Attainment of global diabetes targets in 2021: a pooled analysis of individual-level data from national surveys in 100 low-income, middle-income, and high-income countries

*Global Health and Population Project on Access to Care for Cardiometabolic Diseases Collaborators**

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*A full author list is provided at the end of the article

Correspondence to:
Dr David Flood, Department of Internal Medicine, University of Michigan, Ann Arbor, MI 48109, USA
dcflood@umich.edu

Summary

Background WHO launched the Global Diabetes Compact in 2021 to improve worldwide diabetes outcomes by scaling up access to comprehensive, affordable, and high-quality care. This initiative established population diabetes metrics and targets for countries to attain by 2030, namely, 80% of all people with diabetes are diagnosed; and, among people with diagnosed diabetes, 80% have good glycaemic control (HbA_{1c} <8·0%), 80% have good blood pressure control (<140/90 mm Hg), and 60% of people older than 40 years use statins. We aimed to estimate attainment of global diabetes targets worldwide and across country and individual characteristics in 2021.

Methods We analysed pooled, individual participant data from nationally representative household health surveys done in 100 low-income, middle-income, and high-income countries between 2010 and 2023. The sample included non-pregnant adults aged 30–69 years. Diabetes was defined as use of glucose-lowering medications or biochemical evidence of diabetes (fasting plasma glucose ≥7·0 mmol/L or HbA_{1c} ≥6·5% [48 mmol/mol]). The primary outcomes were the proportion of people attaining each diabetes metric. We analysed data using hierarchical Bayesian logistic regression models with the survey year set to 2021. We estimated the age-standardised proportion attaining each metric across the pooled dataset, by country-level characteristics such as World Bank income group, by country, and by individual-level characteristics including age, sex, educational attainment, and BMI.

Findings In 2021, across the pooled dataset, the age-standardised proportion of people with diabetes who had been diagnosed was 63·2% (95% CI 61·8–64·6). Among those diagnosed, 63·2% (62·1–64·4) achieved glycaemic control (HbA_{1c} <8·0%), 70·8% (69·8–71·9) achieved blood pressure control (<140/90 mm Hg), and 31·8% (30·4–33·2) were using statins. Of the 100 included countries, eight met the target for diabetes diagnosis, seven met the target for glycaemic control, 15 met the target for blood pressure control, and eight met the target for statin use. By country income group, the age-standardised proportion of people with diabetes who had been diagnosed ranged from 35·3% (33·5–37·1) in low-income countries to 69·9% (68·3–71·5) in high-income countries. Among those with diagnosed diabetes, glycaemic control ranged from 56·0% (54·2–57·8) in lower-middle-income countries to 73·7% (72·7–74·6) in high-income countries; blood pressure control ranged from 58·3% (57·3–59·4) in lower-middle-income countries to 82·4% (81·4–83·4) in high-income countries; and statin use ranged from 9·7% (8·0–11·4) in low-income countries to 58·7% (57·4–59·9) in high-income countries. Across individual-level characteristics, patterns of inequities were observed in the attainment of each metric.

Interpretation There are pronounced inequities at multiple levels in the attainment of global diabetes metrics. Substantial progress is needed to reduce inequities and to achieve the 2030 targets.

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Introduction

Diabetes is a defining global health challenge of this era due to its immense impact on patients and their families, health-care systems, and national economies.[1] The Non-Communicable Disease Risk Factor Collaboration (NCD-RisC) estimated that more than 800 million adults worldwide had diabetes in 2022, a four-fold increase since 1990, with the largest increases observed in low-income and middle-income countries.[2] Diabetes directly causes 1·7 million annual deaths, according to the most recent estimates from the Global Burden of Disease Diseases and Injuries Collaborators study (GBD).[3] Despite these epidemiological trends, diabetes complications can be avoided through interventions at multiple points in the disease course. Timely identification of diabetes, initiation of behaviour-change interventions and medications to manage blood glucose and associated cardiovascular disease risk factors, and screening and management of complications within well organised care systems can substantially reduce acute and chronic complications.[4,5] In fact, people with diabetes who achieve comprehensive risk factor control have a

Research in context

Evidence before this study

We searched PubMed and Google Scholar on March 21, 2025, without language or date restrictions, using search terms in four categories: diabetes; diabetes-related metrics (control, treatment, management, care, or burden); geographical scope (cross-country, cross-national, multiple countries, worldwide, or global); and method (cross-sectional, population-representative, meta-analysis, or pooled studies and surveys). Our literature search identified previous global analyses that have estimated diabetes-related outcomes including prevalence, diagnosis, treatment, and burden. We also identified the study launching the WHO Global Diabetes Compact, which proposed population-based metrics with country-level targets to be achieved by 2030 for diabetes diagnosis, glycaemic control, blood pressure control, and statin use. Target levels were set to align with levels in the top 85th to 100th percentile of countries. To date, however, evidence on attainment of the global diabetes metrics has been based on summary estimates from previous published studies.

Added value of this study

To our knowledge, this study provides the most granular, comprehensive, and equity-focused evidence on attainment of the WHO global diabetes metrics. We directly estimated outcomes for the year 2021 using individual participant data from nationally representative health surveys in 100 countries, representing more than 75% of the global population. Several key findings emerge. First, our use of individual-level data illuminates within-country inequities that summary-level data alone cannot capture. Second, by analysing pooled data across countries, we quantify profound between-country inequities by characteristics such as World Bank income group. Third, our findings identify diagnosis and statin use as metrics with the most variation between countries. Finally, our study supports the 2030 targets as ambitious, as we found that between 7% and 15% of countries had attained each target in 2021.

Implications of all the available evidence

Rate of attainment of diabetes targets is low with marked inequities at multiple levels. Our study highlights the scale of missed opportunities and underscores the need to strengthen health systems to deliver equitable care addressing multiple risk factors (glycaemia, blood pressure, and cholesterol) for people with diabetes. These findings serve as a baseline for monitoring progress and a call to action to close global inequities in diabetes care.

similar risk of incident cardiovascular disease and mortality as the general population.[6,7] Yet, there have been missed opportunities to implement evidence-based interventions in many settings worldwide.[2,8,9]

To improve worldwide diabetes outcomes, WHO launched the Global Diabetes Compact in 2021.[10] The WHO Compact aims to scale up access to comprehensive, affordable, and high-quality diabetes care services across global populations. One component of the WHO Compact involves establishing population-based diabetes metrics and targets for member states to attain by 2030.[11] The five core metrics encompass diagnosis, glycaemic control, blood pressure control, and statin use among people with diabetes (type 1 or type 2), as well as access to insulin and supplies among people with type 1 diabetes. These metrics were selected on the basis of their relevance for major health outcomes, ability to be modified through scalable interventions, and availability of population monitoring data. Target levels were set to align with levels in the top 85th to 100th percentile of countries. The 2030 targets are for 80% of people with diabetes to be diagnosed, and, among those already diagnosed, 80% to have good glycaemic control, 80% to have good blood pressure control, and 60% of those aged 40 years and older to use statins.[11]

Evaluating baseline levels of attainment of targets is a crucial step in the global diabetes response. This evidence can be used to motivate a multisectoral diabetes strategy, including mobilisation of additional resources, and helps to identify gaps and inequities in care that inform health policies to meet the 2030 global diabetes targets. Since the launch of the WHO Compact, however, evidence on attainment of the global diabetes targets has been based on summary estimates from previous published studies. There is a need for more granular, equity-focused assessments of attainment within and across countries. Our study aimed to address this gap by estimating attainment of global diabetes targets across 100 countries and heterogeneity in attainment by country-level and individual-level characteristics.

Methods

Study design and data sources

We did a cross-sectional analysis of pooled, individual participant data from nationally representative health surveys done in 100 low-income, middle-income, and high-income countries. Our methodology for identifying, accessing, and pooling national health surveys has been described previously and is summarised in the appendix (p 3).[12,13] We identified all countries that had done a WHO Stepwise Approach to Surveillance (STEPS) survey,[14] as STEPS surveys are the WHO's preferred method to monitor non-communicable diseases in the population.[15] For countries without STEPS surveys, we searched for available surveys from other survey programmes or from the reference lists of other global collaborative research networks. For the remainder of countries without an identified survey, we did systematic internet searches.[12] In instances where multiple surveys were available for a single country, we used the most recent

See Online for appendix

survey available to us. In this analysis, a survey was eligible for inclusion if it was done in 2010 or later, had availability of individual participant data through public data use files or private data-sharing agreements, was nationally representative, included measurements of either fasting plasma glucose (FPG) or HbA_{1c}, and contained questions on self-reported history of diabetes. We considered a survey to be nationally representative if it used a probability-based sampling method designed to reflect the country's general population structure (appendix pp 8–52). We broadly defined a country as any nation or territory with a degree of self-governance over health policies and systems.

This study was judged to be exempt from institutional review board approval by the University of Michigan (HUM00206291) as the research involved survey data that could not be linked to a specific individual.

Sample

The overall study sample comprised non-pregnant individuals aged between 30 and 69 years with an available diabetes biomarker (FPG or HbA_{1c}) and non-missing data on age, sex, BMI, and educational attainment. This age range was chosen to align with the Sustainable Development Goal target 3.4, which focuses on reducing premature deaths from non-communicable diseases including diabetes. Some surveys did not sample certain age groups. The STEPS surveys in 20 countries had an upper age limit for eligibility of 64 years. The non-STEPS surveys in four countries had different age ranges of sample eligibility (China 45–69 years; India 60–69 years; Namibia 35–69 years; and Peru 30–59 years).

Definition of diabetes

We defined diabetes on the basis of the definition in the WHO Global Monitoring Framework as either self-reported use of a glucose-lowering medication, including insulin or an oral hypoglycaemic drug, or biochemical evidence of diabetes based on FPG of ≥7·0 mmol/L or HbA_{1c} ≥6·5%.[16,17] In 19 surveys measuring both FPG and HbA_{1c}, we only used FPG in our definition. This decision was made to enhance cross-country comparability, as use of both biomarkers identifies more people with diabetes than use of FPG alone.[18] Countries that collected HbA_{1c} but not FPG included Brazil, England, Haiti, Indonesia, Portugal, and South Africa. In the survey done in Pakistan, participants could not reliably report glucose-lowering medications, so we followed the survey team's recommendation to define diabetes using FPG alone. To avoid errors found in some WHO STEPS survey reports,[19] we verified that all surveys using point-of-care capillary glucose measurements used portable devices that were internally calibrated to FPG (appendix pp 53–58). The exception was the Eritrea survey in which values were converted to FPG by applying a factor of 1·11.[20]

Outcomes

Primary outcomes were based on four core global diabetes metrics in the WHO Compact.[11] These were the proportion of all people with diabetes who are diagnosed; and, among people with diagnosed diabetes, the proportion who achieve glycaemic control (HbA_{1c} <8·0%), achieve blood pressure control (<140/90 mm Hg), and use statins. In the 19 surveys measuring both FPG and HbA_{1c}, we defined glycaemic control using HbA_{1c} as preferred in guidelines.[21] In surveys without HbA_{1c} measurements, we defined glycaemic control as FPG <9·2 mmol/L, which corresponds to the mean FPG associated with achieving HbA_{1c} of less than 8·0%.[22] Previous diabetes diagnosis and statin use were assessed through participants' self-report. For example, STEPS surveys ask, "Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?" and "Are you currently taking statins regularly to prevent or treat heart disease?" In surveys that did not explicitly ask about statin medications, we classified respondents as using statins if they reported taking a cholesterol-lowering medication. Surveys in nine countries did not collect data on statin or cholesterol-lowering medication use (Barbados, Brazil, Comoros, El Salvador, Fiji, Haiti, Namibia, Pakistan, and South Africa) and were omitted for analyses of the statin outcome. Blood pressure was assessed as the mean of multiple readings, as detailed previously.[8] Of note, the fifth WHO Compact monitoring indicator regarding access to insulin and supplies for people with type 1 diabetes could not be assessed with our available data.

Statistical analysis

We fit hierarchical Bayesian logistic regression models with each outcome modelled as a binary indicator at the individual level in the pooled dataset.[23,24] This approach

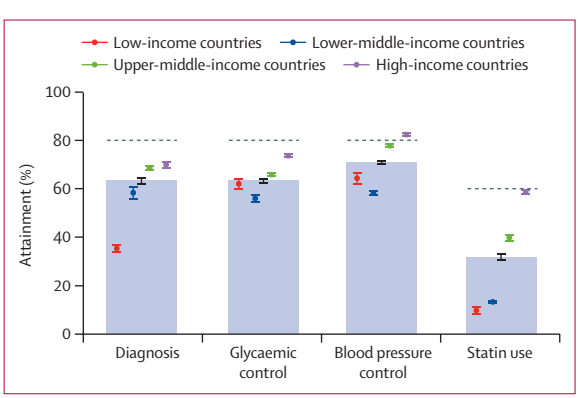
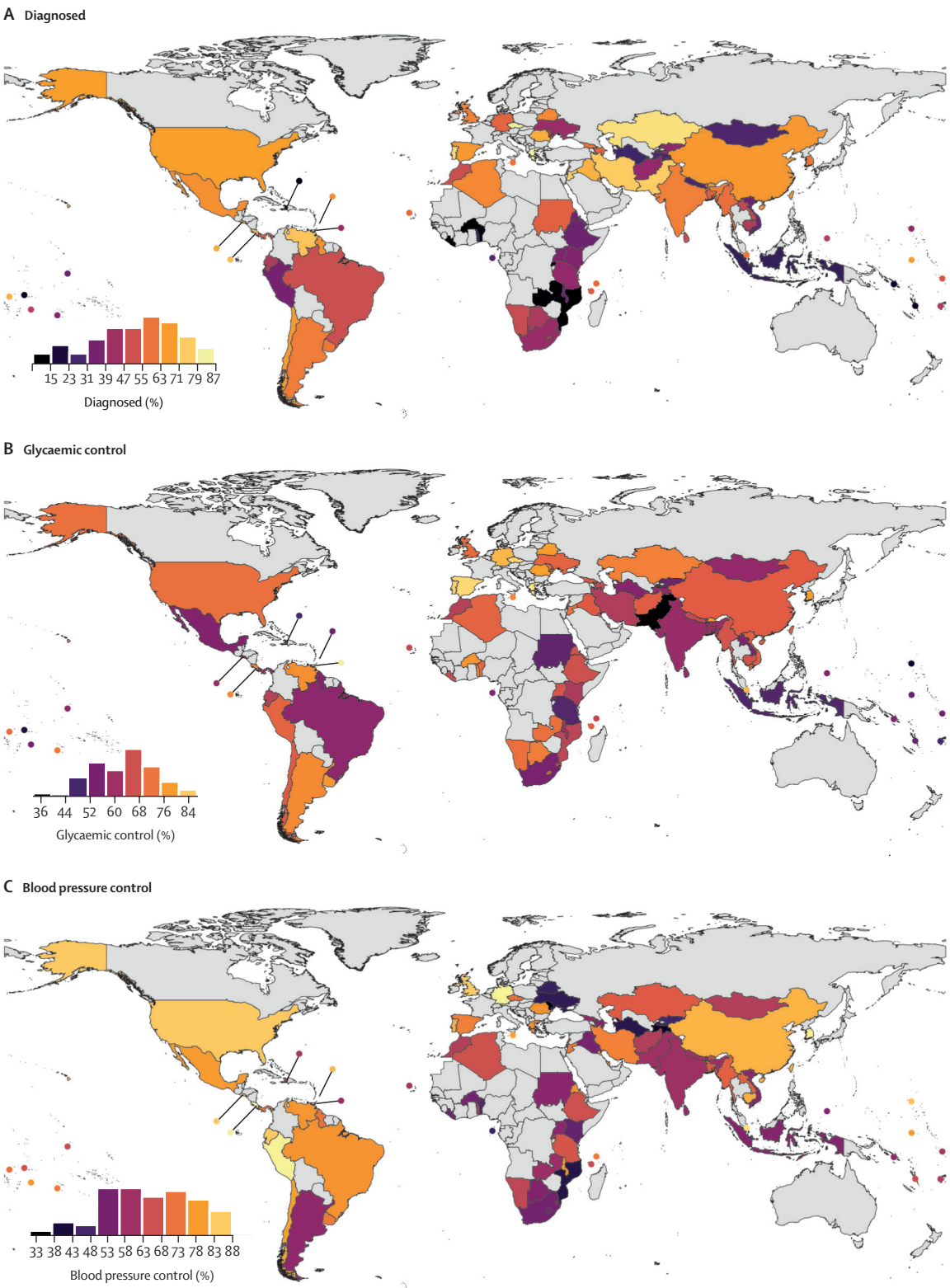


Figure 1: **Attainment of global diabetes metrics in 100 countries**
Figure shows the age-standardised proportion of adults aged 30–69 years who are diagnosed, among all people with diabetes; and, among people with diagnosed diabetes, the proportion who achieve glycaemic control (HbA_{1c} <8·0%), achieve blood pressure control (<140/90 mm Hg), and use statins if aged 40–69 years. Bars indicate the worldwide proportion attaining each metric. Error bars represent 95% CIs. The dashed horizontal lines denote the 2030 targets in the WHO Global Diabetes Compact. Estimates are standardised to the WHO standard population.



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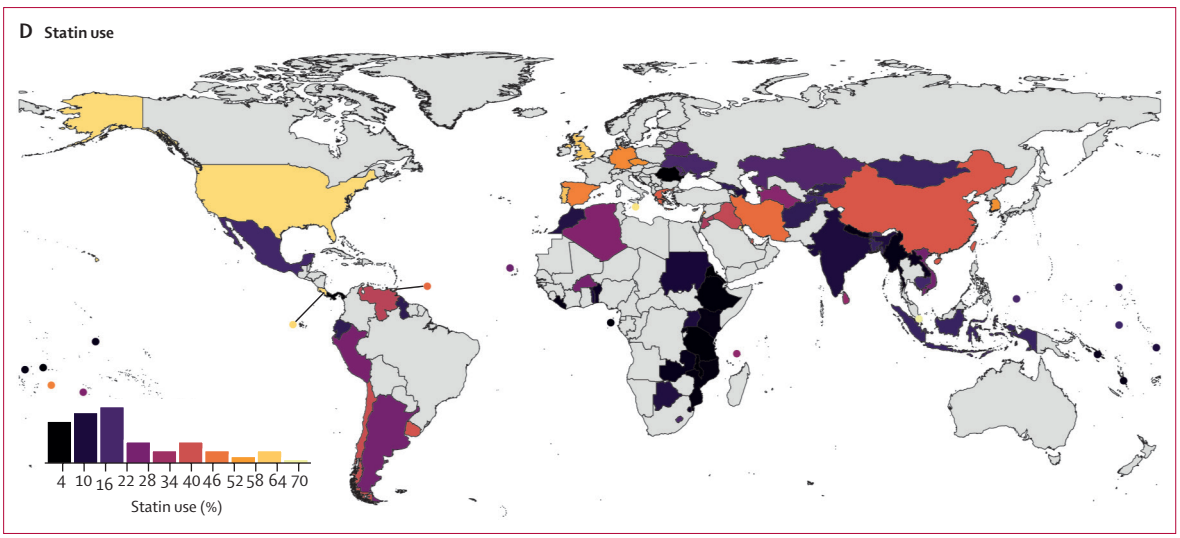


Figure 2: **Map of the proportion of individuals in each country attaining global diabetes metrics**
Age-standardised proportion of adults aged 30–69 years who are diagnosed, among all people with diabetes (A); and, among people with diagnosed diabetes, the proportion who achieve glycaemic control (HbA_{1c} <8·0%; B), achieve blood pressure control (<140/90 mm Hg; C), and use statins if aged 40–69 years (D). The countries shaded in grey did not have available data.

leveraged our individual participant data to allow partial pooling, or borrowing of information across similar countries and regions.[25] Random intercepts were incorporated to account for the hierarchical clustering of individuals within countries and countries within regions, as defined by NCD-RisC.[2] Individual-level predictors with fixed effects included age, sex (male or female), educational attainment (no schooling, primary education, or secondary or higher education), and BMI. Age and BMI were included as continuous variables using natural cubic splines with five knots.[26] World Bank income group was included with both a fixed effect and a random slope varying across countries. Survey year was included as a fixed effect with both linear and quadratic terms to capture potential non-linear trends over time. We obtained 2000 posterior samples of parameter estimates based on the fitted Bayesian logistic regression models using the brms package in R.[27] Further details on model specification are provided in the appendix (pp 59–64). We did a complete-case analysis because the proportion of missing data was small (1–3%) across key variables (appendix pp 65–67).

To compute proportions for each outcome, we used model coefficient estimates and their associated variances to generate 2000 predicted probabilities per individual. The survey year was set to 2021, when the WHO Compact launched, to establish a baseline for progress monitoring. We compiled individuals' predicted probabilities along with covariates and sampling design variables into a single dataset per outcome. We accounted for the complex survey design and sampling weights by creating unique cluster and stratum identifiers for each survey. This approach ensured accurate sampling variance estimation across the pooled dataset. We rescaled sampling weights to reflect each country's total 2021 population aged 30–69 years and the age distribution of the WHO standard population.[28,29] In a separate analysis, we computed crude estimates by omitting the age-standardisation procedure. Predicted probabilities from each posterior sample draw were then summarised into survey-weighted means overall and by individual-level and country-level predictors. Variances were computed by combining within-draw variance (reflecting survey design) and between-draw variance (reflecting Bayesian model estimation uncertainty). We estimated relative differences (computed as prevalence ratios) and absolute differences within individual-level predictors of age, sex, BMI, and educational attainment.

Results were visualised by use of bar charts, choropleth maps, and forest plots. We also plotted outcomes against each country's Socio-demographic Index (SDI) value for the year 2021 from the GBD study. The SDI is a composite indicator of a country's social and economic development. We overlaid a best-fit curve in each plot using a quadratic model, which allowed us to quantify the proportion of statistical variation explained by a country's SDI. Data cleaning, harmonisation, and outcome definitions were done with Stata version 18. Bayesian modelling and post-estimation analyses were done with R version 4.3.1.

We did multiple sensitivity analyses. First, we expanded the definition of glycaemic control, blood pressure control, and statin outcomes to include all people with diabetes (ie, both diagnosed or undiagnosed). This all-diabetes denominator aligns with the WHO monitoring guideline definition[15] and provides a complementary perspective on metric attainment at the population level not conditioned on health-care access.

Second, we applied a stricter threshold for glycaemic control, defined as HbA_{1c} <7·0% (equivalent to FPG <8·0 mmol/L).[22] Third, glycaemic control in most surveys was assessed by use of FPG thresholds with corresponding HbA_{1c} levels inferred from the literature.[22] To further interrogate our use of FPG thresholds, we used data from 21 surveys containing both HbA_{1c} and FPG measurements to generate a multivariable linear regression equation predicting HbA_{1c} from FPG. We based our modelling approach on a previous NCD RisC publication, specifying as covariates sex, age, BMI, region, and an interaction between region and FPG.[18] We then predicted HbA_{1c} from FPG in countries without HbA_{1c} data.

Results

The final pooled dataset included individual participant data from national health surveys done between 2010 and 2023 in 100 countries. Of these, 16 surveys were done in low-income countries, 33 in lower-middle-income countries, 29 in upper-middle-income countries, and 22 in high-income countries. A total of 71 surveys were done as part of the WHO STEPS survey programme. The median response rate was 85·0% (IQR 64·0–93·5)

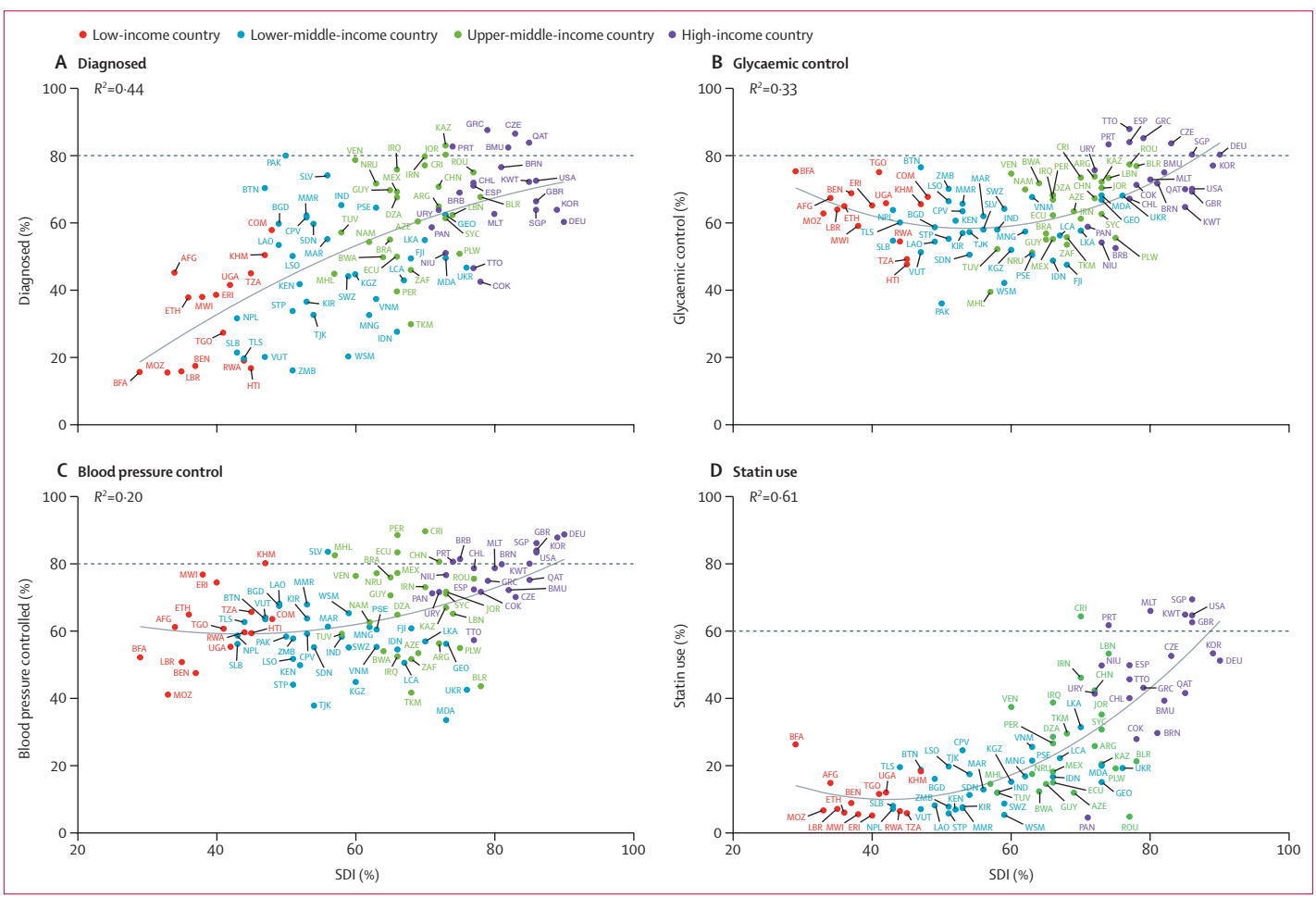


Figure 3: **Proportion of individuals in each country attaining global diabetes metrics by country Socio-demographic Index**

The panels show the age-standardised proportion of adults aged 30–69 years who are diagnosed, among all people with diabetes (A); and, among people with diagnosed diabetes, the proportion who achieve glycaemic control (HbA_{1c} <8·0%; B), achieve blood pressure control (<140/90 mm Hg; C), and use statins if aged 40–69 years (D). Each country's attainment is plotted versus its Socio-demographic Index. A best-fit curve was overlaid by use of a quadratic model in each panel: panel A intercept −27·5, SDI coefficient 1·82, and SDI² coefficient −0·008; panel B intercept 114·9, SDI coefficient −2·10, and SDI² coefficient 0·019; panel C intercept 78·6, SDI coefficient −0·90, and SDI² coefficient 0·010; panel D intercept 51·7, SDI coefficient −1·97, and SDI² coefficient 0·023. Aruba and Wallis and Futuna were excluded as these countries did not have an SDI value. Zanzibar is omitted in this figure as no SDI value was available. SDI=sociodemographic index. AFG=Afghanistan. DZA=Algeria. ARG=Argentina. AZE=Azerbaijan. BGD=Bangladesh. BRB=Barbados. BLR=Belarus. BEN=Benin. BMU=Bermuda. BTN=Bhutan. BWA=Botswana. BRA=Brazil. BRN=Brunei. BFA=Burkina Faso. CPV=Cabo Verde. KHM=Cambodia. CHL=Chile. CHN=China. COM=Comoros. COK=Cook Islands. CRI=Costa Rica. CZE=Czech Republic. ECU=Ecuador. SLV=El Salvador. GBR=England. ERI=Eritrea. SWZ=Eswatini. ETH=Ethiopia. FJI=Fiji. GEO=Georgia. DEU=Germany. GRC=Greece. GUY=Guyana. HTI=Haiti. IND=India. IDN=Indonesia. IRN=Iran. IRQ=Iraq. JOR=Jordan. KAZ=Kazakhstan. KEN=Kenya. KIR=Kiribati. KWT=Kuwait. KGZ=Kyrgyzstan. LAO=Laos. LBN=Lebanon. LSO=Lesotho. LBR=Liberia. MWI=Malawi. MLT=Malta. MHL=Marshall Islands. MEX=Mexico. MDA=Moldova. MNG=Mongolia. MAR=Morocco. MOZ=Mozambique. MMR=Myanmar. NAM=Namibia. NRU=Nauru. NPL=Nepal. NIU=Niue. PAK=Pakistan. PLW=Palau. PSE=Palestine. PAN=Panama. PER=Peru. PRT=Portugal. QAT=Qatar. ROU=Romania. RWA=Rwanda. LCA=Saint Lucia. WSM=Samoa. STP=Sao Tome and Principe. SYC=Seychelles. SGP=Singapore. SLB=Solomon Islands. ZAF=South Africa. KOR=South Korea. ESP=Spain. LKA=Sri Lanka. SDN=Sudan. TJK=Tajikistan. TZA=Tanzania. TLS=Timor-Leste. TGO=Togo. TTO=Trinidad and Tobago. TKM=Turkmenistan. TUV=Tuvalu. UGA=Uganda. UKR=Ukraine. USA=United States of America. URY=Uruguay. VUT=Vanuatu. VEN=Venezuela. VNM=Vietnam. ZMB=Zambia. Some labels are omitted owing to space constraints.

in the 97 surveys reporting a response rate. The pooled sample included 289 801 individuals, of whom 33 513 had diabetes (appendix pp 68–74). Women comprised 58·8% (unweighted) of individuals in the pooled sample. The median crude diabetes prevalence in surveys across the 100 countries was 10·3% (IQR 6·9–23·5).

In 2021, across the pooled dataset, the age-standardised proportion of people with diabetes who had been diagnosed was 63·2% (95% CI 61·8–64·6). Among those diagnosed, 63·2% (62·1–64·4) achieved glycaemic control (HbA_{1c} <8·0%), 70·8% (69·8–71·9) achieved blood pressure control (<140/90 mm Hg), and 31·8% (30·4–33·2) were using statins (figure 1). By income group, the age-standardised proportion of people with diabetes who had been diagnosed ranged from 35·3% (33·5–37·1) in low-income countries to 69·9% (68·3–71·5) in high-income countries. Glycaemic control among people with diagnosed diabetes ranged from 56·0% (CI 54·2–57·8) in lower-middle-income countries to 73·7% (72·7–74·6) in high-income countries. Blood pressure control among people with diagnosed diabetes ranged from 58·3% (57·3–59·4) in lower-middle-income countries to 82·4% (81·4–83·4) in high-income countries. Statin use among people with diagnosed diabetes ranged from 9·7% (8·0–11·4) in low-income countries to 58·7% (57·4–59·9) in high-income countries.

There were marked differences in age-standardised metric attainment across countries, as shown in figure 2. Of the 100 included countries in this analysis, eight achieved the target for diabetes diagnosis, seven achieved the target for glycaemic control, 15 achieved the target for blood pressure control, and eight achieved the target for statin use (figure 3). When each country's attainment was plotted versus its SDI, the R^2 values were highest for diabetes diagnosis (R^2=0·44) and statin use (R^2=0·61). In comparison, glycaemic control (R^2=0·33) and blood pressure control (R^2=0·20) had lower R^2 values, reflecting less statistical variation explained by country SDI.

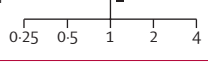
Figure 4 shows the prevalence ratios and absolute differences in metric attainment by individual characteristics. By age group, older individuals were more likely to have a diagnosis, similar glycaemic control and statin use, and lower blood pressure control. Compared with the 30–39-year age group, people in the 60–69-year age group had a 25·2 percentage point (95% CI 22·8–27·7) greater absolute attainment in diagnosis. Compared with the 30–39-year age group, people in the 60–69-year age group had a –18·4 percentage point (–20·3 to –16·4) lower absolute attainment in blood pressure control. By sex, women had higher rates than men across all metrics: diabetes diagnosis (64·2% *vs* 62·6%; absolute difference 1·5 percentage points [95% CI 0·2–2·8]), glycaemic control (64·2% *vs* 62·6%; absolute difference 1·6 percentage points [0·4–2·8]), blood pressure control (75·3% *vs* 67·8%; absolute difference 7·5 percentage points [6·0–9·1]), and statin use (38·9% *vs* 27·3%; absolute difference 11·6 percentage points [9·6–13·5]). By educational attainment, individuals with secondary or higher education had significantly higher rates across all metrics compared with those with no schooling. Compared with people with no formal schooling, those with secondary or higher education had a 6·2 percentage point (4·4–8·0) greater absolute attainment in diagnosis, a 9·5 percentage point (6·4–12·6) greater absolute attainment in glycaemic control, a 4·5 percentage point (2·1–6·8) greater absolute attainment in blood pressure control, and an 8·2 percentage point (4·7–11·8) greater absolute attainment in statin use.

A Diagnosed

	Prevalence ratio (95% CR)	% Attainment	Difference from reference (95% CR)
Age, years			
30 to 39	1 (ref)	44·0%	Ref
40 to 49	1·37 (1·31 to 1·43)	60·2%	16·2 (14·4 to 18·1)
50 to 59	1·57 (1·50 to 1·65)	69·1%	25·1 (23·2 to 27·1)
60 to 69	1·58 (1·49 to 1·67)	69·2%	25·2 (22·8 to 27·7)
Sex			
Male	1 (ref)	62·6%	Ref
Female	1·02 (1·00 to 1·04)	64·2%	1·5 (0·2 to 2·8)
BMI			
<18·5	0·79 (0·74 to 0·84)	48·7%	–12·7 (–15·7 to –9·6)
18·5 to <25	1 (ref)	61·4%	Ref
25 to <30	1·07 (1·05 to 1·09)	65·5%	4·2 (3·0 to 5·3)
≥30	1·05 (1·03 to 1·08)	64·7%	3·4 (1·8 to 4·9)
Education			
No schooling	1 (ref)	58·7%	Ref
Primary education	1·07 (1·04 to 1·10)	62·7%	4·0 (2·2 to 5·9)
Secondary or higher	1·11 (1·07 to 1·14)	64·9%	6·2 (4·4 to 8·0)

B Glycaemic control

	Prevalence ratio (95% CR)	% Attainment	Difference from reference (95% CR)
Age, years			
30 to 39	1 (ref)	61·1%	Ref
40 to 49	1·01 (0·97 to 1·05)	61·6%	0·5 (–1·8 to 2·8)
50 to 59	1·06 (1·01 to 1·11)	65·0%	3·9 (1·1 to 6·8)
60 to 69	1·04 (0·98 to 1·09)	63·4%	2·3 (–0·8 to 5·4)
Sex			
Male	1 (ref)	62·6%	Ref
Female	1·03 (1·01 to 1·04)	64·2%	1·6 (0·4 to 2·8)
BMI			
<18·5	0·88 (0·85 to 0·91)	53·9%	–7·3 (–9·4 to –5·2)
18·5 to <25	1 (ref)	61·2%	Ref
25 to <30	1·04 (1·03 to 1·06)	63·8%	2·6 (1·6 to 3·6)
≥30	1·09 (1·06 to 1·11)	66·4%	5·2 (31·8 to 6·6)
Education			
No schooling	1 (ref)	56·5%	Ref
Primary education	1·09 (1·03 to 1·14)	61·3%	4·8 (1·9 to 7·8)
Secondary or higher	1·17 (1·10 to 1·23)	66·0%	9·5 (6·4 to 12·6)



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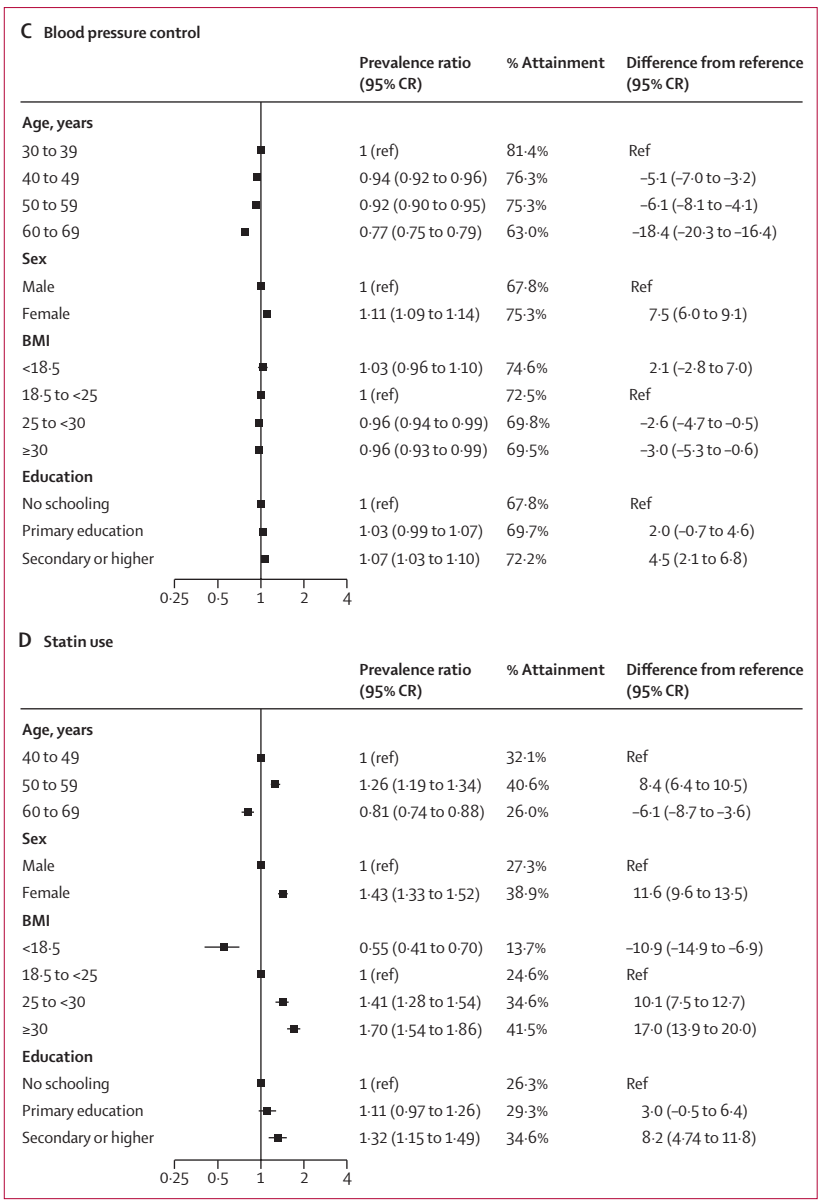

Figure 4: **Relative and absolute differences in the proportion attaining global metrics in 2021 by individual characteristics**

The panels show the age-standardised absolute and relative differences across individual characteristics of adults worldwide aged 30–69 years attaining global diabetes metrics. The panels show the proportion diagnosed, among all people with diabetes (A); and, among people with diagnosed diabetes, the proportion who achieve glycaemic control (HbA_{1c} <8·0%; B), achieve blood pressure control (<140/90 mm Hg; C), and use statins if aged 40–69 years (D). CR=credible range (the Bayesian equivalent of a 95% CI).

When the definition of glycaemic control, blood pressure control, and statin outcomes was expanded to include all people with diabetes in the denominator (both diagnosed and undiagnosed), worldwide results showed higher attainment for glycaemic control (68·9% [95% CI 68·2–69·6] *vs* 63·2% [62·1–64·4] among those diagnosed), similar attainment for blood pressure control (68·7% [67·8–69·5] *vs* 70·8% [69·8–71·9] among those diagnosed), and lower use of statins (22·1% [21·1–23·1] *vs* 31·8% [30·4–33·2] among those diagnosed). At the country level, when using the all-diabetes denominator rather than only diagnosed diabetes, the mean difference in attainment was 6·9% higher for glycaemic control, 2·4% higher for blood pressure control, and 7·4% lower for statin use (appendix p 80). In the second sensitivity analysis, which used a stricter glycaemic threshold of HbA_{1c} <7·0%, worldwide results showed much lower attainment (37·8% [36·8–38·8] *vs* 63·2% [62·1–64·4] among those diagnosed). In the third sensitivity analysis, which used regression equations to predict HbA_{1c} from FPG in countries without HbA_{1c} data, worldwide results showed similar attainment for glycaemic control (65·6% [64·8–66·4] *vs* 63·2% [62·1–64·4] among those diagnosed).

Discussion

Using nationally representative, individual participant data from 100 low-income, middle-income, and high-income countries, we found that, in 2021, approximately 60% of people living with diabetes had received a diagnosis, and, among those who were diagnosed, 60% attained blood glucose control, 70% attained blood pressure control, and only 30% had been taking a statin medication. Few countries met the 2030 global diabetes targets. Countries' social and economic development—as measured by SDI—was generally associated with greater attainment. At the individual level, education, a proxy for individuals' socioeconomic status, was strongly associated with higher attainment across metrics. These findings show that substantial progress is needed to reduce inequities at multiple levels to achieve the 2030 global diabetes targets.

The 2023 *Lancet* Health Policy article by Edward W Gregg and colleagues, outlined the scientific rationale for the diabetes metrics and 2030 targets.[11] Using summary data, the authors reported that the median attainment across countries was 61% for diagnosis and, among those diagnosed, median attainment was 68% for glycaemic control, 56% for blood pressure control, and 12% for statin use. Our study builds on this previous work by providing the most granular, comprehensive, and equity-focused evidence to evaluate attainment of global diabetes targets. Several key findings emerged. First, our use of individual-level data illuminates within-country disparities that summary-level data alone cannot capture. For example, compared with those with no schooling, people with diabetes who had secondary or higher education had higher attainment across all of the outcomes. Second, by analysing pooled data across countries, we quantify profound between-country inequities. For example, we observed that people with diabetes in high-income countries compared with low-income countries have a 35 percentage point greater chance of being diagnosed. Third, our findings identify diagnosis and statin use as metrics with the most

variation explained by a country's SDI. Fourth, our study supports the 2030 targets as ambitious, as we found that across the metrics between 7% and 15% of countries had attained them. Fifth, we find that use of the all-diabetes group as the denominator—rather than those diagnosed with diabetes only—will tend to show higher levels of glycaemic control, similar blood pressure control, and lower levels of statin use. Our findings suggest the definitions are complementary: the diagnosed-only denominator represents the health system's ability to manage diabetes once it has been diagnosed, and the all-diabetes denominator represents attainment among the entire population with diabetes not conditional on health-care access.

Our study examining global diabetes target attainment provides complementary evidence to the findings from other global data analyses. The GBD study quantified that nearly 80 million disability-adjusted life-years (DALYs) were lost to diabetes worldwide in 2021.[3] This number understates diabetes' full impact, as the GBD methodology captures complications such as ischaemic heart disease and chronic kidney disease separately through its risk factor framework. In 2023, the GBD study also estimated that 55·8% of people aged 15 years or older with diabetes had been diagnosed, and, among these, 91·4% were being treated.[30] Similarly, the International Diabetes Federation's Diabetes Atlas used summary-level data to estimate global diabetes prevalence and diagnosis rates. Their modelling suggested that 57·2% of adults with diabetes aged 20–79 years worldwide had been diagnosed in 2024,[1] compared with our finding of 63·2% (95% CI 61·8–64·6) among adults with diabetes aged 30–69 years in the 100 included countries in 2021.[31] The NCD-RisC reported age-standardised worldwide diabetes prevalence in 2021 of 13·9% (12·3–15·7) among men and 13·4% (12·1–15·0) among women.[2] Another paper from NCD-RisC in 2021 reported blood pressure control rates of 23% among women and 18% for men, among all people with hypertension globally;[32] however, these estimates cannot be directly compared with our primary analysis, which only assessed blood pressure control among people with diagnosed diabetes. Similar to our group's previous findings,[8] NCD RisC work also has shown very large country-level inequities in diabetes treatment coverage that were largely driven by under-diagnosis. A limitation of the NCD RisC[2] and GBD diabetes analyses,[30] as well as similar previous work from our group,[33] was that treatment was defined narrowly on the basis of glycaemic management with glucose-lowering medications and did not include treatment of blood pressure or cholesterol. At the population level, control of these cardiovascular disease risk factors is at least as important as glycaemic control in reducing DALYs attributable to diabetes.[9,34]

What is to be done to improve diabetes outcomes globally? Our study provides data to inform health policy and stimulate investments to advance implementation of equitable diabetes care. This aligns with the premise of the WHO Compact and initiatives such as the *Lancet* Commission on Diabetes.[35] However, global diabetes is a so-called wicked problem, one embedded within complex health systems and social determinants of health, for which purely data-driven technical solutions will be insufficient.[36] Within this prism, our results nonetheless have policy implications. One clear imperative is the need to strengthen health systems' diagnostic capabilities. Previous research has shown that diagnosis represents the step with the greatest voltage drop in the diabetes care cascade.[33,37] A substantial challenge in diabetes care, even compared with other non-communicable diseases such as hypertension, is the requirement for regular laboratory testing—not only of blood glucose but also of HbA_{1c}, cholesterol, creatinine, and urine albumin. Point-of-care technologies exist for all these tests, and scaling up their implementation at primary health facilities is a pathway to democratise access to laboratory services for people with diabetes.[37] Another imperative emerging from our study is scaling up statin use among people with diabetes. The underlying drivers for persistently low statin use in many countries over the last two decades remain unclear but probably include a combination of system-level, provider-level, and patient-level factors:[38,39] high medication costs, incomplete inclusion on essential medicine lists, concerns about intolerance, variability of guideline adherence, and the belief that cholesterol measurements are required to initiate and monitor statin therapy. Indeed, modelling studies suggest that most of the health gains from scaling up diabetes care in low-income and middle-income countries would derive from improved management with blood pressure and statin therapies.[9]

At the population level, policies to increase physical activity, improve diets, and reduce sodium consumption are needed to improve glycaemia and blood pressure. At the individual level, it is crucial to ensure access to essential medications, including glucose-lowering, antihypertensive, and statin drugs. A conspicuous yet unaddressed challenge is equitable access to novel diabetes medications such as GLP-1 receptor agonists and SGLT2 inhibitors. These drugs have transformed the clinical management of type 2 diabetes from a glucocentric model that prioritises glycaemic control toward a cardiorenal protective model that uses medications that reduce cardiovascular and kidney complications and their associated mortality.[40] Yet these medications might potentially exacerbate global diabetes inequities if access remains limited to wealthy populations in high-income countries. Finally, although we lacked data to report on insulin access, it remains unacceptable that tens of thousands of people with type 1 diabetes die each year due to insulin inaccessibility. Insulin, discovered over a century ago, remains our closest approximation to a magic bullet in the diabetes

treatment armamentarium. Yet seemingly intractable problems, including high costs, continue to impede insulin access globally.

Our study has limitations. First, included surveys varied in the biomarkers used to define diabetes status and glycaemic control. Differences between FPG and HbA_{1c} measurements might produce varying estimates of glycaemic parameters across some populations.[41] However, the literature does not consistently indicate a major directional bias that would undermine our overall findings. Second, we used the WHO Compact's definition of glycaemic control of HbA_{1c} (<8·0%). Although this threshold is reasonable at the population level, we recognise that glycaemic targets will vary by local setting and individuals' clinical characteristics. Third, the use of FPG to define glycaemic control in many surveys differed from some diabetes guidelines. We adopted this approach, also used in the WHO Compact target-setting exercise, because HbA_{1c} measurements are infrequently available in national health surveys, particularly in low- and middle-income countries, and the WHO Package of Essential NCD interventions recommends use of FPG to monitor glycaemic control when HbA_{1c} is unavailable.[21] Fourth, we defined diabetes status on the basis of a single biomarker measurement rather than repeat testing or additional clinical history, as recommended in clinical guidelines.[16] Our definition might result in some false- positive diabetes classifications, potentially leading to a slight overestimate in diabetes prevalence and underestimate of the diagnosed proportion. We justify our use of a single measurement as it aligns with WHO recommendations for population monitoring of diabetes[11,15] and is consistent with established epidemiological practices.[1,2,16,31] Fifth, some surveys had different age ranges of sample eligibility, including in China (45–69 years) and India (60–69 years). We standardised sampling weights to the WHO standard population, but our model could not fully account for the true age distributions in these countries. For example, the finding that statin use was lower among adults with diagnosed diabetes aged 60–69 years might reflect the disproportionate influence of the India survey in our model. Similarly, as age was associated with a higher probability of diagnosis, our pooled results weighted by each country's population might have led us to overestimate the overall proportion of people with diabetes who are diagnosed. Sixth, surveys were done in different years between 2010 and 2023. To address potential temporal trends, we adjusted for survey year and set estimates for the year 2021 when the WHO Compact was released. Seventh, we were unable to distinguish between type 1 and type 2 diabetes as the underlying surveys do not collect the necessary data for this determination. However, the majority of adults aged 30–69 years with diabetes have type 2 diabetes.[1] Eighth, we did not provide estimates for all countries worldwide because surveys were not available in all countries. Although GBD and NCD-RisC generate estimates for countries without data through hierarchical meta-regression of summary-level data, our approach required individual-level data from each country. We view our approach as a strength, as our findings are based directly on available empirical data. Moreover, the methodological basis of extrapolating health system performance to countries without data remains less clear than for risk factor estimation, given the unique sociopolitical determinants of each country's health system. Our study also is broadly generalisable as included surveys were done in 100 countries representing more than 75% of the global population aged 30–69 years in 2021. Ninth, we relied on self-reported measures for diabetes diagnosis and statin use. Statin use was inferred from cholesterol-lowering medication reports in surveys lacking questions specifically on statin use, which might have overestimated the already low statin use found in our study. Finally, our cross-sectional data cannot capture longitudinal patterns of health care follow-up among people with diabetes.

In conclusion, there are pronounced inequities at multiple levels in the attainment of global diabetes targets. Strengthening health systems' diagnostic capabilities and increasing statin uptake represent key policy priorities needed to meet the 2030 global targets, improve health equity, and address the rising burden of diabetes worldwide.

Global Health and Population Project on Access to Care for Cardiometabolic Diseases Collaborators

Grace S Chung, Yajuan Si, Krishna Aryal, Silver Bahendeka, José R Banegas, Till Bärnighausen, Marta Barreto, Abdul Basit, Omar Yaxmehen Bello-Chavolla, Pascal Bovet, Luisa CC Brant, Rodrigo M Carrillo-Larco, Babangida S Chori, Renata Cífková, Sarah Cuschieri, Albertino Damasceno, Maria Dorobantu, Farshad Farzadfar, Pascal Geldsetzer, Mongal Singh Gurung, David Guwatudde, Ian R Hambleton, Christin Heidemann, Dismand Houinato, Alpamys Issanov, Jutta Jørgensen, Khem Karki, Demetre Labadarios, Jinkook Lee, Zeyu Lou, Nuno Lunet, Konstantinos Makrilakis, Deborah C Malta, João S Martins, Kibachio Joseph Mwangi, Augustine N Odili, Binur Orazumbekova, Gastón Perman, Sarah Quesnel-Crooks, Hedley Knewjen Quitana, Timothy Raxworthy, Fernando Rodríguez-Artalejo, Sahar Saeedi Moghaddam, Antonio Sarria-Santamera, Ronel Sewpal, Abla Sibai, Xueling Sim, Mafalda Sousa-Uva, Lela Sturua, Mubarak A Sulola, Giota Touloumi, Jithin Sam Varghese, Kavita Venkataraman, Yuan S Zhang, Mingqian Zheng, Rifat Atun, Sebastian Vollmer, Maja E Marcus, Michaela Theilmann, Mohammed K Ali, Edward W Gregg, Justine Davies, Jennifer Manne-Goehler, and David Flood.

Contributors

JM-G and DF conceived the idea for this study. Many authors led the primary data collection in their respective countries. MEM, MT, JM-G, and DF led the data collation. YS designed the statistical analysis, and GSC and DF implemented the statistical coding under the supervision of YS. GSC and DF wrote the first draft of the manuscript and had full access to the data. All authors provided critical feedback on the manuscript. DF had the final responsibility to submit for publication.

Declaration of interests

JM-G reports carrying out COVID-19 clinical trials for Regeneron Pharmaceuticals and consultant fees from WHO. DF reports consultant fees from WHO. All other authors declare no competing interests.

Data sharing

Data included in this study are publicly available for 81 of the 100 included country surveys. For details on data access, please see the

appendix (pp 5–7). Replication code is available at the Harvard Dataverse (https://doi.org/10.7910/DVN/KP5Q9H).

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