Diabetes Epidemiology Studies

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Research Area in Diabetes

1. Epidemiology
- Prevalence, Incidence, Trend
- Risk factors

2. Behavioral and Lifestyle Factors
- Lifestyle
- Diet
- Weight Loss and Management

3. Medical Management and Control
- Medication

New Medication

Drug Choice

Glucose-lower Medication

Blood Pressure Management

Lipid Management

4. Complications & Comorbidities
- Cardiovascular Disease (CVD)
- Retinopathy
- Neuropathy
- Nephropathy
- Foot Diabetic

5. Diagnosis and Screening
- Diagnosis tests and methods
- Screening and Risk Score

6. Health Systems and Economics
- Registries System
- Cost-Effectiveness and Expenditure Studies

7. Outcomes
- Death and Mortality
- Burden and DALY (Years of Life Lost, Years Lived with Disability)

8. Psychological Factors
- Motivation
- Mental Health **(Diabetes Burnout)**

9. Education and Support
- Educational Interventions

Self-Care

Self-Efficacy

Adherence (Medication, Diet)

Quality of Life

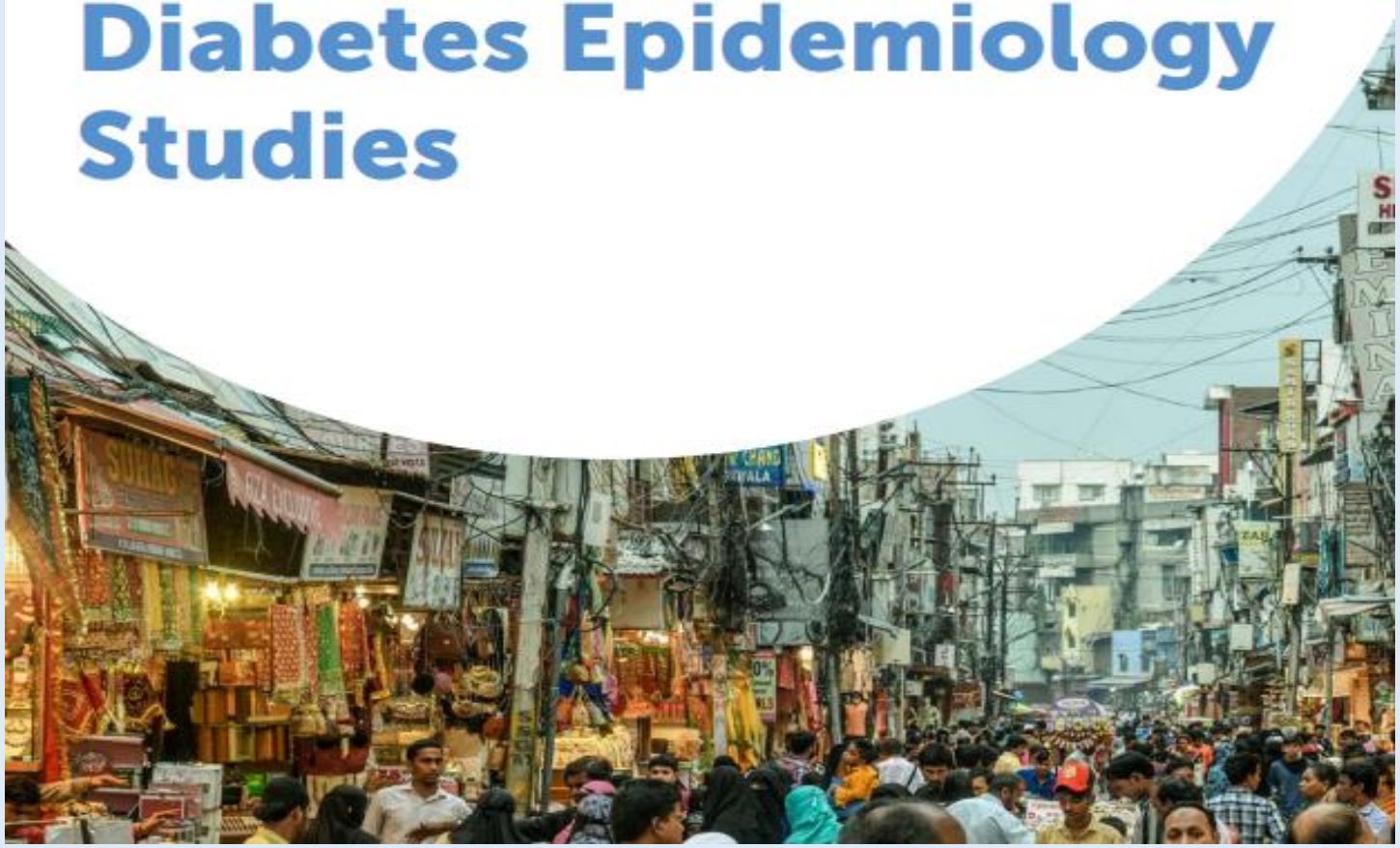
10. Technology Integration
- Continuous Glucose Monitoring (CGM)
- Insulin Pumps
- Telemedicine

11. Genetic Studies
- Gene
- Biomarker

International Diabetes Federation

IDF guide for

Diabetes Epidemiology Studies



Diabetes Epidemiology Studies

- To measure the distribution of the disease (prevalence and incidence)
- To measure its determinants (risk factors)
- To measure its consequences (complications, mortality and health expenditure)

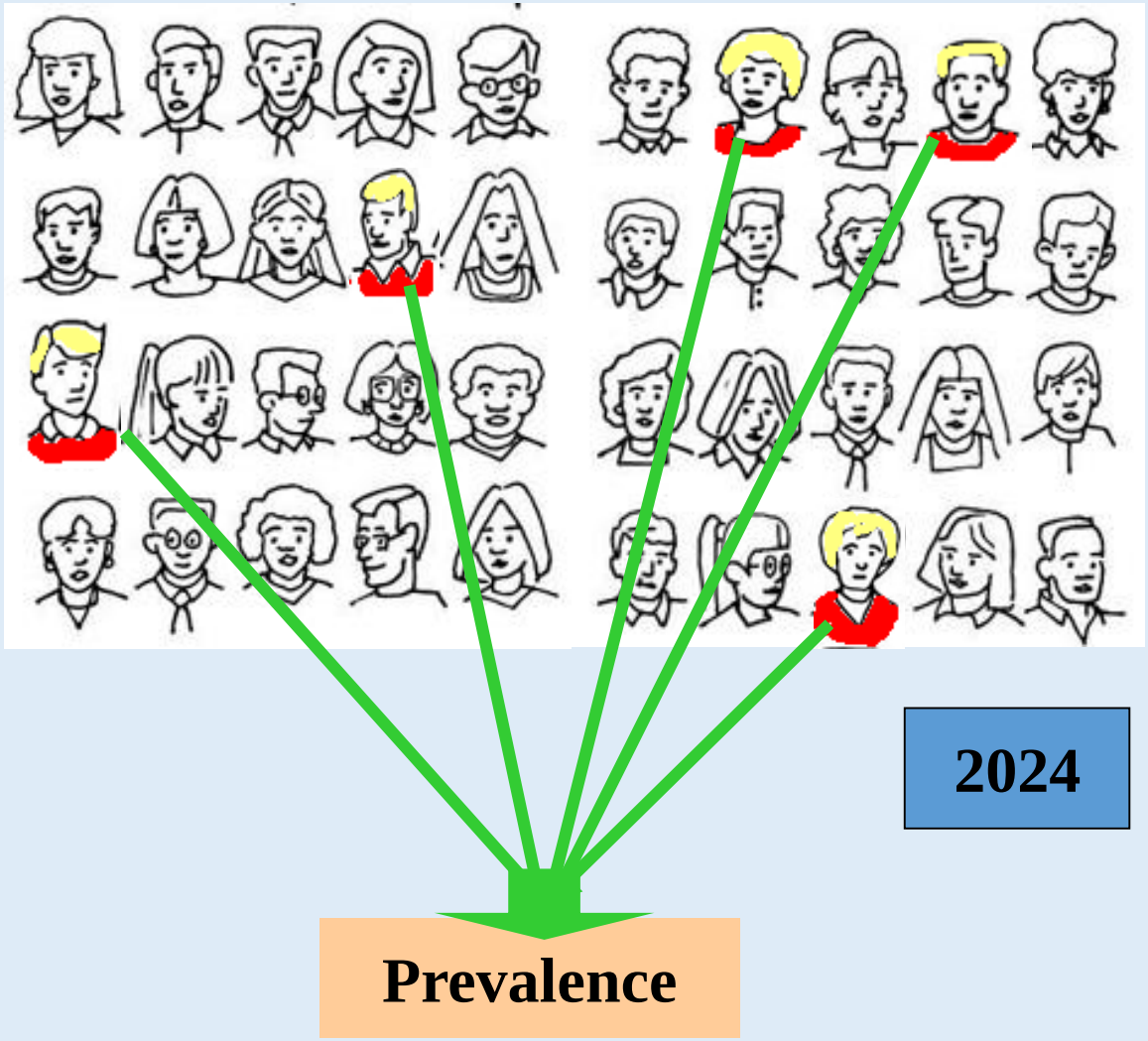
Measurement of Morbidity

- **Prevalence**
- **Incidence**

Prevalence

2024

Prevalence



Tests for Diabetes

- Various biomedical tests are employed to detect hyperglycaemia:

➢ Fasting plasma glucose (**FPG**)
➢ 2-hour plasma glucose (**2h-PG**) during a 75g oral glucose tolerance test (OGTT)
➢ And glycated haemoglobin (**HbA1c**) are accepted for the diagnosis of diabetes.

- These tests do not identify the same people!

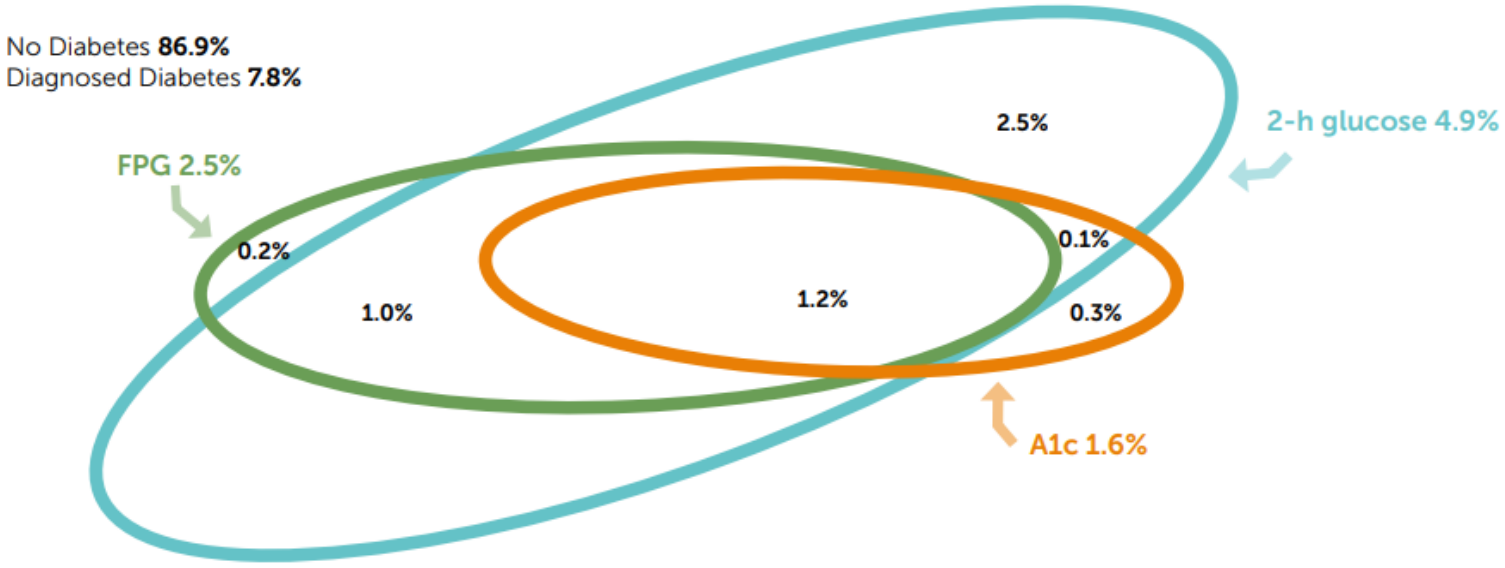
- People diagnosed using FPG, 2h-PG and HbA1c tests do not overlap completely with each other.

- Compared with **2h-PG**, FPG and HbA1c diagnose fewer people with diabetes.

Prevalence

- Different diagnostic tests for diabetes may produce different prevalence values.

Figure 2.1. Venn diagram based on the data from NHANES 2005–2006 in the US. Diagnostic criteria used in this diagram are: FPG ≥ 7 mmol/L (126 mg/dl). 2h-PG ≥ 11.1 mmol/L (200 mg/dl). HbA1c ≥ 6.5% (≥ 48 mmol/mol).



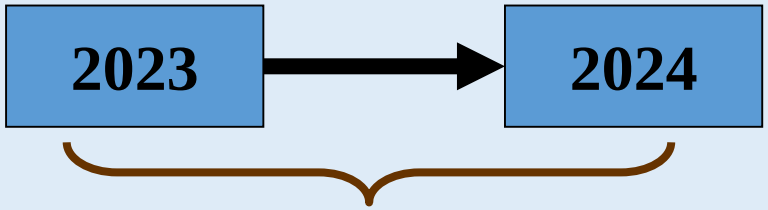
Source: Cowie CC, Rust KF, Byrd-Holt DD, et al. Prevalence of Diabetes and High Risk for Diabetes Using A1C Criteria in the U.S. Population in 1988–2006. Diabetes Care. 2010 Mar;33(3): 562–568. 10.2337/dc09-1524.

Incidence

2023

Defined Population

Incidence



Defined Population

Specified period of time

Incidence

Tell us how fast the disease is occurring in a population

Incidence; Numerator & Denominator

- Numerator is number of events that occurred in a defined population over a specified period of time

- Denominator
  - **Population** (a city has a total population of 100,000 people)
    - ✓ Population at midyear (at midyear, the population of the city is recorded as **98,500** due to seasonal **migration**)
    - ✓ Population at risk (out of the total population, 90,000 are at risk of developing a specific disease (e.g., only adults are considered, excluding children))
    - ✓ Person-time (in a study of 1,000 participants over 2 years, the total person-time is calculated as: 1,000 participants × 2 years = 2,000 person-years)
    - ✓ Subgroups in population (the population can be divided into subgroups based on age: 0-18 years: 20,000; 19-35 years: 30,000; 36-65 years: 35,000; 65+ years: 15,000)
  - **Events** (in a year, there are 50 new cases of the disease reported in the population at risk)

Measurement of Mortality

Crude Death Rate (CDR)

Formula:

$$\frac{\text{Total no. of deaths from all causes in 1 year}}{\text{No. of persons in the population at midyear}} \times \mathbf{1000}$$

Example:

$$\frac{\text{3200 deaths from all causes in 1 year}}{\text{800,000 persons in the population at midyear}} \times 1000 = \mathbf{4\ per\ 1000}$$

Crude Death Rate

Example:

Population A CDR= **15.2** per 1000

Population B CDR= **9.9** per 1000

What population have better condition?

Crude Death Rate

Age – specific mortality rate in 1000 persons

	CDR	< 1	1 - 4	5 - 7	8 - 44	45 - 64	> 65
A	**15.2**	13.5	0.6	0.4	1.5	10.7	59.7
B	**9.9**	22.6	1	0.5	3.6	18.8	41.1

Standardized Mortality Rate/Ratio (SMR)

- Direct and Indirect standardization may be used to adjust for differences in the distribution of age (and sometimes sex and other factors) to generate a standardized mortality ratio

Specific Mortality Rates; Age-Specific

$$\frac{\text{No. of deaths from all causes in 1 year in early adults}}{\text{No. of early adults in the population}} \times 1000$$

Specific Mortality Rates; Cause (Disease)–Specific

$$\frac{\text{No. of deaths from T2D in 1 year}}{\text{No. of persons in the population at midyear}} \times 1000$$

Specific Mortality Rates, Both

$$\frac{\text{No. of deaths from T2D in 1 year in elderly}}{\text{No. of elderly in the population}} \times 1000$$

Case–Fatality Rate

$$\frac{\text{No. of individuals dying during a specified period of time after disease onset or diagnosis}}{\text{No. of individuals with the specified disease}} \times \mathbf{100}$$

$$\frac{\text{10 death from T2D during 1 year}}{\text{2,000 patients with T2D}} \times 100 = \mathbf{0.5\%}$$

Proportionate Mortality Rate (PMR)

- Of all deaths, what proportion were due to disease “ X ”

$$\frac{\text{200 deaths from T2D in the Tehran in 2024}}{\text{20,000 deaths in the Tehran in 2024}} \times \mathbf{100 = 1\%}$$

Survival Rate

- Although survival is commonly used to describe cancer outcomes, often as proportions of people that are alive at specific time-points, such as 5 or 10 years after diagnosis, it is **rarely** used to describe outcomes of diabetes.

- Five–years survival: The percent of patients who are alive 5 years after treatment begins or 5 years after diagnosis.

Life Expectancy (LE) and Disability-Adjusted Life Years (DALY)

- Life expectancy (LE) provides a measure of the average **number of years** a person is expected to live.

- Years of life lost (YLL) is a useful and easily understood metric of the effect of an increased mortality risk, and is calculated by comparing life expectancy in people with diabetes to that of people without diabetes.

- Disability-adjusted life-years (DALYs) can be estimated by combining quality of life measures and life expectancy estimates, and is the approach used by Global Burden of Disease (GBD) studies. Different disability weights are applied depending on whether or not complications of diabetes are present.

Assessing Relationship

Associated Risk Factors/ Related Factors

- Diabetes, and specifically T2D, is associated with cardiovascular risk factors such as hypertension and dyslipidemia, etc.

- Modelling based on **outcome**: Regression models are used to adjust the confounding factors

Continues	• FBS, Time (Trend) • Linear Regression (Beta, Coefficient)
Binary	• Diabetes, Metabolic Syndrome • Logistic Regression (Odds Ration)
Time to Event (Survival Analysis)	• Incidence of Diabetes over Time • Cox Regression (Hazard Ratio)

The sum of years of follow-up from the start of the study to the earliest instance of death, emigration, loss to follow-up or end of follow-up)

Global Burden of Diseases (GBD), IHME

Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021

*GBD 2021 Diabetes Collaborators**

Summary

Background Diabetes is one of the leading causes of death and disability worldwide, and affects people regardless of country, age group, or sex. Using the most recent evidentiary and analytical framework from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD), we produced location-specific, age-specific, and sex-specific estimates of diabetes prevalence and burden from 1990 to 2021, the proportion of type 1 and type 2 diabetes in 2021, the proportion of the type 2 diabetes burden attributable to selected risk factors, and projections of diabetes prevalence through 2050.

Methods Estimates of diabetes prevalence and burden were computed in 204 countries and territories, across 25 age groups, for males and females separately and combined; these estimates comprised lost years of healthy life, measured in disability-adjusted life-years (DALYs; defined as the sum of years of life lost [YLLs] and years lived with disability [YLDs]). We used the Cause of Death Ensemble model (CODEm) approach to estimate deaths due to diabetes, incorporating 25 666 location-years of data from vital registration and verbal autopsy reports in separate total (including both type 1 and type 2 diabetes) and type-specific models. Other forms of diabetes, including gestational and monogenic diabetes, were not explicitly modelled. Total and type 1 diabetes prevalence was estimated by use of a Bayesian meta-regression modelling tool, DisMod-MR 2.1, to analyse 1527 location-years of data from the scientific literature, survey microdata, and insurance claims; type 2 diabetes estimates were computed by subtracting type 1 diabetes from total estimates. Mortality and prevalence estimates, along with standard life expectancy and disability weights, were used to calculate YLLs, YLDs, and DALYs. When appropriate, we extrapolated estimates to a hypothetical population with a standardised age structure to allow comparison in populations with different age structures. We used the comparative risk assessment framework to estimate the risk-attributable type 2 diabetes burden for 16 risk factors falling under risk categories including environmental and occupational factors, tobacco use, high alcohol use, high body-mass index (BMI), dietary factors, and low physical activity. Using a regression framework, we forecast type 1 and type 2 diabetes prevalence through 2050 with Socio-demographic Index (SDI) and high BMI as predictors, respectively.

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This online publication has been corrected. The corrected version first appeared at thelancet.com on September 28, 2023

See **Comment** page 163

*Collaborators are listed at the end of the Article

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Prevalence

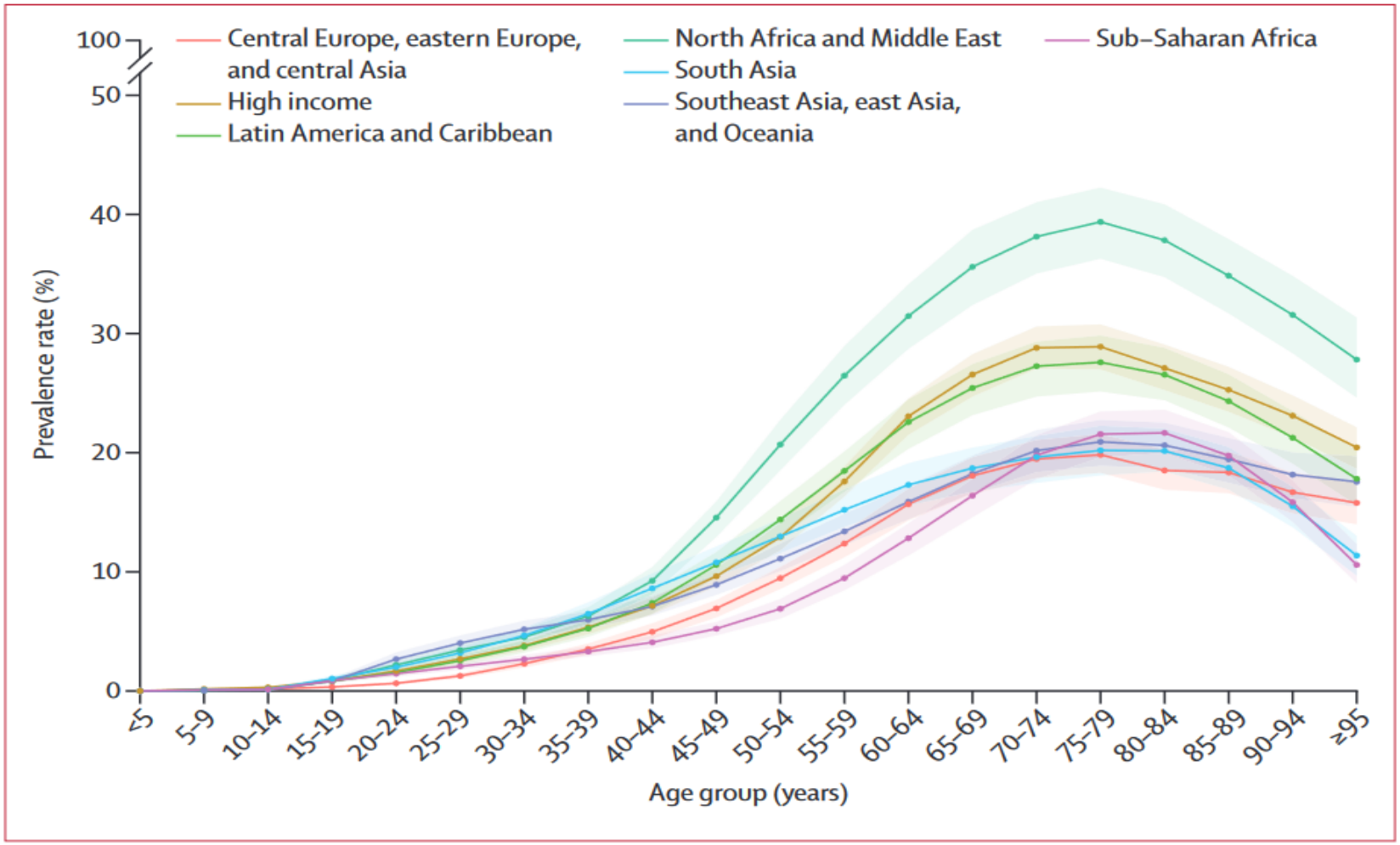

Figure 2: **Prevalence of total diabetes by age and GBD super-region in 2021**
The shaded areas represent 95% uncertainty intervals. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

Trend

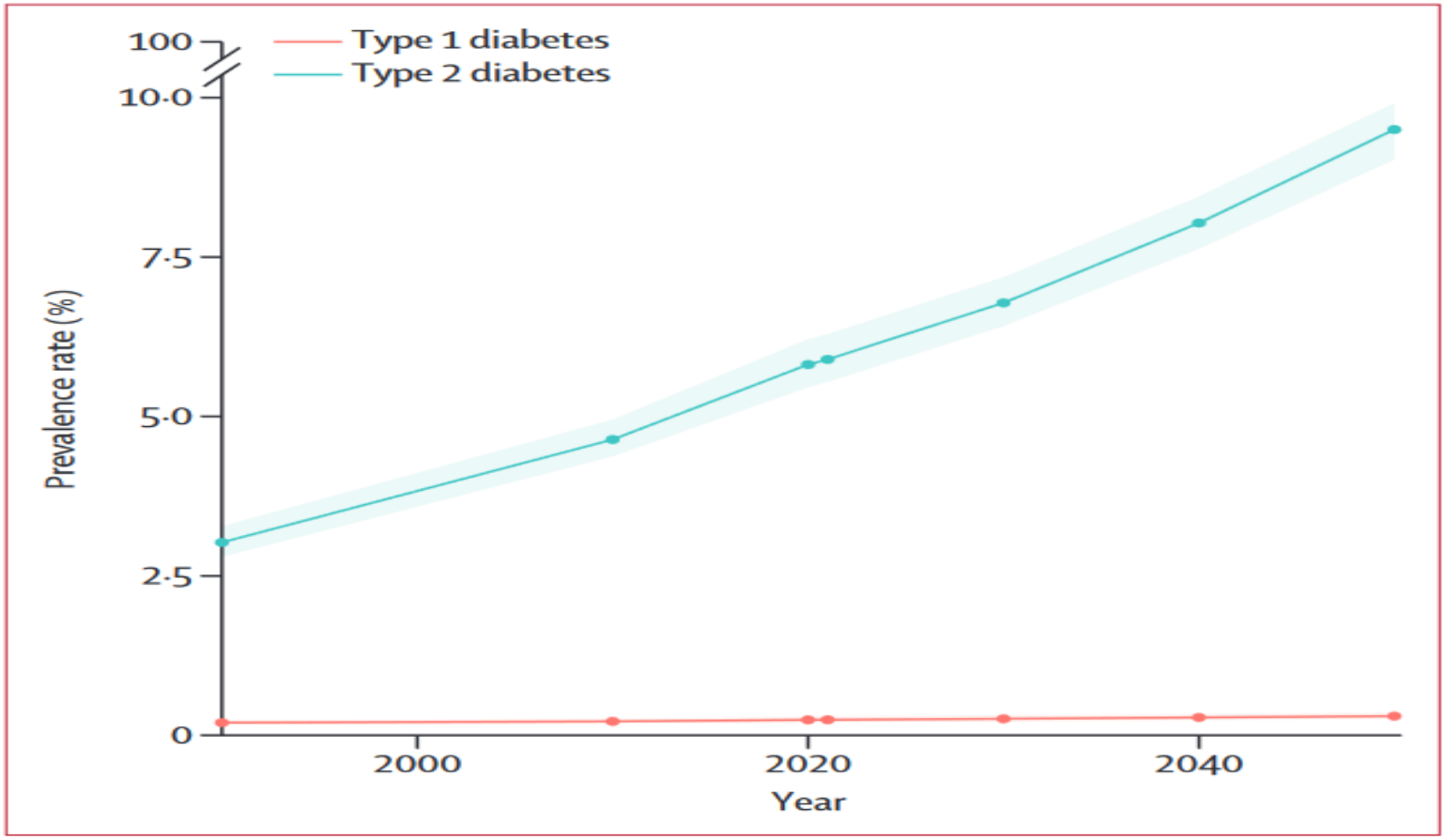

Figure 4: **Global age-standardised prevalence of type 1 and type 2 diabetes from 1990 through 2050 forecasts**
The shaded area represents 95% uncertainty intervals. Total diabetes is the sum of type 1 and type 2 diabetes.

Risk-Attributable Burden; Risk Factors

Six Categories

- Environmental/occupational risks
- High alcohol use
- Tobacco use
- Dietary risks
- Low physical activity
- High body-mass index

- High/low air temperature; Air pollution; Ambient particulate matter pollution
- Smoking; Second-hand smoke
- Low in fruits, vegetable, whole grains, dietary fiber; High in red meat, processed meat, sugar-sweetened beverage

Nonfatal diabetes and Diabetic outcomes

Table S6. Case definitions for nonfatal diabetes and diabetic outcomes

Quantity of interest	Reference or Alternative	Definition
Diabetes mellitus	Reference	Fasting plasma glucose (FPG) greater than or equal to 126 mg/dl (7 mmol/L) or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	FPG greater than a threshold not equal to 126 mg/dl (7mmol/L) or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	Blood glucose tests measured from glycated hemoglobin (HbA1c) or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	Blood glucose tests measured from oral glucose tolerance test (OGTT) or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	Blood glucose tests measured from post-prandial glucose test (PPG) or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	Combination of non-FPG blood glucose test(s) and FPG or current treatment (insulin or drugs)
Diabetes mellitus	Alternative	Blood glucose tests measured from FPG, HbA1c, OGTT, or PPG (no treatment)
Diabetes mellitus type 1	Reference	Cases of physician diagnosed type 1 diabetes, or type 1 diabetes cases in a diabetic registry or hospital, or any case of diabetes in persons <15 years who are on insulin
Diabetes mellitus type 1	Alternative	Cases of type 1 diabetes determined by c-peptide, islet cell autoantibodies (ICA), Glutamic Acid Decarboxylase Autoantibodies (GADA)
Diabetes mellitus type 1	Alternative	Cases of type 1 diabetes found using pharmacy data, diabetic camps, or another alternative data collection system that is not a registry
Neuropathy	Reference	People with diabetes mellitus who have diabetic neuropathy determined by microfilament test
Neuropathy	Alternative	People with diabetes mellitus who have diabetic neuropathy determined by a test that is not a microfilament test
Diabetic foot	Reference	People with diabetes mellitus who have diabetic foot, which is a poorly healing ulcer
Amputations due to diabetes mellitus	Reference	People with diabetes mellitus who have a lower limb amputation
Amputations due to diabetes mellitus	Alternative	People with diabetes mellitus who have a specific part of the lower limb amputated (eg., toes only, feet only, below ankle only)
Low vision due to diabetic retinopathy	Reference	Low vision (presenting visual acuity of <6/18 ≥3/60 in the better eye using the Snellen chart) from damage to the retina caused by damaged blood vessels due to diabetes. Presenting vision is measured using any corrective lenses currently in use.
Low vision due to diabetic retinopathy	Alternative	Low vision (presenting visual acuity of <6/18 ≥3/60 in the better eye using the Snellen chart) from damage to the retina caused by damaged blood vessels due to diabetes, as measured by Rapid Assessment of Avoidable Blindness (RAAB) surveys.
Blindness due to diabetic retinopathy	Reference	Blindness (acuity in the better eye of <3/60 or <10% visual field around central fixation point) from damage to the retina caused by damaged blood vessels that can leak blood into the retina and cause scarring. Presenting vision is measured using any corrective lenses currently in use.
Blindness due to diabetic retinopathy	Alternative	Blindness (acuity in the better eye of <3/60 or <10% visual field around central fixation point) from damage to the retina caused by damaged blood vessels that can leak blood into the retina and cause scarring as measured by Rapid Assessment of Avoidable Blindness (RAAB) surveys.

Burden; DALY

	DALY count in 2021 (thousands)	Percentage change in DALY count, 1990–2021 (%)	Age-standardised DALY rate in 2021 (per 100 000)	Percentage change in age-standardised DALY rate, 1990–2021 (%)
Global	**79 200 (67 800 to 92 500)**	**189·8% (171·1 to 203·4)**	**915·0 (782·6 to 1067·4)**	**38·6% (29·7 to 45·3)**
Central Europe, eastern Europe, and central Asia	**4370 (3670 to 5230)**	**126·9% (119·3 to 132·4)**	**700·0 (588·3 to 840·2)**	**70·8% (65·4 to 75·1)**
Central Asia	800 (675 to 970)	236·0% (211·0 to 257·1)	923·6 (780·8 to 1119·9)	96·6% (82·6 to 108·9)
Armenia	32·3 (27·0 to 39·3)	52·3% (38·8 to 67·0)	771·2 (646·7 to 942·3)	4·5% (−4·7 to 14·9)
Azerbaijan	97·7 (77·0 to 122)	249·3% (196·6 to 319·7)	870·6 (689·0 to 1090·4)	72·0% (45·0 to 108·0)
Georgia	49·4 (40·1 to 60·8)	57·6% (42·9 to 78·0)	903·5 (732·2 to 1121·7)	81·4% (65·6 to 104·6)
Kazakhstan	144 (111 to 180)	142·5% (118·1 to 164·1)	750·2 (581·8 to 932·6)	70·4% (53·5 to 85·2)
Kyrgyzstan	30·3 (23·7 to 38·0)	199·3% (172·3 to 226·4)	560·7 (436·3 to 696·9)	76·5% (61·8 to 91·6)
Mongolia	17·2 (13·6 to 21·1)	337·2% (268·5 to 419·9)	564·3 (448·0 to 688·7)	76·7% (48·4 to 112·3)
Tajikistan	52·6 (43·1 to 64·1)	237·8% (182·8 to 307·7)	801·9 (659·3 to 955·8)	63·2% (36·7 to 96·7)
Turkmenistan	44·3 (35·8 to 53·2)	357·2% (286·9 to 446·2)	929·3 (757·9 to 1110·5)	112·3% (80·2 to 153·5)
Uzbekistan	341 (292 to 411)	479·8% (418·0 to 538·7)	1147·1 (980·2 to 1375·1)	150·9% (124·3 to 175·8)
Central Europe	1550 (1250 to 1890)	73·7% (63·6 to 82·0)	748·1 (598·1 to 913·2)	23·0% (15·3 to 29·4)
Albania	17·8 (13·7 to 23·2)	147·8% (119·1 to 175·6)	417·5 (323·5 to 544·8)	26·9% (12·3 to 40·5)
Bosnia and Herzegovina	75·2 (61·2 to 91·0)	171·1% (134·0 to 204·2)	1253·6 (1022·6 to 1527·9)	88·3% (62·4 to 111·5)


سپاس از توجه شما