and obesity in the past 5 years, but less than half have included blood glucose measurement in these surveys.

ACCESS TO INSULIN AND OTHER ESSENTIAL MEDICINES

The lack of access to affordable insulin remains a key impediment to successful treatment and results in needless complications and premature deaths. Insulin and oral hypoglycaemic agents are reported as generally available in only a minority of low-income countries. Moreover, essential medicines critical to gaining control of diabetes, such as agents to lower blood pressure and lipid levels, are frequently unavailable in low- and middle-income countries. Policy and programme interventions are needed to improve equitable access.

CONCLUSIONS AND RECOMMENDATIONS

This first WHO *Global report on diabetes* underscores the enormous scale of the diabetes problem, and also the potential to reverse current trends. The political basis for concerted action to address diabetes is there, woven into the Sustainable Development Goals, the United Nations Political Declaration on NCDs, and the WHO NCD Global Action Plan. Where built upon, these foundations will catalyse action by all.

Countries can take a series of actions, in line with the objectives of the WHO NCD Global Action Plan 2013–2020, to reduce the impact of diabetes:

- Establish national mechanisms such as high-level multisectoral commissions to ensure political commitment, resource allocation, effective leadership and advocacy for an integrated NCD response, with specific attention to diabetes.
- Build the capacity of ministries of health to exercise a strategic leadership role, engaging stakeholders across sectors and society. Set national targets and indicators to foster accountability. Ensure that national policies and plans addressing diabetes are fully costed and then funded and implemented.
- Prioritize actions to prevent people becoming overweight and obese, beginning before birth and in early childhood. Implement policies and programmes to promote breastfeeding and the consumption of healthy foods and to discourage the consumption of unhealthy foods, such as sugary sodas. Create supportive built and social environments for physical activity. A combination of fiscal policies, legislation, changes to the environment and raising awareness of health risks works best for promoting healthier diets and physical activity at the necessary scale.
- Strengthen the health system response to NCDs, including diabetes, particularly at primary-care level. Implement guidelines and protocols to improve diagnosis and management of diabetes in primary health care. Establish policies and programmes to ensure equitable access to essential technologies for diagnosis and management. Make essential medicines such as human insulin available and affordable to all who need them.
- Address key gaps in the diabetes knowledge base. Outcome evaluations of innovative programmes intended to change behaviour are a particular need.

- Strengthen national capacity to collect, analyse and use representative data on the burden and trends of diabetes and its key risk factors. Develop, maintain and strengthen a diabetes registry if feasible and sustainable.

There are no simple solutions for addressing diabetes but coordinated, multicomponent intervention can make a significant difference. Everyone can play a role in reducing the impact of all forms of diabetes. Governments, health-care providers, people with diabetes, civil society, food producers and manufacturers and suppliers of medicines and technology are all stakeholders. Collectively, they can make a significant contribution to halt the rise in diabetes and improve the lives of those living with the disease.



BACKGROUND

KEY MESSAGES

Diabetes is a chronic, progressive disease characterized by elevated levels of blood glucose.

Diabetes of all types can lead to complications in many parts of the body and can increase the overall risk of dying prematurely.

Countries have committed to halt the rise in diabetes, to reduce diabetes-related premature mortality and to improve access to essential diabetes medicines and basic technologies.

Effective tools are available to prevent type 2 diabetes and to improve management to reduce the complications and premature death that can result from all types of diabetes.

Diabetes is a serious, chronic disease that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood glucose), or when the body cannot effectively use the insulin it produces (1). Raised blood glucose, a common effect of uncontrolled diabetes, may, over time, lead to serious damage to the heart, blood vessels, eyes, kidneys and nerves. More than 400 million people live with diabetes.

Type 1 diabetes (previously known as insulin-dependent, juvenile or childhood-onset diabetes) is characterized by deficient insulin production in the body. People with type 1 diabetes require daily administration of insulin to regulate the amount of glucose in their blood. If they do not have access to insulin, they cannot survive. The cause of type 1 diabetes is not known and it is currently not preventable. Symptoms include excessive urination and thirst,

constant hunger, weight loss, vision changes and fatigue.

Type 2 diabetes (formerly called non-insulin-dependent or adult-onset diabetes) results from the body's ineffective use of insulin. Type 2 diabetes accounts for the vast majority of people with diabetes around the world (1). Symptoms may be similar to those of type 1 diabetes, but are often less marked or absent. As a result, the disease may go undiagnosed for several years, until complications have already arisen. For many years type 2 diabetes was seen only in adults but it has begun to occur in children.

Impaired glucose tolerance (IGT) and **impaired fasting glycaemia (IFG)** are intermediate conditions in the transition between normal blood glucose levels and diabetes (especially type 2), though the transition is not inevitable. People with IGT or IFG are at increased risk of heart attacks and strokes.

Overweight and obesity are the strongest risk factors for type 2 diabetes

Gestational diabetes (GDM) is a temporary condition that occurs in pregnancy and carries long-term risk of type 2 diabetes (2). The condition is present when blood glucose values are above normal but still below those diagnostic of diabetes (3). Women with gestational diabetes are at increased risk of some complications during pregnancy and delivery, as are their infants. Gestational diabetes is diagnosed through prenatal screening, rather than reported symptoms.

RISK FACTORS FOR DIABETES

Type 1. The exact causes of type 1 diabetes are unknown. It is generally agreed that type 1 diabetes is the result of a complex interaction between genes and environmental factors, though no specific environmental risk factors have been shown to cause a significant number of cases. The majority of type 1 diabetes occurs in children and adolescents.

Type 2. The risk of type 2 diabetes is determined by an interplay of genetic and metabolic factors. Ethnicity, family history of diabetes, and previous gestational diabetes combine with older age, overweight and obesity, unhealthy diet, physical inactivity and smoking to increase risk.

Excess body fat, a summary measure of several aspects of diet and physical activity, is the strongest risk factor for type 2 diabetes, both in terms of clearest evidence base and largest relative risk. Overweight and obesity, together with physical inactivity, are estimated to cause a large proportion of the global diabetes burden (4). Higher waist

circumference and higher body mass index (BMI) are associated with increased risk of type 2 diabetes, though the relationship may vary in different populations (5). Populations in South-East Asia, for example, develop diabetes at a lower level of BMI than populations of European origin (6).

Several dietary practices are linked to unhealthy body weight and/or type 2 diabetes risk, including high intake of saturated fatty acids, high total fat intake and inadequate consumption of dietary fibre (7, 8, 9). High intake of sugar-sweetened beverages, which contain considerable amounts of free sugars,¹ increases the likelihood of being overweight or obese, particularly among children (10, 11). Recent evidence further suggests an association between high consumption of sugar-sweetened beverages and increased risk of type 2 diabetes (7, 12, 13, 14).

Early childhood nutrition affects the risk of type 2 diabetes later in life. Factors that appear to increase risk include poor fetal growth, low birth weight (particularly if followed by rapid postnatal catch-up growth) and high birth weight (15, 16, 17, 18, 19, 20, 21).

Active (as distinct from passive) smoking increases the risk of type 2 diabetes, with the highest risk among heavy smokers (22). Risk remains elevated for about

1. This includes "all monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer, plus sugars naturally present in honey, syrups, and fruit juices". Source: Joint WHO/FAO Expert Consultation, WHO Technical Report Series 916 Diet, Nutrition, and the Prevention of Chronic Diseases. Geneva, WHO, 2003.

10 years after smoking cessation, falling more quickly for lighter smokers (23).

Gestational diabetes. Risk factors and risk markers for GDM include age (the older a woman of reproductive age is, the higher her risk of GDM); overweight or obesity; excessive weight gain during pregnancy; a family history of diabetes; GDM during a previous pregnancy; a history of stillbirth or giving birth to an infant with congenital abnormality; and excess glucose in urine during pregnancy (24). Diabetes in pregnancy and GDM increase the risk of future obesity and type 2 diabetes in offspring.

COMPLICATIONS OF DIABETES

When diabetes is not well managed, complications develop that threaten health and endanger life. Acute complications are a significant contributor to mortality, costs and poor quality of life. Abnormally high blood glucose can have a life-threatening impact if it triggers conditions such as diabetic ketoacidosis (DKA) in types 1 and 2, and hyperosmolar coma in type 2. Abnormally low blood glucose can occur in all types of diabetes and may result in seizures or loss of consciousness. It may happen after skipping a meal or exercising more than usual, or if the dosage of anti-diabetic medication is too high.

Over time diabetes can damage the heart, blood vessels, eyes, kidneys and nerves, and increase the risk of heart disease and stroke. Such damage can result in reduced blood flow, which – combined with nerve damage

(neuropathy) in the feet – increases the chance of foot ulcers, infection and the eventual need for limb amputation. Diabetic retinopathy is an important cause of blindness and occurs as a result of long-term accumulated damage to the small blood vessels in the retina. Diabetes is among the leading causes of kidney failure.

Uncontrolled diabetes in pregnancy can have a devastating effect on both mother and child, substantially increasing the risk of fetal loss, congenital malformations, stillbirth, perinatal death, obstetric complications, and maternal morbidity and mortality. Gestational diabetes increases the risk of some adverse outcomes for mother and offspring during pregnancy, childbirth and immediately after delivery (pre-eclampsia and eclampsia in the mother; large for gestational age and shoulder dystocia in the offspring) (25). However, it is not known what proportion of obstructed births or maternal and perinatal deaths can be attributed to hyperglycaemia.

The combination of increasing prevalence of diabetes and increasing lifespans in many populations with diabetes may be leading to a changing spectrum of the types of morbidity that accompany diabetes. In addition to the traditional complications described above, diabetes has been associated with increased rates of specific cancers, and increased rates of physical and cognitive disability (26). This diversification of complications and increased years of life spent with diabetes indicates a need to better monitor the quality of life of people with diabetes and assess

Diabetes can damage the heart, blood vessels, eyes, kidneys and nerves, leading to disability and premature death

the impact of interventions on quality of life.

ECONOMIC IMPACT OF DIABETES

Diabetes imposes a large economic burden on the global health-care system and the wider global economy. This burden can be measured through direct medical costs, indirect costs associated with productivity loss, premature mortality and the negative impact of diabetes on nations' gross domestic product (GDP).

Direct medical costs associated with diabetes include expenditures for preventing and treating diabetes and its complications. These include outpatient and emergency care; inpatient hospital care; medications and medical supplies such as injection devices and self-monitoring consumables; and long-term care.

Based on cost estimates from a recent systematic review, it has been estimated that the direct annual cost of diabetes to the world is more than US\$ 827 billion (27, 28). The International Diabetes Federation (IDF) estimates that total global health-care spending on diabetes more than tripled over the period 2003 to 2013 – the result of increases in the number of people with diabetes and increases in per capita diabetes spending (29).

While the major diabetes cost drivers are hospital inpatient and outpatient care, a contributing factor to this increase is the rise in expenditure on patented, branded medicines used to treat people with diabetes, including both new oral treatments for type 2 diabetes

and analogue insulins¹. None of these preparations has yet been included in the WHO *Model list of essential medicines*,² because systematic evidence reviews find that they provide little or no advantage over cheaper generic alternatives (30).

The increase in total global diabetes health expenditure is expected to continue. Low- and middle- income countries will carry a larger proportion of this future global health-care expenditure burden than high-income countries.

Catastrophic medical expenditure. Besides the economic burden on the health-care system and national economy, diabetes can impose a large economic burden on people with diabetes and their families in terms of higher out-of-pocket health-care payments and loss of family income associated with disability and premature loss of life.

The relationship between diabetes and the risk of catastrophic medical expenditure by individuals and families has been explored in 35 developing countries. This research found that people with diabetes had a significantly greater chance of incurring catastrophic medical expenditure compared to similar individuals without diabetes. Health insurance was not significantly related to lower risks of

**People
with diabetes are
more likely to incur
catastrophic personal
health expenditure**

1. These are insulins derived from human insulin by modifying its structure to change the pharmacokinetic profile.

2. WHO's *Model list of essential medicines* comprises a set of medicines that satisfy the priority health-care needs of the population, meaning they should be available at all times, in adequate amounts and in appropriate dosage forms, at a price the community can afford.

catastrophic medical expenditure. The effects were more marked in lower-income countries (31).

Impact on national economies.

One study estimates that losses in GDP worldwide from 2011 to 2030, including both the direct and indirect costs of diabetes, will total US\$ 1.7 trillion, comprising US\$ 900 billion for high-income countries and US\$ 800 billion for low- and middle-income countries (32).

DIABETES AND THE GLOBAL PUBLIC HEALTH AGENDA

Diabetes is recognized as an important cause of premature death and disability. It is one of four priority noncommunicable diseases (NCDs) targeted by world leaders in the 2011 Political Declaration on the Prevention and Control of NCDs (33). The declaration recognizes that the incidence and impacts of diabetes and other NCDs can be largely prevented or reduced with an approach that incorporates evidence-based, affordable, cost-effective, population-wide and multisectoral interventions. To catalyse national action, the World Health Assembly adopted a comprehensive global monitoring framework in 2013, comprised of nine voluntary global targets to reach by 2025 (see Box 1, page 16). This was accompanied by the WHO *Global action plan for the prevention and control of NCDs 2013–2020* (WHO NCD Global Action Plan), endorsed by the 66th World Health Assembly (34), which provides a roadmap and policy options to attain the nine voluntary global targets. Diabetes and its key risk factors are strongly reflected in the targets and indicators of the global monitoring framework and the WHO NCD Global Action Plan.

These commitments were deepened in 2015 by the United Nations General Assembly's adoption of the 2030 Agenda for Sustainable Development (35). In this context, countries have agreed to take action to achieve ambitious targets by 2030 – to reduce premature mortality from NCDs by one-third; to achieve universal health coverage; and to provide access to affordable essential medicines.

To halt the rise in obesity and type 2 diabetes it is imperative to scale-up population-level prevention. Policy measures are needed to increase access to affordable, healthy foods and beverages; to promote physical activity; and to reduce exposure to tobacco. Mass media campaigns and social marketing can influence positive change and make healthy behaviours more the norm. These strategies have the potential to reduce the occurrence of type 2 diabetes and may also reduce complications associated with diabetes.

To reduce avoidable mortality from diabetes and improve outcomes, access to affordable treatment is critical. Lack of access to insulin in many countries and communities remains a critical impediment to successful treatment efforts. Inadequate access to oral hypoglycaemic medication, and medication to control blood pressure and lipids, is also a barrier. Improved management in primary care with ongoing support by community health workers can lead to better control of diabetes and fewer complications.

This report builds on ongoing global work to address NCDs. It aims to draw focused attention to the

Diabetes is 1 of 4 priority NCDs targeted by world leaders

public health challenge of diabetes and to generate momentum for national, regional and global action. Part 1 presents an overview of the global prevalence of diabetes, the burden of mortality related to blood glucose, and what is known about the extent of diabetes-related complications. Part 2 reviews evidence for action to prevent type 2 diabetes through population-wide and targeted interventions. Part 3 discusses diagnosis and early detection

of diabetes, along with actions required to improve outcomes for those living with it. Part 4 gives the current status of national responses to diabetes and provides data on efforts to monitor, prevent and manage it (diabetes country profiles are available at www.who.int/diabetes/global-report). The final section presents conclusions and recommendations for realizing the global commitments made to prevent diabetes and reduce its health impact.

BOX 1. VOLUNTARY GLOBAL TARGETS FOR PREVENTION AND CONTROL OF NONCOMMUNICABLE DISEASES TO BE ATTAINED BY 2025



(1) A 25% relative reduction in the overall mortality from cardiovascular diseases, cancer, diabetes, or chronic respiratory diseases



(2) At least 10% relative reduction in the harmful use of alcohol, as appropriate, within the national context



(3) A 10% relative reduction in prevalence of insufficient physical activity



(4) A 30% relative reduction in mean population intake of salt/sodium



(5) A 30% relative reduction in prevalence of current tobacco use



(6) A 25% relative reduction in the prevalence of raised blood pressure or contain the prevalence of raised blood pressure, according to national circumstances



(7) Halt the rise in diabetes and obesity



(8) At least 50% of eligible people receive drug therapy and counselling (including glycaemic control) to prevent heart attacks and strokes



(9) An 80% availability of the affordable basic technologies and essential medicines, including generics, required to treat major noncommunicable diseases in both public and private facilities

Source: (34).



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PART 1

GLOBAL BURDEN OF DIABETES

KEY MESSAGES

Diabetes caused 1.5 million deaths in 2012.

Higher-than-optimal blood glucose was responsible for an additional 2.2 million deaths as a result of increased risks of cardiovascular and other diseases, for a total of 3.7 million deaths related to blood glucose levels in 2012.

Many of these deaths (43%) occur under the age of 70.

In 2014, 422 million people in the world had diabetes – a prevalence of 8.5% among the adult population.

The prevalence of diabetes has been steadily increasing for the past 3 decades and is growing most rapidly in low- and middle-income countries.

Associated risk factors such as being overweight or obese are increasing.

Diabetes is an important cause of blindness, kidney failure, lower limb amputation and other long-term consequences that impact significantly on quality of life.

1.1 MORTALITY FROM HIGH BLOOD GLUCOSE, INCLUDING DIABETES

In 2012 there were 1.5 million deaths worldwide directly caused by diabetes. It was the eighth leading cause of death among both sexes and the fifth leading cause of death in women in 2012 (1).

Blood glucose levels that are higher-than-optimal, even if below the diagnostic threshold for diabetes, are a major source of mortality and morbidity. The diagnostic criterion for diabetes is fasting plasma glucose ≥ 7.0 mmol/L – a diagnostic point selected on the basis of micro-vascular complications such as diabetic retinopathy. The risk of macro-vascular disease, such as heart attack or stroke, however, starts increasing well before this

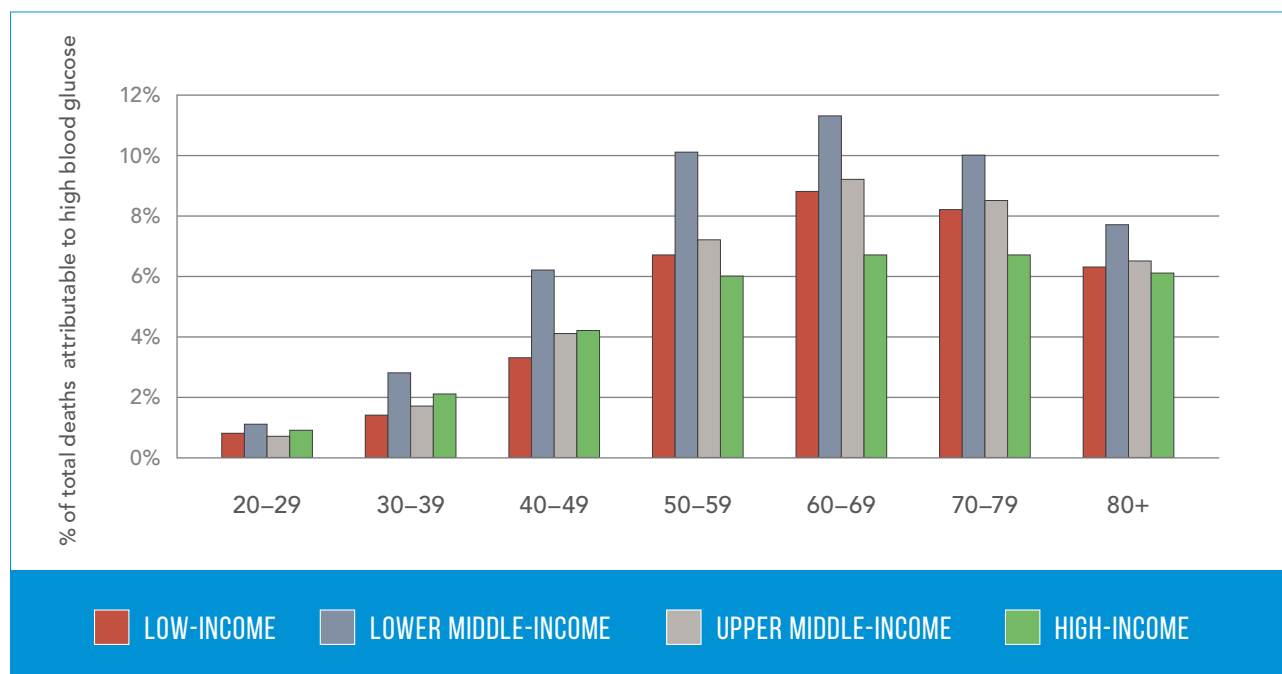
diagnostic point (2, 3). To better understand the full impact of blood glucose levels on mortality therefore requires a look at mortality related to blood glucose as a risk factor.

The total burden of deaths from high blood glucose¹ in 2012 has been estimated to amount to 3.7 million. This number includes 1.5 million diabetes deaths, and an additional 2.2 million deaths from

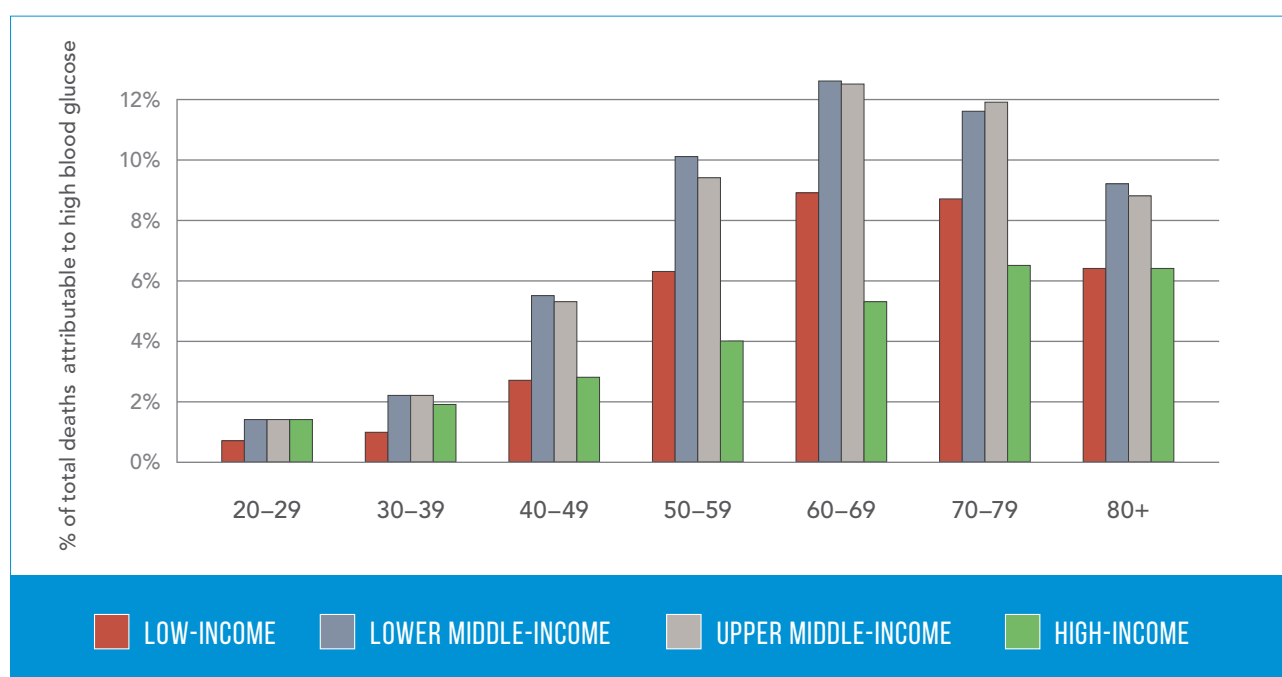
1. **High blood glucose** is defined as a distribution of fasting plasma glucose in a population that is higher than the theoretical distribution that would minimize risks to health (derived from epidemiological studies). Further details on the values used to calculate the estimates presented here can be found in (2). High blood glucose is a statistical concept, not a clinical or diagnostic category.

FIGURE 1. PERCENTAGE OF ALL-CAUSE DEATHS ATTRIBUTED TO HIGH BLOOD GLUCOSE, BY AGE AND COUNTRY INCOME GROUP, ^a 2012
(A) MEN, (B) WOMEN

A (MEN)



B (WOMEN)



a. As categorized by the World Bank for 2012.

cardiovascular diseases, chronic kidney disease, and tuberculosis related to higher-than-optimal blood glucose. Its magnitude highlights that high blood glucose causes a large burden of mortality beyond those deaths directly caused by diabetes. The largest number of deaths resulting from high blood glucose occur in upper-middle income countries (1.5 million) and the lowest number in low-income countries (0.3 million).

After the age of 50, middle-income countries have the highest proportion of deaths attributed to high blood glucose, for both men and women (see Figure 1). Except in high-income countries, the proportion of deaths attributable

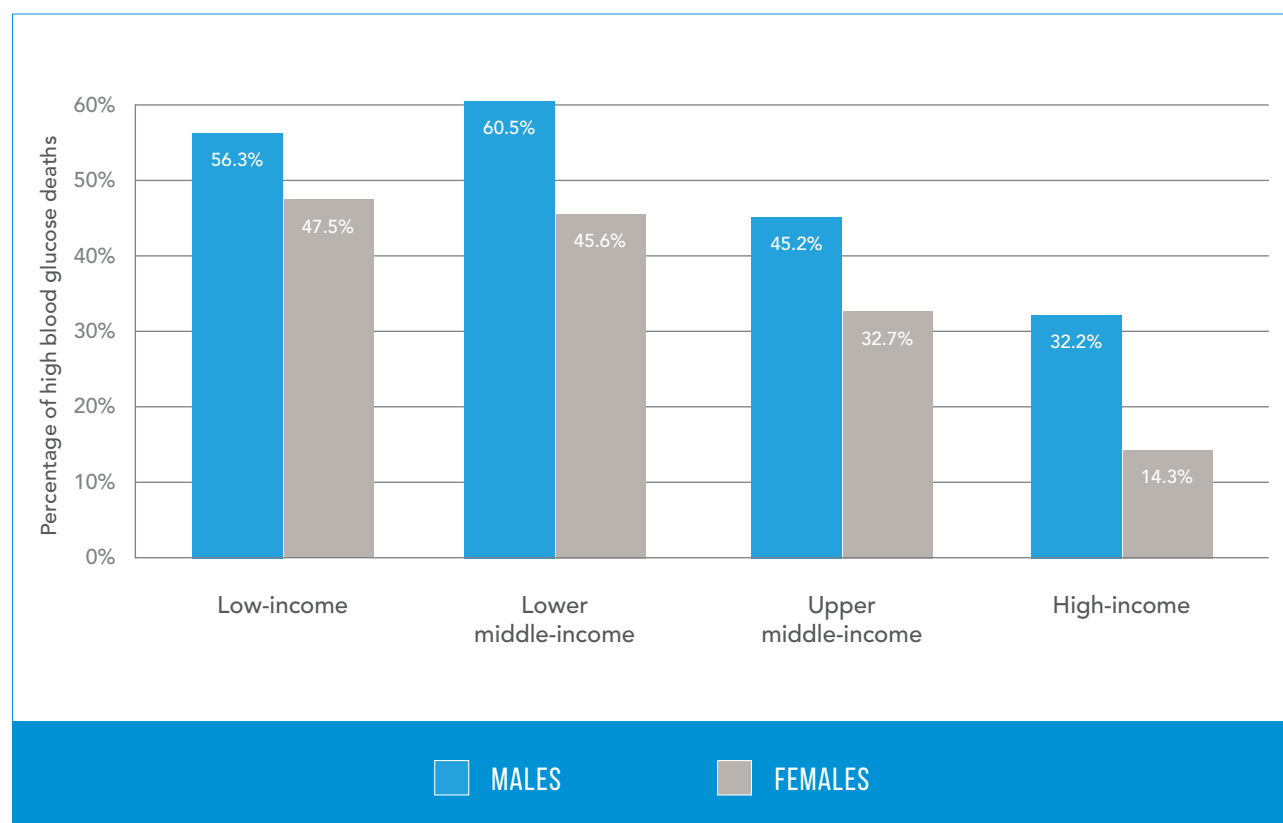
to high blood glucose for both men and women are highest in the age group 60–69 years.

Forty-three per cent of all deaths attributable to high blood glucose occur prematurely, before the age of 70 years – an estimated 1.6 million deaths worldwide. Globally, high blood glucose causes about 7% of deaths among men aged 20–69 and 8% among women aged 20–69. Figure 2 shows that the percentage of premature deaths attributable to high blood glucose is higher in low- and middle-income countries than in high-income countries, and higher among men than women.

High blood glucose age-standardized mortality rates,

43% of all deaths due to high blood glucose occur before the age of 70

FIGURE 2. PERCENTAGE OF DEATHS ATTRIBUTED TO HIGH BLOOD GLUCOSE THAT OCCUR AT AGES 20–69 YEARS, BY SEX AND COUNTRY INCOME GROUP, 2012



which account for differences in population structure, are highly variable across WHO regions (Table 1). Rates are highest in the WHO Eastern Mediterranean, South-East Asia, and African Regions, and much lower in the remaining regions. In the WHO

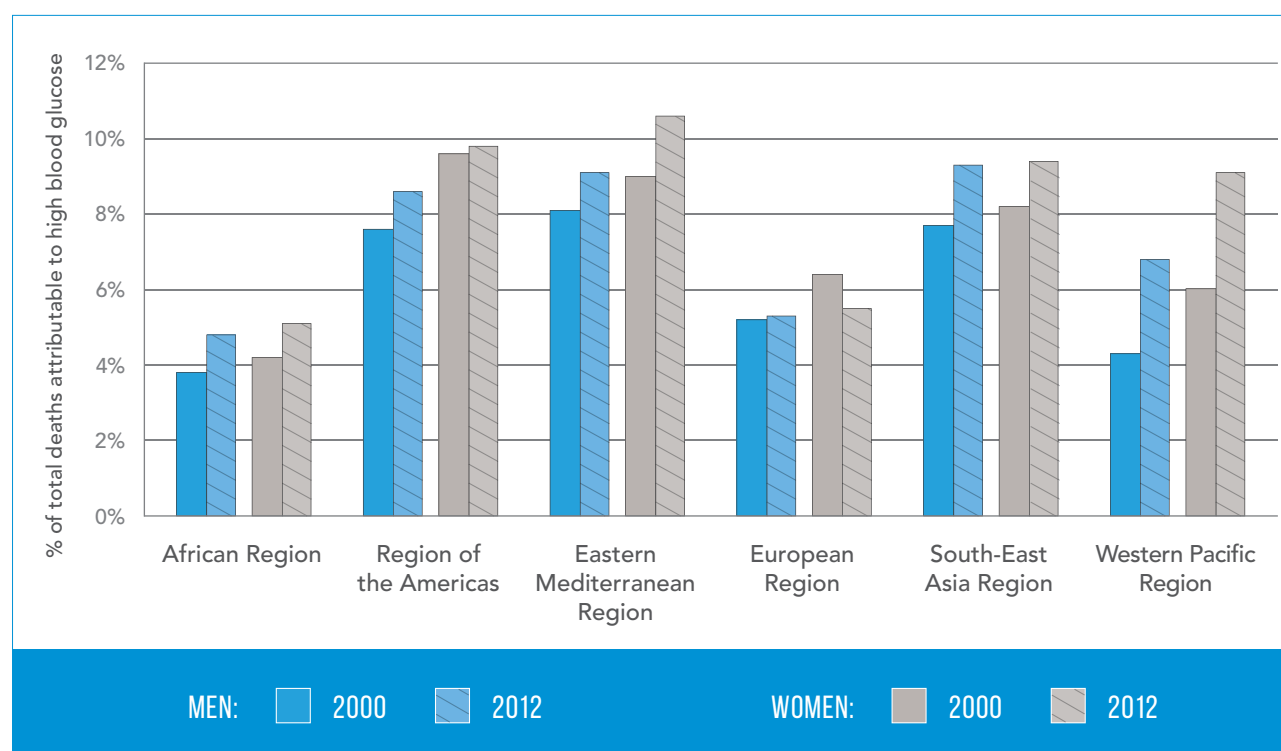
European and South-East Asia Regions and the Region of the Americas, high blood glucose mortality rates are considerably higher for men than for women.

During the period 2000–2012 the proportion of premature deaths

TABLE 1. HIGH BLOOD GLUCOSE AGE-STANDARDIZED MORTALITY RATES PER 100 000 BY WHO REGION, AGE 20+

	Both sexes	Female	Male
African Region	111.3	110.9	111.1
Region of the Americas	72.6	63.9	82.8
Eastern Mediterranean Region	139.6	140.2	138.3
European Region	55.7	46.5	64.5
South-East Asia Region	115.3	101.8	129.1
Western Pacific Region	67	65.8	67.8

FIGURE 3. PERCENTAGE OF ALL DEATHS ATTRIBUTABLE TO HIGH BLOOD GLUCOSE FOR ADULTS AGED 20–69 YEARS, BY WHO REGION AND SEX, FOR YEARS 2000 AND 2012



(ages 20–69) attributable to high blood glucose increased for both sexes across all WHO regions, except among women in the WHO European Region (Figure 3). The increase in the proportion of deaths attributable to high blood glucose was highest in the WHO Western Pacific Region, where the total number of deaths attributable to high blood glucose during this period also increased from 490 000 to 944 000.

1.2 PREVALENCE OF DIABETES AND ASSOCIATED RISK FACTORS

WHO estimates that, globally, 422 million adults aged over 18 years were living with diabetes in 2014 (more details on methodology can be found in Annex B and reference 4). The largest numbers of people with diabetes were estimated for the WHO South-East Asia and Western

Pacific Regions (see Table 2), accounting for approximately half the diabetes cases in the world.

The number of people with diabetes (defined in surveys as those having a fasting plasma glucose value of greater than or equal to 7.0 mmol/L or on medication for diabetes/raised blood glucose) has steadily risen over the past few decades, due to population growth, the increase in the average age of the population, and the rise in prevalence of diabetes at each age. Worldwide, the number of people with diabetes has substantially increased between 1980 and 2014, rising from 108 million to current numbers that are around four times higher (see Table 2). Forty per cent of this increase is estimated to result from population growth and ageing, 28% from a rise in age-specific prevalences, and 32% from the interaction of the two (4).

In 2014

422
million
adults had diabetes

TABLE 2. ESTIMATED PREVALENCE AND NUMBER OF PEOPLE WITH DIABETES (ADULTS 18+ YEARS)

WHO Region	Prevalence (%)		Number (millions)	
	1980	2014	1980	2014
African Region	3.1%	7.1%	4	25
Region of the Americas	5%	8.3%	18	62
Eastern Mediterranean Region	5.9%	13.7%	6	43
European Region	5.3%	7.3%	33	64
South-East Asia Region	4.1%	8.6%	17	96
Western Pacific Region	4.4%	8.4%	29	131
Total ^a	4.7%	8.5%	108	422

a. Totals include non-Member States.

Source: (4).

Diabetes prevalence has doubled since 1980

In the past 3 decades the prevalence¹ (age-standardized) of diabetes has risen substantially in countries at all income levels, mirroring the global increase in the number of people who are overweight or obese. The global prevalence of diabetes has grown from 4.7% in 1980 to 8.5% in 2014, during which time prevalence has increased or at best remained unchanged in every country (4). Over the past decade, diabetes prevalence has risen faster in low- and middle-income countries than in high-income countries (see Figure 4a). The WHO Eastern Mediterranean Region has experienced the greatest rise in diabetes prevalence, and is now the WHO region with the highest prevalence (13.7%) (see Figure 4b).

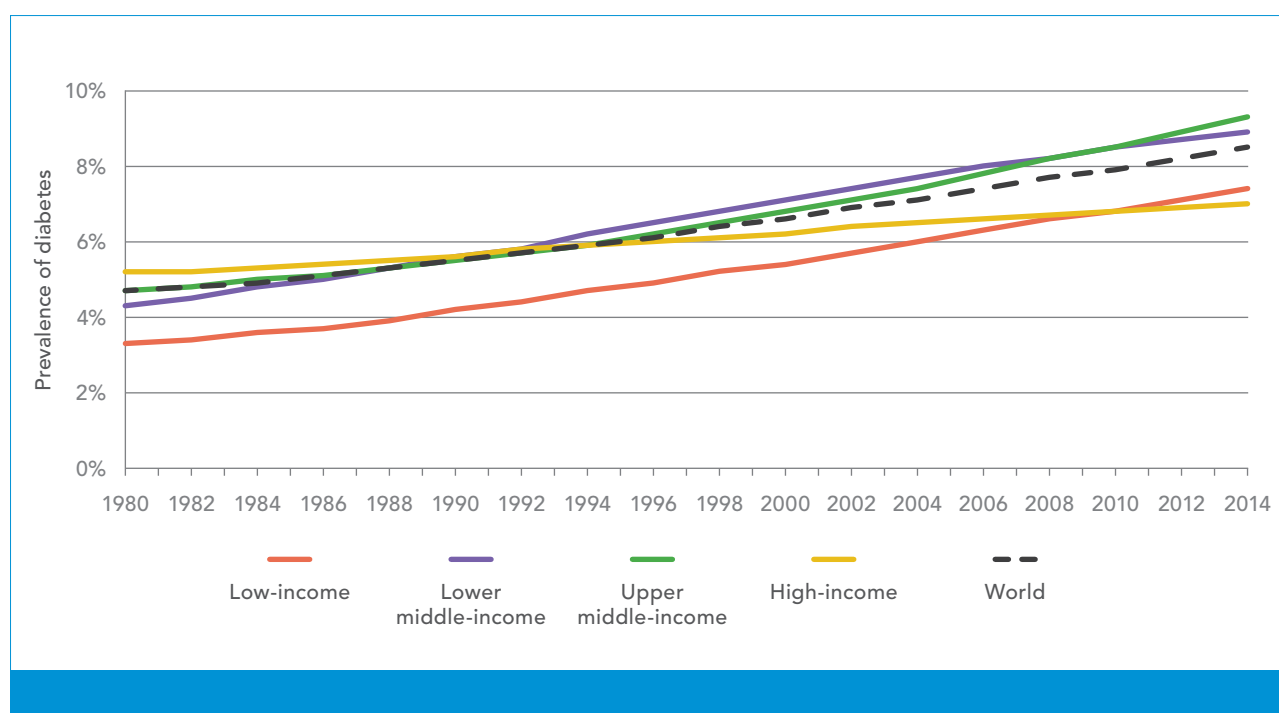
1. Unless otherwise noted, prevalence estimates reported in this section are age-standardized.

TYPE 1 DIABETES

Distinguishing between type 1 and type 2 diabetes is not always easy as it often requires relatively sophisticated laboratory tests for pancreas function. Distinct global estimates of diabetes prevalence for type 1 and type 2 therefore do not exist.

Much of our knowledge of the incidence of type 1 diabetes relates to children and has been generated by collaborative initiatives to develop population-based, standardized registries of new cases worldwide, such as the WHO DIAMOND Project (5). Globally, these registries recorded large differences in the incidence and prevalence of type 1 diabetes, ranging from over 60 to under 0.5 cases annually per 100 000 children aged under 15 years; differences in case ascertainment

FIGURE 4A. TRENDS IN PREVALENCE OF DIABETES, 1980–2014, BY COUNTRY INCOME GROUP



may have contributed to the variability. Of the study sites in the WHO DIAMOND project, type 1 diabetes is most common in Scandinavian populations and in Sardinia and Kuwait, and much less common in Asia and Latin America (6). Data are generally lacking for sub-Saharan Africa and large parts of Latin America. In the past few decades the annual incidence appears to be rising steadily by about 3% in high-income countries (7, 8, 9).

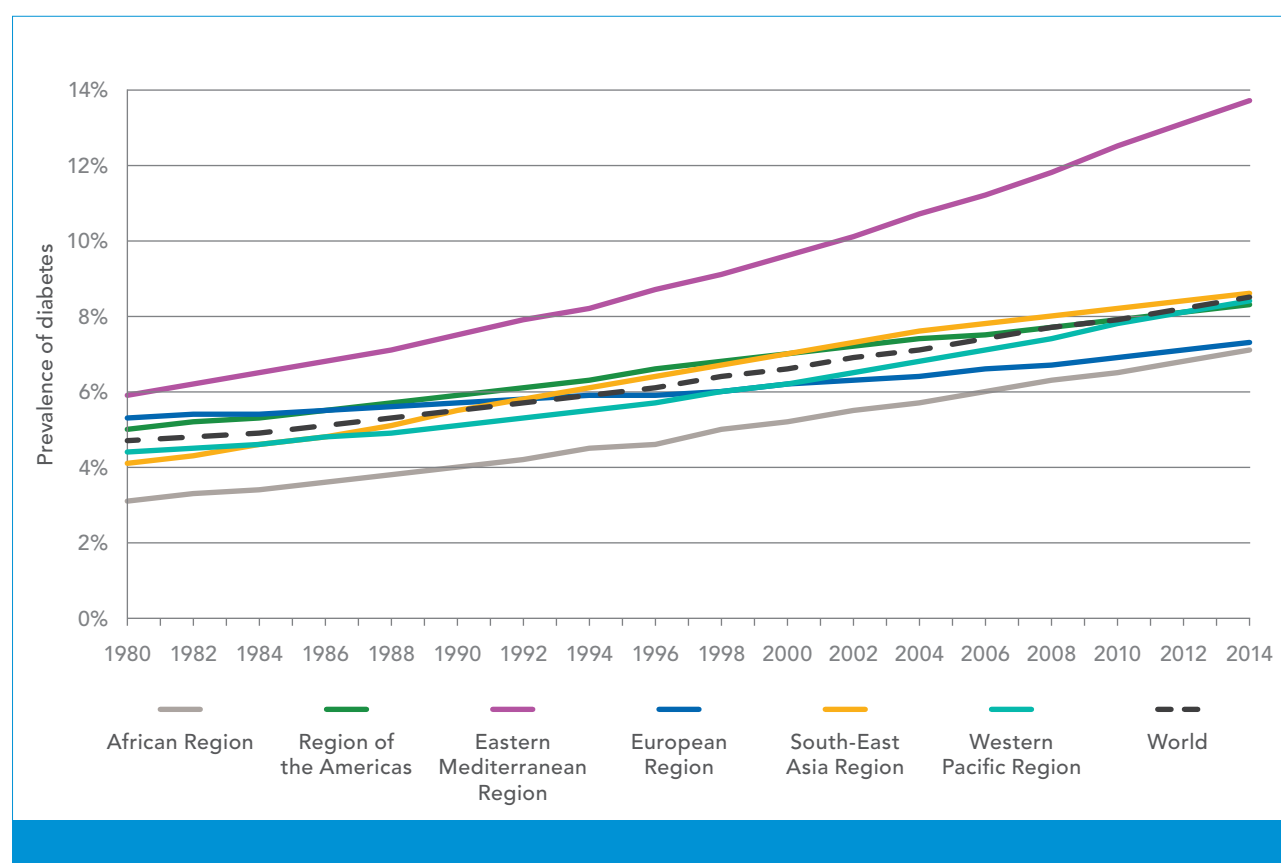
TYPE 2 DIABETES AND GESTATIONAL DIABETES

Previously seen mainly in middle-aged and elderly people, type 2 diabetes occurs increasingly frequently in children and young

people. Type 2 diabetes is often undiagnosed and studies to assess the number of newly occurring cases are complicated and consequently there are almost no data on true incidence. In high-income countries the prevalence of type 2 diabetes is frequently highest among people who are poor (10). There are few data on the income gradient of diabetes in low- and middle-income countries, but data that exist suggest that although the prevalence of diabetes is often highest among wealthy people, this trend is reversing in some middle-income countries (10).

The proportion of undiagnosed type 2 diabetes varies widely – a recent review of data from seven countries found that between 24%

FIGURE 4B. TRENDS IN PREVALENCE OF DIABETES, 1980–2014, BY WHO REGION



**More than
1 in 3 adults
were overweight
and more than
1 in 10 were
obese in 2014**

and 62% of people with diabetes were undiagnosed and untreated (11). Analysis of data from WHO-supported STEPS surveys in 11 countries underscores the wide variation in the proportion of people undiagnosed and untreated: among people whose measured blood glucose was at or above the diagnostic threshold for diabetes, between 6% and 70% had been diagnosed with diabetes, and between 4% and 66% were taking medication to lower their blood glucose (12). Even in high-income countries the proportion of undiagnosed diabetes can be as high as 30–50% (13).

The frequency of previously undiagnosed diabetes in pregnancy and gestational diabetes varies among populations but probably affects 10–25% of pregnancies (14). It has been estimated that most (75–90%) of cases of high blood glucose during pregnancy are gestational diabetes (15).

ASSOCIATED RISK FACTORS

Regular physical activity reduces the risk of diabetes and raised blood glucose, and is an important contributor to overall energy balance, weight control and obesity prevention – all risk exposures linked to future diabetes prevalence (16). The global target of a 10% relative reduction in physical inactivity is therefore strongly associated with the global target of halting the risk in diabetes.

However, the prevalence of physical inactivity globally is of increasing concern. In 2010, the latest year for which data are available, just under a quarter

of all adults aged over 18 years did not meet the minimum recommendation for physical activity per week and were classified as insufficiently physically active (16). In all WHO regions and across all country income groups women were less active than men, with 27% of women and 20% of men classified as insufficiently physically active. Physical inactivity is alarmingly common among adolescents, with 84% of girls and 78% of boys not meeting minimum requirements for physical activity for this age. The prevalence of physical inactivity is highest in high-income countries where it is almost double that of low-income countries. Among WHO regions, the Eastern Mediterranean Region showed the highest prevalence of inactivity in both adults and adolescents.

Being overweight or obese is strongly linked to diabetes. Despite the global voluntary target to halt the rise in obesity by 2025 (16, 17), being overweight or obese has increased in almost all countries. In 2014, the latest year for which global estimates are available, more than one in three adults aged over 18 years were overweight and more than one in 10 were obese. Women were more overweight or obese than men. The prevalence of obesity was highest in the WHO Region of the Americas and lowest in the WHO South-East Asian Region (see Figure 5a). The proportion of people who are overweight or obese increases with country income level. High- and middle-income countries have more than double the overweight and obesity prevalence of low-income countries (see Figure 5b).

FIGURE 5A. PREVALENCE OF BEING OVERWEIGHT (BMI 25+) IN ADULTS OVER 18 YEARS, 2014, BY SEX AND WHO REGION

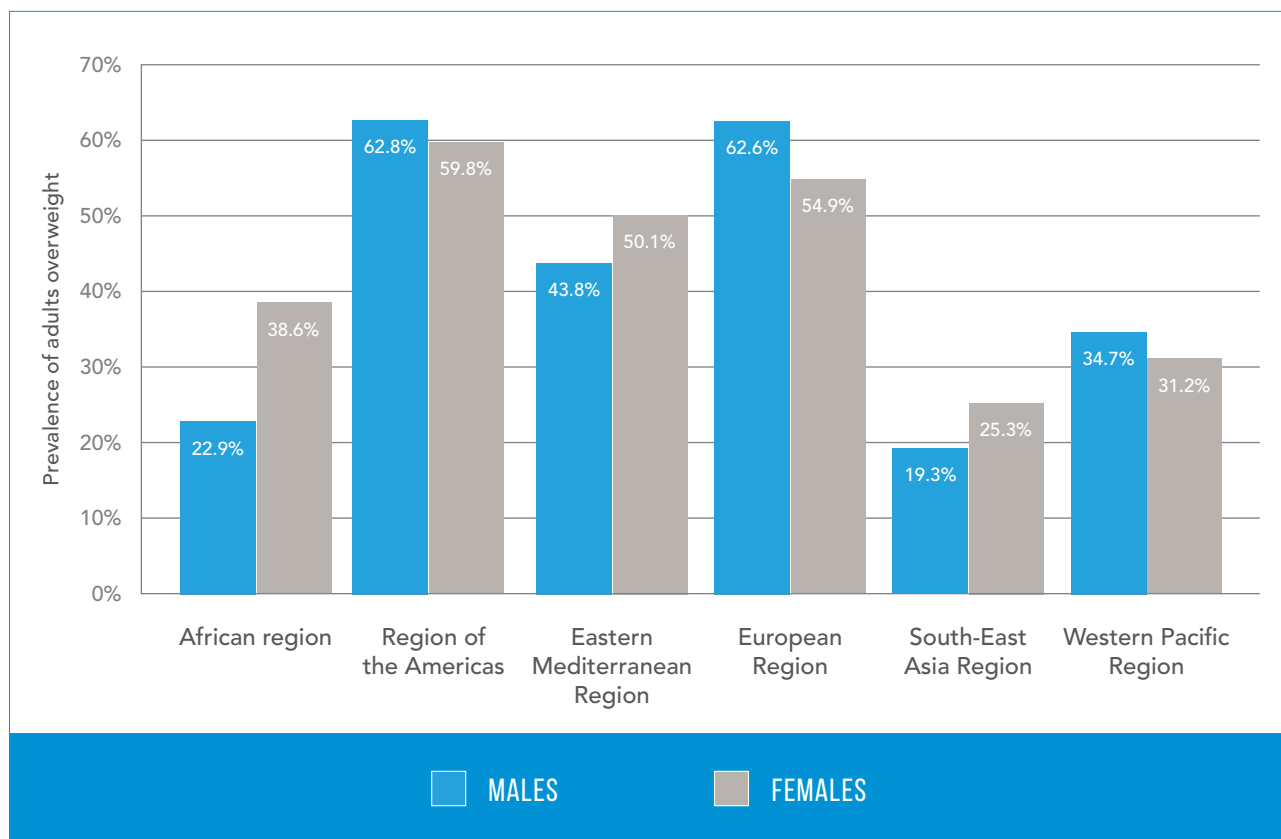
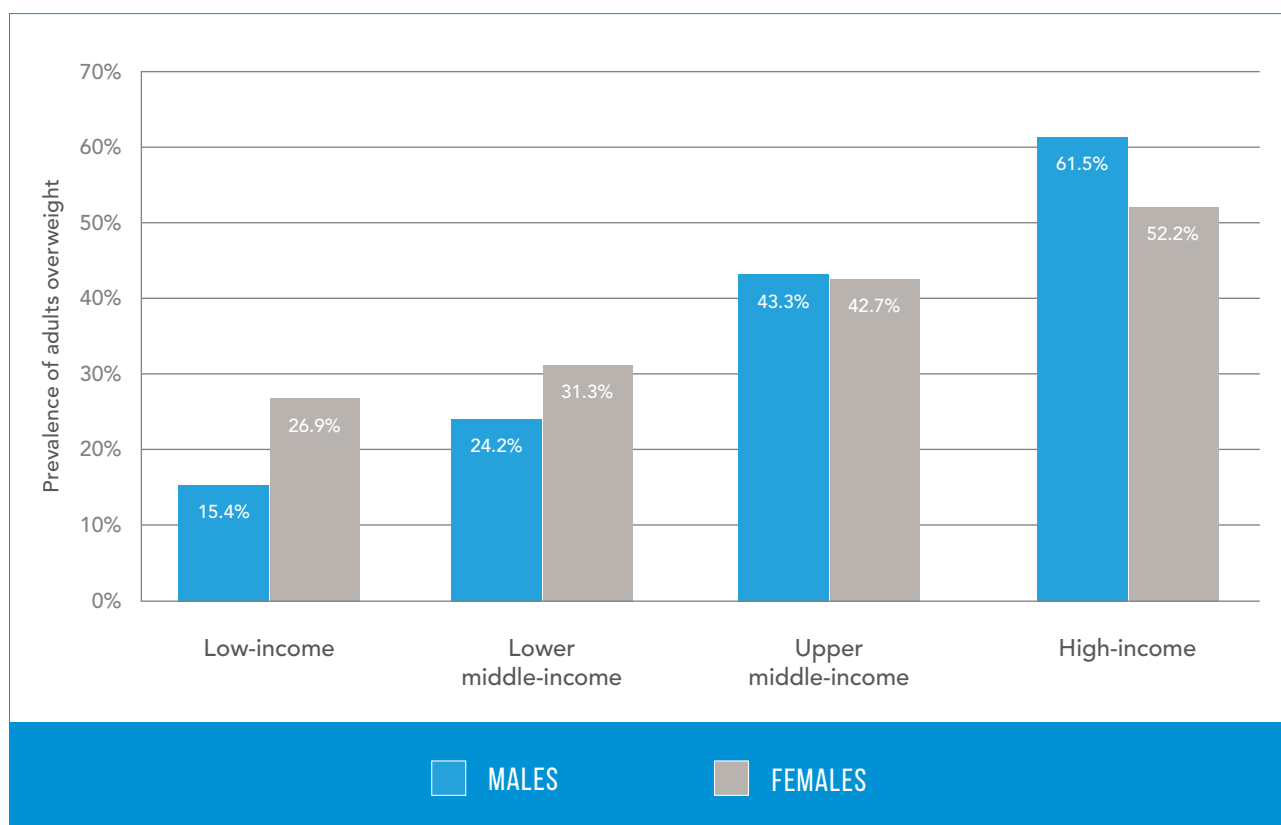


FIGURE 5B. PREVALENCE OF BEING OVERWEIGHT (BMI 25+) IN ADULTS OVER 18 YEARS, 2014, BY SEX AND COUNTRY INCOME GROUP



Lower limb amputation rates are 10 to 20 times higher among people with diabetes

1.3 BURDEN AND TRENDS IN THE COMPLICATIONS OF DIABETES

Diabetes, if not well controlled, may cause blindness, kidney failure, lower limb amputation and several other long-term consequences that impact significantly on quality of life. There are no global estimates of diabetes-related end-stage renal disease, cardiovascular events, lower-extremity amputations or pregnancy complications, though these conditions affect many people living with diabetes. Where data are available – mostly from high-income countries – prevalence, incidence and trends vary hugely between countries (18, 19).

LOSS OF VISION

Diabetic retinopathy caused 1.9% of moderate or severe visual impairment globally and 2.6% of blindness in 2010 (20). Studies suggest that prevalence of any retinopathy in persons with diabetes is 35% while proliferative (vision-threatening) retinopathy is 7% (21). However, retinopathy rates are higher among: people with type 1 diabetes; people with longer duration of diabetes; Caucasian populations; and possibly among people of lower socioeconomic status (21).

END-STAGE RENAL DISEASE

Pooled data from 54 countries show that at least 80% of cases of end-stage renal disease (ESRD) are caused by diabetes, hypertension or a combination of the two (18). The proportion of ESRD attributable to diabetes alone ranges from 12–55%. The incidence of ESRD is up to 10 times as high

in adults with diabetes as those without. The prevalence of ESRD is heavily dependent on access to dialysis and renal replacement therapy – both of which are highly variable between (and in some cases within) countries.

CARDIOVASCULAR EVENTS

Adults with diabetes historically have a two or three times higher rate of cardiovascular disease (CVD) than adults without diabetes (22). The risk of cardiovascular disease increases continuously with rising fasting plasma glucose levels, even before reaching levels sufficient for a diabetes diagnosis (2, 3). The few countries in north America, Scandinavia and the United Kingdom of Great Britain and Northern Ireland that have studied time trends in the incidence of cardiovascular events (myocardial infarction, stroke or CVD mortality) report large reductions over the past 20 years among people with type 1 or type 2 diabetes (23), although less than the reduction in the non-diabetic population. This decrease has been attributed to reduction in the prevalence of smoking and better management of diabetes and associated CVD risk factors.

LOWER EXTREMITY AMPUTATIONS

Diabetes appears to dramatically increase the risk of lower extremity amputation because of infected, non-healing foot ulcers (19). Rates of amputation in populations with diagnosed diabetes are typically 10 to 20 times those of non-diabetic populations, and over the past decade have ranged from 1.5 to 3.5 events per 1000 persons per

year in populations with diagnosed diabetes. Encouragingly several studies show a 40% to 60% reduction in rates of amputations among adults with diabetes during the past 10–15 years in the United Kingdom, Sweden, Denmark, Spain, the United States of America and Australia (19). No such data estimates exist for low- or middle-income countries.

1.4 SUMMARY

The number of people in the world with diabetes has quadrupled since 1980. Population growth and ageing have contributed to this increase, but are not solely responsible for it. The prevalence (age-standardized) of diabetes is growing in all regions. Global prevalence doubled from 1980 to 2014, mirroring a rise in

overweight and obesity. Prevalence is growing most rapidly in low- and middle-income countries.

Blood glucose levels begin to have an impact on morbidity and mortality even below the diagnostic threshold for diabetes. Diabetes and higher-than-optimal blood glucose together are responsible for 3.7 million deaths, many of which could be prevented.

The numbers and trends presented in this section have implications for the health and well-being of populations, and for health systems. The complications of diabetes have significant impact on the individuals who experience them and their impact is also felt at population level. Diabetes is a serious threat to population health.



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PART 2

PREVENTING DIABETES

KEY MESSAGES

Type 2 diabetes is largely preventable.

Multisectoral, population-based approaches are needed to reduce the prevalence of modifiable diabetes risk factors – such as overweight, obesity, physical inactivity and unhealthy diet – in the general population.

A combination of fiscal policies, legislation, changes to the environment and raising awareness of health risks works best for promoting healthier diets and physical activity.

Diabetes can be delayed or prevented in people who are overweight and have impaired glucose tolerance (IGT). Diet and physical activity interventions are more effective than medication.

The vast majority of the world's diabetes cases are type 2 (1). Some risk factors for type 2 diabetes – such as genetics, ethnicity and age – are not modifiable. Others, such as being overweight or obese, unhealthy diet, insufficient physical activity and smoking are modifiable through behavioural and environmental changes. Several effective policy options are available to facilitate these behavioural changes and create supportive environments for healthy lifestyles. At the individual level, intensive interventions to improve diet and physical activity can prevent or delay the onset of type 2 diabetes in people at high risk.

2.1 POPULATION-BASED PREVENTION

There are strong indications – if not yet direct evidence – that population-based programmes

aimed at modifiable risk factors can reduce the incidence of diabetes while also lowering blood pressure and other cardiovascular risk factors. Population-based data from Cuba show a fall in type 2 diabetes during a period of economic crisis when the population experienced a reduction in calorie intake and a simultaneous increase in physical activity (2), suggesting population-wide changes in diet and physical activity do affect type 2 diabetes prevalence.

Actions to address overweight and obesity are critical to preventing type 2 diabetes. Evidence on what works as a package of interventions for the prevention of overweight and obesity is limited, but much is known about promotion of healthy diet and physical activity, which are key to prevention and attaining the global obesity and diabetes target (see Box 1, page 16). Promoting healthy diets and increasing

physical activity in the population will help reduce the occurrence of obesity and type 2 diabetes, and will accrue additional benefits by reducing complications among people with all types of diabetes and glucose intolerance. WHO's recommendations for healthy diet and physical activity relevant to diabetes are summarized in Box 2.

Population-level interventions to reduce tobacco use may contribute to prevention of type 2 diabetes, given emerging evidence of a link between smoking and type 2 diabetes risk. Active tobacco use

can be reduced through a set of legislative, regulatory, fiscal and educational measures including graphic warnings on cigarette packs, bans on advertising and promotion, raising taxes on tobacco and implementing mass media campaigns (6). WHO Member States have committed to these and other actions through WHO's Framework Convention on Tobacco Control, which entered into force in 2005. Reducing population exposure to tobacco may also reduce diabetes-related complications, in part through reducing cardiovascular risk.

BOX 2. HEALTHY DIET AND PHYSICAL ACTIVITY

Adults can reduce their risk of type 2 diabetes and improve insulin sensitivity and glucose uptake through regular and adequate levels of physical activity and healthy diets that include sufficient consumption of dietary fibre, and replacing saturated fatty acids with polyunsaturated fatty acids. WHO has developed recommendations on healthy diet and physical activity that, if implemented, can reduce an individual's risk of type 2 diabetes and other NCDs.

Dietary recommendations by WHO and the Food and Agriculture Organization (FAO) for the prevention of type 2 diabetes include limiting saturated fatty acid intake to less than 10% of total energy intake (and for high risk groups, less than 7%); and achieving adequate intakes of dietary fibre (minimum daily intake of 20 g) through regular consumption of wholegrain cereals, legumes, fruits and vegetables (3). WHO is currently updating its guidelines on fat intake and carbohydrate intake, which will include recommendations on dietary fibre as well as fruits and vegetables. WHO strongly recommends reducing the intake of free sugars to less than 10% of total energy intake and suggests that further reduction to 5% could have additional health benefits (4).

WHO recommendations on physical activity are provided for different age groups (5):

- It is recommended that children and youth aged 5–17 years should do at least 60 minutes of moderate- to vigorous-intensity physical activity daily.
- It is recommended that adults aged 18–64 years should do at least 150 minutes of moderate-intensity aerobic physical activity (for example brisk walking, jogging, gardening) spread throughout the week, or at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity.
- For older adults the same amount of physical activity is recommended, but should also include balance and muscle strengthening activity tailored to their ability and circumstances.

The rise in diabetes risk factors has occurred in the context of changes in the social, economic and physical environments in which we are born and live. Population-based prevention aims not only to reduce risk factors for diabetes and NCDs, but also to shape the broader environments in which people live, eat, study, work and play, so that healthy choices are accessible and easy to make.

No single policy or intervention can achieve changes of this magnitude. Such an agenda calls for a “whole-of-government” approach, in which all sectors systematically consider the health impact of policies in trade, agriculture, finance, transport, education and urban planning – recognizing that health is enhanced or obstructed as a result of policies in these and other areas.

A LIFE-COURSE APPROACH TO PREVENTING DIABETES

Taking a life-course perspective is essential for type 2 diabetes prevention. Early in life, when eating and physical activity habits are formed and when the long-term regulation of energy balance may be programmed (7), there is a critical window for intervention to mitigate the risk of obesity and type 2 diabetes later in life (8). The report of the WHO Commission on Ending Childhood Obesity (9) provides a comprehensive, integrated package of recommendations to address childhood obesity that will contribute to the reduction of risks for developing type 2 diabetes. A life-course approach to diabetes would also recognize the increasing risk that comes with

advancing age, and the need to identify the unique needs for risk reduction in older adults.

IMPROVING EARLY CHILDHOOD NUTRITION

Strategies to improve early childhood nutrition should not be overlooked among type 2 diabetes prevention efforts. These actions must be aimed at improving maternal health and nutritional status and infant and young child-feeding practices, focusing on the first 1000 days from a woman’s pregnancy to her child’s second birthday (3). Specific measures include promoting the nutritional well-being of pregnant women; promotion of breastfeeding, including the implementation of the Code of Marketing of Breast Milk Substitutes; improving the nutritional status of infants and young children through exclusive breastfeeding up to 6 months of age; introducing a variety of safe, nutritious and adequate foods at 6 months of age to complement breastfeeding (which should continue until babies are 2 years of age or more); promoting growth in height; preventing the consumption of foods that are high in energy, fats, sugars and sodium; and facilitating physical activity (10).

SUPPORTIVE ENVIRONMENTS FOR PHYSICAL ACTIVITY

The physical or built environment plays an important role in facilitating physical activity for many people. Urban planning and active transport policies can ensure that walking, cycling and other forms of non-motorized

Actions to address overweight and obesity are critical to preventing type 2 diabetes

Policies that increase the price of foods high in fat, sugar and salt can decrease their consumption

transport are accessible and safe for all. The physical environment can also provide sports, recreation and leisure facilities, and ensure there are adequate safe spaces for active living for both children and adults (11). The poorest groups in society, especially women, may have less time and fewer resources to participate in leisure-time activity, making policy interventions that target active transport and incidental physical activity throughout the day much more important. Promotion of stair use – including placement of physical activity promotion messages on stairs – as part of a workplace programme has been shown to increase awareness and use of stairs (12).

The sports sector can encourage regular structured activities, especially among children and adolescents, and can strengthen the link between physical activity, sports and health. Partnerships with communities, the private sector and nongovernmental organizations can also contribute to developing facilities for physical activity.

SETTINGS-BASED INTERVENTIONS

Settings-based interventions can support diabetes prevention and control. These interventions reach families and communities where they live, study, work and play to implement both population-wide and individual high-risk interventions. Settings-based interventions should be comprehensive, make use of existing programmes when possible and focus on actions that do not require additional resources.

A whole-of-school approach that focuses on improving both diet and physical activity can be very effective in improving dietary patterns both inside and outside school (13). Successful school-based physical activity interventions should result in consistent improvements in the knowledge, attitudes and behaviour of children and, when tested, in physical and clinical outcomes (14). WHO's health-promoting schools initiative has demonstrated the importance of highlighting both the impact on attendance and educational achievement, as well as the health benefits of a whole-of-school approach (15).

Workplace interventions addressing diet and physical activity can be effective in changing behaviours and health-related outcomes (16). Healthy-eating messages in cafés and restaurants have been shown to stimulate consumption of healthy food – provided that healthy food items are made available as part of the intervention (17). Workplaces can help develop environments that are conducive to physical activity at work and provide incentives and opportunities for active commuting to and from work. Workplaces may offer their employees free or discounted vouchers for physical activity facilities.

FISCAL, LEGISLATIVE AND REGULATORY MEASURES FOR HEALTHY DIET

Fiscal measures. Price is often reported as a barrier to people buying and consuming healthy foods. Likewise, policy action to increase the price of foods high in fat, sugar and salt can decrease

their consumption (see Box 3). There is emerging evidence that appropriately designed fiscal policies, when implemented together with other policy actions, have the potential to promote healthier diets (18). Fiscal policies should be considered a key component of a comprehensive strategy for prevention and control of NCDs, including diabetes.

Trade and agricultural policies that promote healthy diets. Trade measures have proven effective in reducing the availability of unhealthy foods and changing people's diet. For example, in 2000 Fiji banned the supply of high-fat mutton flaps under the Trading Standards Act. Also, in Mauritius, the reduction of saturated fatty acids in cooking oil and their replacement with soya bean oil is estimated to have changed consumption patterns for the best, and reduced average total cholesterol levels (19). Changes in agricultural subsidies to encourage fruit and vegetable production can

be beneficial in increasing their consumption and improving diet. Evidence strongly supports the use of such subsidies and related policies to facilitate sustained long-term production, transport and marketing of healthier foods (20).

Regulation of marketing of foods high in sugars, fats and salt. There is ample evidence that the marketing of foods and non-alcoholic beverages influences children's knowledge, attitudes, beliefs and preferences. WHO has developed a set of recommendations and an implementation framework on the marketing of foods and non-alcoholic beverages to children (26). This aims to assist Member States in designing and implementing new policies – or strengthening existing ones – that regulate the marketing of food to children.

Nutrition labelling is a regulatory tool that can guide consumers towards healthier food choices.

BOX 3. THE “SUGAR-SWEETENED BEVERAGE TAX”, MEXICO

The prevalence of overweight and obesity in Mexico stands at more than 33% in children and around 70% in adults (21). Mexico has the highest prevalence of diabetes among Organization for Economic Cooperation and Development (OECD) member countries (22), and the highest per capita consumption of soft drinks worldwide (23).

In January 2014 Mexico implemented a nationwide tax on drinks containing added sugar (bebidas azucaradas) that increased their price by over 10%. While it is too early to draw far-reaching conclusions, one analysis estimated that the 10% increase in the price of added-sugar drinks was associated with an 11.6% decrease in the quantity consumed (24).

During the first year of the tax, purchases of taxed sugar-sweetened beverages decreased by an average of 6% compared to what would have been expected without implementation of the tax (25), with higher reductions found in households of low socioeconomic status.

**Interventions
that promote healthy
diet, physical activity
and weight loss
can prevent type 2
diabetes in people
at high risk**

Nutrition labelling comprises nutrient declarations and supplementary nutrition information commonly referred to as front-of-pack labelling. The nutrient declarations provide quantitative information and usually appear on small print on the back of packages; front-of-pack labelling is designed to assist in interpreting nutrient declarations. Front-of-pack labelling may also encourage manufacturers to make the composition of retail food products healthier, to achieve competitive advantages or to avoid unfavourable disclosures about food composition. There is evidence that simple, front-of-pack labels on packaged foods, or point-of-purchase information in grocery stores, cafés or restaurants, can be beneficial to support healthier options, as can menu labelling (27).

**EDUCATION, SOCIAL MARKETING AND
MOBILIZATION**

Consumer awareness and knowledge of healthy diet and physical activity can be achieved through sustained media and educational campaigns aimed at increasing consumption of healthy foods (or reducing consumption of less healthy ones), and increasing physical activity. These campaigns have greater impact and are more cost-effective when used within multicomponent strategies (28). For example, a social marketing campaign in Tonga using netball to promote physical activity among women as part of a national NCD campaign has resulted in increased participation both in netball and leisure-time physical activity by women (29).

**2.2 PREVENTING DIABETES IN
PEOPLE AT HIGH RISK**

Research in different parts of the world has shown that intensive interventions that change people's diet, increase physical activity and lead to the loss of excess body weight can prevent type 2 diabetes in people with impaired glucose tolerance, with or without impaired fasting glucose. For example, the Diabetes Prevention Program (DPP) in the USA (30), the Finnish Diabetes Prevention Study (DPS) (31) and the Chinese Da Qing Study showed that active intervention, lasting 2 to 6 years, could have extended benefits for glycaemic and cardiovascular outcomes that last for 10 to 20 years (32).

Several pharmacological interventions (for example, metformin and acarbose) have also been shown to prevent or delay type 2 diabetes but, in the majority of studies, this is not as effective as changes in diet and physical activity, and the effect dissipates after discontinuation of the medication (33, 34).

Knowledge gained from these proof-of-concept studies confirms that type 2 diabetes can be delayed or prevented, but turning this knowledge into large-scale impact brings significant challenges. The success of these programmes depends on the feasibility of identifying, assessing and successfully involving high-risk groups (see Box 4). Careful decisions are required about how to assess diabetes risk, how to support those identified as high-risk, and how to ensure care for those diagnosed with diabetes as a result of the risk assessment. The individual or high-risk

BOX 4. EXAMPLES OF TOOLS TO ASSESS THE RISK OF HAVING CURRENT OR FUTURE DIABETES

Measurement of blood glucose remains the best predictor of type 2 diabetes risk, though a wide and ever-increasing range of biomarkers has been reported to predict future development of type 2 diabetes. The risk of having or developing type 2 diabetes can also be assessed using tools that cover variables such as age, sex, history of GDM and family history of diabetes, as well as clinical measures of body mass index, waist circumference and waist-hip ratio. Several tools that assess the risk of having undiagnosed or future diabetes have been developed and adapted for use in diverse populations:

- **FINRISK:** a simple score adapted for use in several countries, using age, BMI, waist circumference, history of anti-hypertensive drug treatment and high blood glucose, physical activity, and daily consumption of fruits, berries or vegetables to estimate risk (35).
- **AUSDRISK:** a 10-item questionnaire that estimates risk of progression to type 2 diabetes over 5 years. Its scoring includes questions based on age, sex, ethnicity, family history of diabetes, history of abnormal glucose metabolism, smoking status, current hypertensive treatment, physical activity, fruit and vegetable consumption, and waist circumference (36).
- **IDRS (Indian Diabetes Risk Score):** a simplified risk score for identifying undiagnosed diabetic subjects using four simple parameters – age, waist circumference, family history of diabetes and physical activity. IDRS is an inexpensive and simple tool for screening for risk of undiagnosed diabetes (37).

approach needs to be translated into well-defined strategies for implementation at community level and in national programmes, in accordance with available resources. It has the potential to overwhelm primary care services, where the responsibility for intervention usually lies.

There is no universal answer regarding the advisability of population screening for type 2 diabetes risk. Assessment of diabetes risk should not be confused with the total risk approach to cardiovascular disease risk in which diabetes is included as one component. Diabetes is not only a risk factor for CVD, it also has its own specific complications. However, given the overlap of diabetes and CVD risk factors, combined screening for risk of both

conditions is a rational approach. The decision to systematically look for people at high risk of diabetes and CVD is a strategic one specific to each health-care setting, and will depend, at least in part, on the numbers likely to be identified and the resources available to adequately deal with them (see also Chapter 4 for early detection of undiagnosed diabetes).

Whether or not intensive individual interventions are made available, and whether or not systematic assessment of risk is undertaken, primary health-care services must be equipped to manage people with high risk of type 2 diabetes. Clinical vigilance alone, even in the absence of systems for early detection of type 2 diabetes or systematic risk prediction, will identify people who are at high

Much type 2 diabetes results from risk factors that can be reduced using a combination of approaches at population and individual levels.

risk for future development of type 2 diabetes. These people should receive (as a minimum) repeat counselling on weight loss, diet, physical activity and smoking.

While type 2 diabetes is potentially preventable, the causes and risk factors for type 1 diabetes remain unknown and prevention strategies have not yet been successful (see Box 5).

2.3 SUMMARY

Much type 2 diabetes results from modifiable risk factors that can be reduced using a combination of approaches at population and individual levels. Creating supportive policy, social and physical environments for healthy lifestyles is a key aspect of type 2 diabetes prevention. Sustaining the lifestyle changes needed to reduce risk requires supportive family and social networks, as well as an enabling food system and physical environment. Healthy food and opportunities for physical activity must be available and affordable.

BOX 5. TOWARDS PREVENTION OF TYPE 1 DIABETES

A variety of immunological approaches have been successful at preventing a disease similar to human type 1 diabetes in laboratory animals. As a result, hope has emerged that analogous interventions in humans might prevent type 1 diabetes or significantly slow the decline in beta cell function that characterizes the condition. Effective intervention of this nature could significantly reduce the incidence of type 1 diabetes and its long-term complications, greatly enhancing quality of life for people living with it.

Primary prevention trials involving dietary modification have been conducted with infants identified through genetic screening as being at highest risk of developing type 1 diabetes. Tested interventions and factors have included early exposure to cows' milk; the age of introduction of solid foods; supplementation with an omega-3 fatty acid; and supplementation with vitamin D. None of the trials has shown a reduction in type 1 incidence.

Other trials have focused on relatives of people with type 1 diabetes. Two large randomized clinical trials have explored the use of vitamin B6 supplementation in adults and children who are related to people with type 1 diabetes and are pancreatic islet antibody-positive, with negative results. Injected insulin and oral insulin have also been explored as preventive interventions in children with antibodies to insulin. The overall results were negative but a subgroup with the highest concentration of anti-insulin antibodies at the start of the trial showed some delay in onset.

Other approaches, as yet unsuccessful, have been treatment of people at high risk with nasal insulin, low-dose cyclosporine and with a monoclonal antibody.

Source: (38)

The WHO Global NCD Action Plan 2013–2020 sets out policy options for reducing modifiable NCD risk factors. Scaled-up implementation of these should reduce the occurrence of type 2 diabetes. Achieving the global voluntary target to halt the rising trend of obesity and diabetes will, however, require innovation and the scaling-up in particular of interventions to promote healthy diets and physical activity, as well as innovative ways to measure impact and expand the evidence base for population-wide prevention.

Implementation of effective strategies to reduce modifiable risk factors for diabetes and other NCDs frequently face powerful industry opposition. Trade measures and regulatory policies such as taxes on foods and beverages; restriction of marketing of unhealthy foods and non-alcoholic beverages; and implementing effective front-of-package labelling frequently face opposition from industry. Interference by food and beverage companies in policy-making and conflicts of interest can lead to the adoption of industry self-regulatory schemes that tend to be less effective than government regulation.

A whole-of-government approach, and even a whole-of-society approach, is essential to the success of most of these strategies. Without support from the highest level of government, it may be difficult to engage effectively with other key sectors, such as trade, industry, agriculture and education.

As noted by the WHO Commission on Ending Childhood Obesity, a

comprehensive approach is needed to change the environmental factors that encourage weight gain and obesity (9). Action is required both to increase physical activity and healthy diet, and to reduce sedentary behaviours and intake of unhealthy foods and beverages. Particular consideration should be given to the impact of these interventions on populations of lower socioeconomic status, who often lack access to healthier foods and opportunities for physical activity.

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