Rural-Urban Differences in Diabetes Care and Control in 42 Low- and Middle-Income Countries: A Cross-sectional Study of Nationally Representative Individual-Level Data

https://doi.org/10.2337/dc21-2342

David Flood,[1–3] Pascal Geldsetzer,[4,5] Kokou Agoudavi,[6] Krishna K. Aryal,[7] Luisa Campos Caldeira Brant,[8,9] Garry Brian,[10] Maria Dorobantu,[11] Farshad Farzadfar,[12] Oana Gheorghe-Fronea,[11,13] Mongal Singh Gurung,[14] David Guwatudde,[15] Corine Houehanou,[16] Jutta M. Adelin Jorgensen,[17] Dimple Kondal,[18,19] Demetre Labadarios,[20] Maja E. Marcus,[21] Mary Mayige,[22] Mana Moghimi,[12] Bolormaa Norov,[23] Gastón Perman,[24] Sarah Quesnel-Crooks,[25] Mohammad-Mahdi Rashidi,[12] Sahar Saeedi Moghaddam,[26] Jacqueline A. Seiglie,[27] Silver K. Bahendeka Karaireho,[28] Eric Steinbrook,[29] Michaela Theilmann,[30] Lisa J. Ware,[31,32] Sebastian Vollmer,[21] Rifat Atun,[33,34] Justine I. Davies,[35–37] Mohammed K. Ali,[38,39] Peter Rohloff,[2,40] and Jennifer Manne-Goehler[41,42]

[1]Division of Hospital Medicine, Department of Medicine, University of Michigan, Ann Arbor, MI
[2]Center for Indigenous Health Research, Wuqu' Kawoq, Tecpán, Guatemala
[3]Research Center for the Prevention of Chronic Diseases, Institute of Nutrition of Central America and Panama, Guatemala City, Guatemala
[4]Division of Primary Care and Population Health, Stanford University, Stanford, CA
[5]Chan Zuckerberg Biohub, San Francisco, CA
[6]Togo Ministry of Health, Lome, Togo
[7]Public Health Promotion and Development Organization, Kathmandu, Nepal
[8]Serviço de Cardiologia e Cirurgia Cardiovascular, Hospital das Clínicas da Universidade Federal de Minas Gerais, Belo Horizonte, Brazil
[9]Departamento de Clínica Médica, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil
[10]The Fred Hollows Foundation New Zealand, Auckland, New Zealand
[11]University of Medicine and Pharmacy Carol Davila, Bucharest, Romania
[12]Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran
[13]Cardiology Department, Emergency Hospital Bucharest, Bucharest, Romania
[14]Health Research and Epidemiology Unit, Ministry of Health, Thimphu, Bhutan
[15]Department of Epidemiology and Biostatistics, School of Public Health, Makerere University, Kampala, Uganda

OBJECTIVE

Diabetes prevalence is increasing rapidly in rural areas of low- and middle-income countries (LMICs), but there are limited data on the performance of health systems in delivering equitable and effective care to rural populations. We therefore assessed rural-urban differences in diabetes care and control in LMICs.

RESEARCH DESIGN AND METHODS

We pooled individual-level data from nationally representative health surveys in 42 countries. We used Poisson regression models to estimate age-adjusted differences in the proportion of individuals with diabetes in rural versus urban areas achieving performance measures for the diagnosis, treatment, and control of diabetes and associated cardiovascular risk factors. We examined differences across the pooled sample, by sex, and by country.

RESULTS

The pooled sample from 42 countries included 840,110 individuals (35,404 with diabetes). Compared with urban populations with diabetes, rural populations had ∼15–30% lower relative risk of achieving performance measures for diabetes diagnosis and treatment. Rural populations with diagnosed diabetes had a 14% (95% CI 5–22%) lower relative risk of glycemic control, 6% (95% CI −5 to 16%) lower relative risk of blood pressure control, and 23% (95% CI 2–39%) lower relative risk of cholesterol control. Rural women with diabetes had lower achievement of performance measures relating to control than urban women, whereas among men, differences were small.

CONCLUSIONS

Rural populations with diabetes experience substantial inequities in the achievement of diabetes performance measures in LMICs. Programs and policies aiming to strengthen global diabetes care must consider the unique challenges experienced by rural populations.

Approximately 80% of the 537 million people with diabetes worldwide live in low- and middle-income countries (LMICs) (1). The rising global prevalence of diabetes is commonly associated with changing dietary, work, and physical activity patterns as countries become more urbanized (2,3). However, individuals living in rural areas have not been spared from this growing diabetes risk. One of every three individuals with diabetes worldwide lives in a rural area (152.6 million total rural individuals with diabetes) (1). Although diabetes prevalence is increasing in rural areas of both LMICs and high-income countries, relative growth has been faster in rural areas of LMICs than in rural areas of high-income countries (4).

In response to the rising rural diabetes burden, health systems in LMICs are increasingly tasked with scaling up primary health care services for diabetes in rural areas. Globally, rural populations are often underserved by health systems as a result of challenges including geographic isolation, health worker shortage, and lower health spending than in urban areas (5,6). In a 2015 landmark report, the United Nations International Labor Organization found that a lack of granular nationally comparable evidence on rural health inequities has impeded policymakers in allocating resources to strengthen rural health systems (6). In the case of diabetes, prior research has demonstrated suboptimal delivery of evidence-based care in LMICs (7–12), but there are scarce data on how health systems in LMICs perform in delivering diabetes care in rural areas.

Evidence on rural-urban inequities in diabetes care and control in LMICs is urgently needed. In April 2021, the World Health Organization (WHO) launched the Global Diabetes Compact, a high-profile effort to strengthen diabetes health services with a focus on primary care management in LMICs. The Global Diabetes Compact aims to set population-based diabetes targets for 2030, stimulate investment in diabetes care, and monitor progress toward targets at the national, regional, and global levels (13,14). Of particular interest in the Global Diabetes Compact are demographic disparities that can inform the design of policies and programs to scale up diabetes care among those populations most left behind. As such, the current study aims to assess rural-urban differences in the diagnosis, treatment, and control of diabetes and associated cardiovascular risk factors in LMICs.

RESEARCH DESIGN AND METHODS

Data Sources

We conducted a cross-sectional analysis of pooled individual-level data from national health surveys conducted in 42 LMICs. Surveys were eligible for inclusion if they were completed in or after 2008, were nationally representative, were conducted in an LMIC as defined by the World Bank in the year the survey was conducted, had availability of individual-level data, contained data on rural versus urban residence, and included biologic measurements for diabetes.

Eligible surveys were identified using a two-step process. First, we searched for WHO Stepwise Approach to Surveillance (STEPS) surveys on the STEPS report website (15) and Non-Communicable Disease Microdata Repository (16). STEPS surveys were our preferred data source because they are recommended by the WHO to track progress toward Non-Communicable Disease targets at the population level (17,18). Second, for countries in which a STEPS survey was not available or had not been conducted, we performed a systematic search to identify additional surveys meeting eligibility criteria. Of the 42 surveys included, 33 were STEPS surveys and nine were non-STEPS surveys.

[16]*Laboratory of Epidemiology of Chronic and Neurological Diseases, Faculty of Health Sciences, University of Abomey-Calavi, Cotonou, Benin*
[17]*Department of Public Health, University of Copenhagen, Copenhagen, Denmark*
[18]*Public Health Foundation of India, Gurugram, India*
[19]*Centre for Chronic Disease Control, New Delhi, India*
[20]*Faculty of Medicine and Health Sciences, Stellenbosch University, Stellenbosch, South Africa*
[21]*Department of Economics and Centre for Modern Indian Studies, University of Göttingen, Göttingen, Germany*
[22]*National Institute for Medical Research, Dar es Salaam, Tanzania*
[23]*Division of Nutrition, National Center for Public Health, Ulaanbaatar, Mongolia*
[24]*Department of Public Health, Instituto Universitario Hospital Italiano de Buenos Aires, Buenos Aires, Argentina*
[25]*Non-Communicable Diseases, Caribbean Public Health Agency, Port of Spain, Trinidad and Tobago*
[26]*Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran*
[27]*Diabetes Unit, Massachusetts General Hospital, Boston, MA*
[28]*Saint Francis Hospital Nsambya, Uganda Martyrs University, Kampala, Uganda*
[29]*University of Michigan Medical School, Ann Arbor, MI*
[30]*Heidelberg Institute of Global Health, Heidelberg University and University Hospital, Heidelberg, Germany*
[31]*South African Medical Research Council–Wits Developmental Pathways for Health Research Unit, Faculty of Health Sciences, Chris Hani Baragwanath Academic Hospital, University of the Witwatersrand, Johannesburg, South Africa*
[32]*Department of Science and Innovation–National Research Foundation Centre of Excellence in Human Development, University of the Witwatersrand, Johannesburg, South Africa*
[33]*Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA*
[34]*Department of Global Health and Social Medicine, Harvard Medical School, Harvard University, Boston, MA*
[35]*Institute of Applied Health Research, University of Birmingham, Birmingham, U.K.*
[36]*Centre for Global Surgery, Department of Global Health, Stellenbosch University, Stellenbosch, South Africa*
[37]*Medical Research Council/Wits University Rural Public Health and Health Transitions Research Unit, Faculty of Health Sciences, School of Public Health, University of the Witwatersrand, Johannesburg, South Africa*
[38]*Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA*
[39]*Department of Family and Preventive Medicine, School of Medicine, Emory University, Atlanta, GA*
[40]*Division of Global Health Equity, Brigham and Women's Hospital, Boston MA*
[41]*Division of Infectious Diseases, Brigham and Women's Hospital, Harvard Medical School, Boston, MA*
[42]*Medical Practice Evaluation Center, Massachusetts General Hospital, Harvard Medical School, Boston, MA*

Corresponding author: David Flood, dcflood@umich.edu

Received 10 November 2021 and accepted 18 May 2022

This article contains supplementary material online at https://doi.org/10.2337/figshare.20063189.

P.R. and J.M.-G. are joint senior authors with equal contribution.

Additional details on the search process, data sources, and measurement devices are reported in the Supplementary Material.

Sample and Definitions

The study sample consisted of respondents who were age 18–69 years, were not pregnant, and had an available biologic measurement for diabetes (point-of-care fasting capillary glucose, laboratory-based measurement of fasting plasma glucose, or glycated hemoglobin [HbA_{1c}]). We used this age criterion because it represented an overlapping age range of respondents in most underlying surveys.

We defined diabetes as use of a glucose-lowering drug (oral glucose-lowering medication or insulin) or an elevated biomarker meeting the WHO criteria for diabetes: fasting plasma glucose (FPG) $\geq$7.0 mmol/L (126 mg/dL), random plasma glucose $\geq$11.1 mmol/L (200 mg/dL), or HbA_{1c} $\geq$6.5% (19–21). In surveys reporting uncalibrated capillary glucose measurements, we converted values to plasma glucose by multiplying by a factor of 1.11 based on evidence that capillary values underestimate plasma values (22). This conversion is standard in large-scale population-based diabetes studies (7,23). Overall, 31 surveys reported using point-of-care capillary glucose, eight surveys reported FPG, and eight surveys reported HbA_{1c}. For individuals in five countries with both a glucose measurement and HbA_{1c} (China, Guyana, Iran, Mexico, and Romania), we used HbA_{1c} as our biomarker of interest in estimating the performance measures described below.

We adopted each survey's definition of rural or urban residence. A list of national definitions is reported in the Supplementary Material. In STEPS and other survey programs (24), these definitions are set by each country's national statistical office based on criteria such as administrative area, land use, infrastructure, and/or population size or density (25). Definitions therefore vary by country. It is not currently possible to generate harmonized classifications of urban and rural areas across countries (26). The United Nations Population Division recommends this approach because national statistical offices are most qualified to establish locally meaningful definitions of areas of residence (26).

Outcomes

Our outcomes were achievement of diabetes performance measures in three domains: diagnosis, treatment, and control of diabetes and associated cardiovascular risk factors. We adapted performance measures for these three domains from recommended population monitoring indicators and clinical guidance in the WHO Package of Essential Noncommunicable Disease Interventions for Primary Health Care (19). Our outcomes were generally consistent with proposed metrics in the WHO Global Diabetes Compact (13). Additional details on our definitions and their availability by survey are shown in the Supplementary Material.

In the diagnosis domain, ever tested was quantified among individuals with diabetes who ever had their blood glucose measured by a health worker. Awareness was quantified among individuals with diabetes who previously had been told by a health worker that they had raised blood glucose.

In the treatment domain, use of glucose-lowering medication was quantified among individuals in either of the following two groups: *1*) HbA_{1c} $\geq$8.0% (FBG $\geq$9.2 mmol/L) or *2*) taking an oral glucose-lowering medication or insulin. Use of blood pressure–lowering medication use was quantified among individuals with diabetes who also had hypertension, defined by systolic blood pressure $\geq$140 mmHg, diastolic blood pressure $\geq$90 mmHg, or current use of an antihypertensive medication. Statin use was quantified among individuals with diabetes age $\geq$40 years. As in our prior work (9), in the treatment domain, we did not restrict the denominator to individuals with diagnosed diabetes, because we were most interested in assessing the performance of health systems in delivering recommended diabetes treatments to all eligible individuals (diagnosed or undiagnosed). This approach is consistent with the WHO Package of Essential Noncommunicable Disease Interventions for Primary Health Care recommended indicator for monitoring treatment of diabetes and cardiovascular risk factors using population data (19).

In the control domain, glycemic control was quantified as HbA_{1c} $<$8.0% (FBG $<$9.2 mmol/L) among individuals with diagnosed diabetes. Blood pressure control was quantified as systolic blood pressure $<$140 and diastolic blood pressure $<$90 mmHg among individuals with diagnosed diabetes (19). Cholesterol control was defined as follows among individuals with diagnosed diabetes: *1*) In individuals age $\geq$40 years, cholesterol control was defined as self-reported statin use because the WHO recommends statin therapy for all people with diabetes in this age range without a cholesterol target (19), and *2*) in individuals age $\leq$40 years, cholesterol control was defined as total cholesterol $<$190 mg/dL based on recommended targets in the 2007 WHO guidelines on the prevention of cardiovascular disease (27). We also assessed performance measures of combined glycemic and blood pressure control (AB control; A refers to HbA_{1c}) and combined glycemic, blood pressure, and cholesterol control (ABC control) (28).

Statistical Analyses

We estimated age-adjusted differences in the proportion of individuals living in rural versus urban areas who achieved each performance measure. Specifically, we constructed survey-weighted multivariable Poisson regression models with robust standard errors adjusted for clustering at the level of the primary sampling unit and inclusion of covariates of rural versus urban residence and age. We ran the models across the overall pooled sample, across the pooled sample stratified by sex, and within each country. Age was included as a continuous variable using restricted cubic splines with five knots in pooled models and, because of smaller sample sizes, three knots in within-country models (29). In within-country models, we excluded the performance measures for statin therapy, cholesterol control, and combined ABC control, because statin use was too low in many surveys to run the regressions. In pooled models, we used country fixed effects and rescaled sample weights such that each country contributed equally. We used equal country weights because we were primarily interested in the performance of health systems in delivering diabetes care to rural populations, and therefore, our primary unit of interest was each country's health system. The large sample in the Indian survey therefore did not disproportionally affect the pooled results.

Relative differences are reported as risk ratios and absolute differences as average

marginal effects (30). The term risk refers to a desirable outcome (achievement of a diabetes performance measure) rather than an undesirable outcome. We report the age-adjusted proportion of individuals with diabetes who achieve each performance measure using average adjusted predictions (30). The implication of these results at the population level is then illustrated in a hypothetic country with the same rural-urban demographics as the pooled sample and a population of 10 million individuals. This population size was chosen because it approximates the median number of individuals age 18–69 years in 2015 among included countries (median 9.4 million) (31). A complete case analysis was used because <0.1% of respondents were missing data on rural or urban residence, and ≤1.8% of respondents were missing data on any outcome (Supplementary Material). Analyses were conducted in Stata (version 16.1).

Sensitivity Analyses

We conducted multiple sensitivity analyses. First, we directly estimated the proportion of individuals achieving each performance measure rather than using the regression-based method adjusting for age. Second, we used a stricter glycemic control target of HbA_{1c} <7.0% (FPG <8.0 mmol/L). Third, we rescaled the survey weights so that each country contributed weight in proportion to the country's 2015 population of individuals age 18–69 years (31).

Data Availability and Ethics

Statistical code is available at the Harvard Dataverse (https://doi.org/10.7910/DVN/8GMQ49). This study used survey data that could not be linked to a specific individual and was determined to be exempt from institutional ethics approval at the University of Michigan (HUM00201307), Ann Arbor, Michigan.

Data and Resource Availability

Data included in this study are publicly available for 37 of the 42 included country surveys. A complete list of web addresses and contacts regarding data access is provided in the Supplementary Material. For surveys that are not publicly accessible and for which we have arranged data-use agreements, data will be made available with permission of the data owners. Replication code is available at the Harvard Dataverse (https://doi.org/10.7910/DVN/8GMQ49).

RESULTS

Survey and Sample Characteristics

The pooled data set included surveys conducted between 2009 and 2019 in 42 LMICs, representing 69% of the total 2015 population in LMICs of individuals age 18–69 years (Table 1 and Supplementary Material). The final sample included 840,110 individuals, of whom 35,404 had diabetes (diagnosed or undiagnosed) and 16,694 had diagnosed diabetes (Supplementary Material). In the pooled sample using equal sampling weights, 54.3% (95% CI 53.1–55.5%) of the total population and 46.9% (95% CI 45.4–48.6%) of the population with diabetes lived in rural areas (Supplementary Material). The prevalence of diabetes in the pooled sample was 6.0% (95% CI 5.5–6.4%) in rural and 9.4% (95% CI 8.9–9.9%) in urban areas (Supplementary Material).

Achievement of Diabetes Performance Measures Across the Pooled Sample

Relative and absolute differences in the achievement of diabetes performance measures among rural versus urban populations across the pooled sample are shown in Fig. 1. Compared with urban populations with diabetes, rural populations with diabetes had a lower relative risk of ∼15–30% of achieving performance measures in the domains relating to diagnosis and treatment. In the control domain, compared with urban populations with diabetes, rural populations with diabetes had a 14% (95% CI 5–22%) lower relative risk of glycemic control, 6% (95% CI −5 to 16%) lower relative risk of blood pressure control, 23% (95% CI 2–39%) lower relative risk of cholesterol control, 20% (95% CI 4–34%) lower relative risk of combined AB control, and 61% (95% CI 29–78%) lower relative risk of combined ABC control.

The age-adjusted proportion of individuals with diabetes achieving performance measures is shown in Fig. 2*A*. In general, the absolute rural-urban difference among individuals with diabetes tended to be larger for performance measures with greater baseline achievement. The population implication of these results in a hypothetic country with the same rural-urban demographics as the pooled sample and a population of 10 million individuals is shown in Fig. 2*B*. In such a country, there would be 429,000 urban individuals with diabetes and 323,000 rural individuals with diabetes. Of these, 64.7% of urban individuals (n = 293,000; 95% CI 282,000–303,000) with diabetes and 49.1% of rural individuals (n = 149,000; 95% CI 140,000–157,000) with diabetes would be aware of their diagnosis. Estimates underlying Fig. 2 are found in the Supplementary Material.

Achievement of Diabetes Performance Measures Across the Pooled Sample by Sex

Men and women in rural areas compared with urban areas had similar relative underachievement of diabetes performance measures relating to the diagnosis and treatment domains (Fig. 3 and Supplementary Material). However, in the control domain, rural women tended to have much lower achievement than urban women, whereas among men, the rural-urban differences were small or even reversed. These differences in achievement by sex were especially marked for the combined outcomes.

Achievement of Diabetes Performance Measures by Country

In the within-country analyses, examples of countries that generally had fewer or no relative rural-urban differences in achievement of diabetes performance measures included Chile, El Salvador, Guyana, Jordan, and Laos. Examples of countries with larger rural-urban differences included Benin, Bhutan, Burkina Faso, Kenya, Tanzania, Turkmenistan, Uganda, and Zanzibar (Supplementary Material). Rural-urban differences in the diagnostic domain were especially marked in several of the African countries in the sample.

Sensitivity Analyses

The results from the first sensitivity analysis estimating proportions unadjusted for age and the secondary sensitivity analysis assessing a stricter glycemic target of HbA_{1c} <7.0% (FPG <8.0 mmol/L) were generally consistent with those from the main analysis. The third sensitivity analysis rescaling sample weights by population size resulted in similar rural-urban differences for most performance measures, but smaller or no differences were observed for glycemic control and combined AB

Table 1—Survey characteristics

Country[a]	ISO code	Income group[b]	Year[c]	Response rate, %[d]	Sample size, *n*[e]	Median age (range), years	Rural, %[f]	Women, %[f]
Africa								
Algeria	DZA	UMIC	2016–2017	94	5,868	41 (18–69)	34	49
Benin	BEN	LIC	2015	99	4,810	36 (18–69)	49	50
Burkina Faso	BFA	LIC	2013	99	3,945	37 (25–64)	76	53
Ethiopia	ETH	LIC	2015	96	7,711	34 (18–69)	82	44
Kenya	KEN	LIC	2015	95	3,974	36 (18–69)	61	50
Malawi	MWI	LIC	2009	96	2,805	38 (25–64)	89	50
Namibia	NAM	UMIC	2013	97	3,244	46 (35–64)	53	60
South Africa	ZAF	UMIC	2012	44	3,860	40 (18–69)	30	53
Tanzania	TZA	LIC	2012	95	4,623	41 (25–64)	69	50
Togo	TGO	LIC	2010	91	3,184	34 (18–64)	62	52
Uganda	UGA	LIC	2014	99	3,408	33 (18–69)	81	57
Zambia	ZMB	LMIC	2017	78	3,331	35 (18–69)	54	50
Zanzibar	ZAN[g]	LIC	2011	98	2,187	40 (24–64)	53	51
Americas								
Chile	CHL	UMIC	2009–2010	85	4,050	43 (18–69)	13	52
El Salvador	SLV	LMIC	2014–2015	68	4,103	40 (20–69)	43	55
Guyana	GUY	LMIC	2016	77	824	42 (18–69)	73	51
Mexico	MEX	UMIC	2018–2019	98	11,401	42 (20–69)	22	55
Eastern Mediterranean								
Afghanistan	AFG	LIC	2018	78	3,336	37 (18–69)	44	44
Iran	IRN	UMIC	2016	98	17,994	43 (18–69)	29	55
Iraq	IRQ	UMIC	2015	99	3,522	39 (18–69)	24	46
Jordan	JOR	UMIC	2019	95	3,326	40 (18–69)	16	50
Morocco	MAR	LMIC	2017	89	4,280	43 (18–69)	36	50
Sudan	SDN	LMIC	2016	95	6,452	37 (18–69)	63	44
Europe								
Armenia	ARM	LMIC	2016	42	1,746	46 (18–69)	33	40
Azerbaijan	AZE	UMIC	2017	97	2,627	47 (18–69)	46	51
Belarus	BLR	UMIC	2016	87	4,736	48 (18–69)	46	52
Georgia	GEO	LMIC	2016	76	3,155	52 (18–69)	52	52
Kyrgyzstan	KGZ	LIC	2013	100	2,482	44 (25–64)	66	48
Moldova	MDA	LMIC	2013	84	3,666	49 (18–69)	57	50
Romania	ROU	UMIC	2015–2016	69	1,685	44 (18–69)	41	53
Turkmenistan	TKM	UMIC	2018	94	3,745	40 (18–69)	52	48
South East Asia								
Bangladesh	BGD	LMIC	2018	97	6,947	38 (18–69)	80	54
Bhutan	BTN	LMIC	2014	96	2,667	39 (18–69)	69	43
India	IND	LMIC	2015–2016	98	658,709	32 (18–54)	64	47
Indonesia	IDN	LMIC	2014	83	5,459	40 (18–69)	48	51
Nepal	NPL	LIC	2019	86	5,061	40 (18–69)	91	53
Western Pacific								
Cambodia	KHM	LIC	2010	96	5,026	43 (25–64)	83	51
China	CHN	UMIC	2009	88	7,568	48 (18–69)	71	53
Fiji	FJI	UMIC	2009	72	1,189	53 (40–69)	55	57
Laos	LAO	LMIC	2013	99	2,393	39 (18–65)	69	58
Mongolia	MNG	LMIC	2019	97	5,996	41 (18–69)	37	50
Vietnam	VNM	LMIC	2015	97	3,015	44 (18–69)	65	50
Overall				95 (84–97)[h]	840,110[i]	40 (38–44)[h]	54 (41–69)[h]	51 (50–53)[h]

LIC, low-income country; UMIC, upper- and middle-income country. [a]World regions are defined by the World Health Organization. [b]Income groups are defined by the World Bank fiscal year category in the year the survey was conducted. [c]Year reflects the year(s) of survey data collection. [d]This value refers to the overall or step 1 response rate. [e]The sample includes nonpregnant individuals age 18–69 years with an available diabetes biomarker. [f]These values are weighted. [g]We use a nonofficial ISO code of ZAN for Zanzibar, which is an autonomous region of Tanzania. [h]This is the median value and interquartile range, with each country having the same weight. [i]This is the sum across all countries.

control. Full results of the sensitivity analyses are provided in the Supplementary Material.

CONCLUSIONS

In nationally representative health surveys pooled from 42 geographically diverse countries representing ~70% of the adult population in LMICs, we found that individuals with diabetes in rural

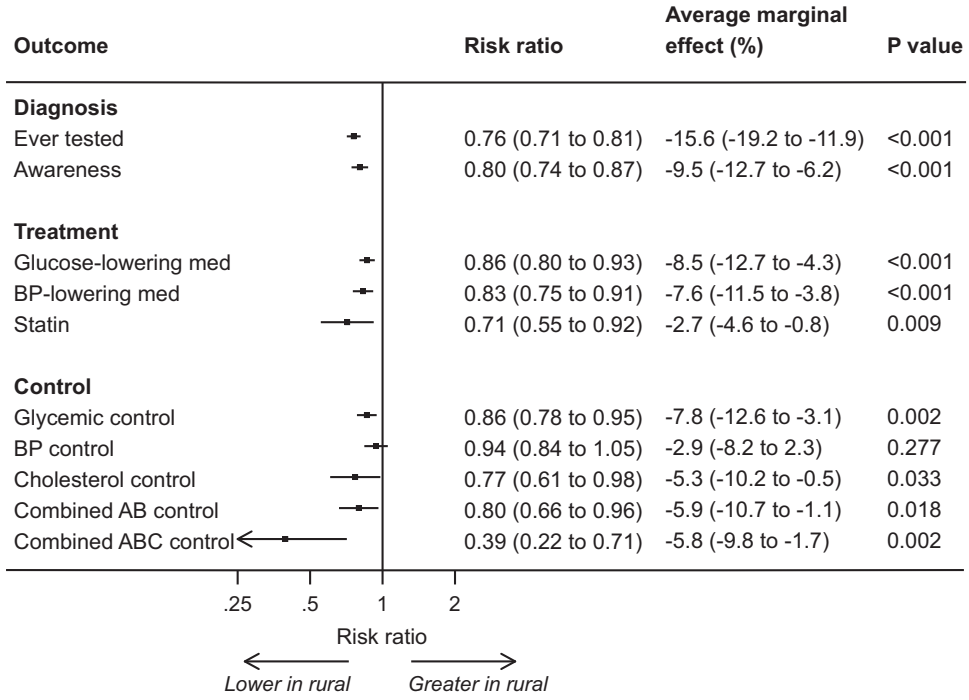


Figure 1—Differences in achievement of diabetes performance measures among rural versus urban (reference category) populations. Results are generated from survey-weighted multivariable Poisson regression models with robust SEs adjusted for clustering at the level of the primary sampling unit and inclusion of covariates of rural versus urban residence and age. Age is included as a continuous variable using restricted cubic splines with five knots at the following percentiles: 5, 27.5, 50, 72.5, and 95% (29). Error bars indicate 95% CIs. BP, blood pressure; med, medication.

compared with urban areas were less likely to achieve performance measures for the diagnosis, treatment, and control of diabetes and associated cardiovascular risk factors. We also observed that absolute levels of achievement of these performance measures were very low among both rural and urban populations with diabetes in LMICs. Our study highlights the need to strengthen primary diabetes care within health systems in LMICs and, as part of this broader effort, to consider the design of policies to address rural-urban inequities.

A surprising finding in our study was the degree to which rural-urban differences in achievement of diabetes performance measures varied by sex. In the control domain, rural-urban differences among women with diagnosed diabetes tended to be quite large, whereas these differences were attenuated or even reversed among men with diagnosed diabetes. Rural-urban differences were similar by sex for the diabetes diagnosis and treatment domains. One potential explanation for these findings is that area of residence may influence access to diabetes care differently for men versus women. Another possible explanation is that men and women have divergent patterns of underlying diabetes severity in rural versus urban areas of LMICs; sex-based differences in mean BMI have been reported across many countries (32). Adding to prior calls for research on sex-specific diabetes outcomes (33), our study suggests a need to investigate the interaction between sex and area of residence with regard to diabetes care in LMICs.

To our knowledge, our study is the largest and most comprehensive assessment of the attainment of diabetes performance measures in rural versus urban areas of LMICs. A 2011 pooled study of seven national health surveys found that individuals with diabetes in rural areas were less likely to be diagnosed in two of the included countries, but no differences were observed for diabetes treatment or control (34). Studies using national health survey data from individual countries have shown that rural residence is often associated with lower attainment of diabetes targets (35–39). The PURE (Prospective Urban Rural Epidemiology) study, conducted in up to 18 LMICs, found lower availability and affordability of glucose-lowering, blood pressure–lowering, and cardiovascular medications among rural compared with urban populations in LMICs (40–42). The rural-urban inequities in medication access observed in PURE may have contributed to the lower achievement of diabetes treatment and control measures in rural areas observed in our study. In high-income countries, similar patterns of inequitable diabetes care have been observed among rural populations with diabetes. In the U.S., adults with diabetes in rural areas compared with those in urban areas have lower receipt of routine diabetes clinical services (43), had less improvement in control of diabetes ABC risk factors from 1999 to 2018 (44), and have higher mortality (45).

Although the main objective of our study was to assess rural-urban differences in achievement of diabetes targets, it was notable that there was generally low achievement among both rural and urban populations with diabetes. In our sample of 42 LMICs, rural individuals with diabetes were less likely to achieve most performance measures. At the same time, there was a greater absolute number of individuals with diabetes in urban areas who did not achieve many of the performance measures. These results were

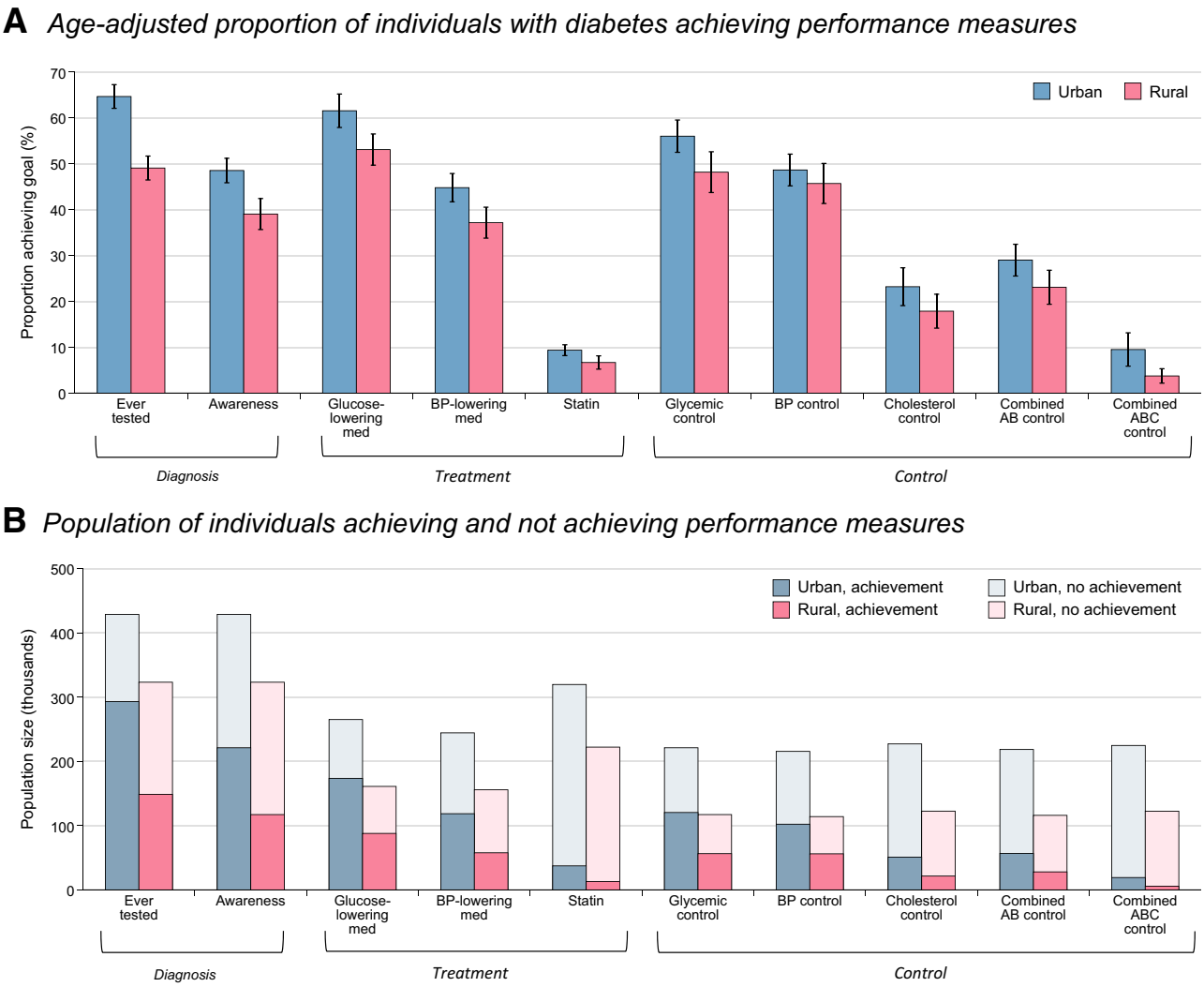


Figure 2—Diabetes performance measures among rural versus urban populations. *A*: Age-adjusted proportion of individuals with diabetes achieving performance measures are calculated as predictive margins from survey-weighted multivariable Poisson regression models with robust SEs adjusted for clustering at the level of the primary sampling unit and inclusion of covariates of rural versus urban residence and age. Estimates underlying the figure are presented in Supplementary Material. Error bars indicate 95% CIs. *B*: Population of individuals achieving and not achieving performance measures are calculated using a hypothetic country with the same rural-urban demographics as the pooled sample and a population of 10 million individuals. Estimates underlying the figure are presented in Supplementary Material. BP, blood pressure.

driven by rural-urban differences in population size and diabetes prevalence. Rural populations across the world tend to be geographically, economically, and socially marginalized (6). As such, inequities in health care for diabetes between rural and urban populations are important to document and address, even if there is a greater absolute number of individuals with diabetes living in urban rather than rural areas.

Our findings add a rural-urban dimension to prior studies from LMICs showing poor diagnosis and management of diabetes along the glycemic care cascade (7), low levels of diabetes treatment coverage (9), inadequate control of diabetes and cardiovascular risk factors (8), and infrequent achievement of guideline-recommended diabetes targets (46,47). The central policy implications of our study are *1*) that programs aiming to strengthen diabetes care in LMICs must consider the unique challenges driving inequities among rural populations with diabetes and *2*) that progress toward population-level diabetes targets should be monitored not only in national populations but also in rural and urban subpopulations.

Strengthening diabetes care in LMICs is a cross-cutting goal for multiple high-profile global health initiatives, including the primary health care movement embodied by the Alma-Ata Declaration (48), initiatives to realize universal health coverage (49), and, more recently, the launch of the WHO Global Diabetes Compact (13,14). Our study focuses on the achievement of indicators for the diagnosis, management, and control of diabetes. Within this framework, modeling studies from LMICs have shown that increasing achievement of blood pressure and statin treatment rather than improving levels of diabetes diagnosis would be most impactful in reducing diabetes complications (8). At the same time, it is important to note that diabetes diagnosis and management are not independent features of robust primary health systems. The delivery of high-quality care is likely to attract more

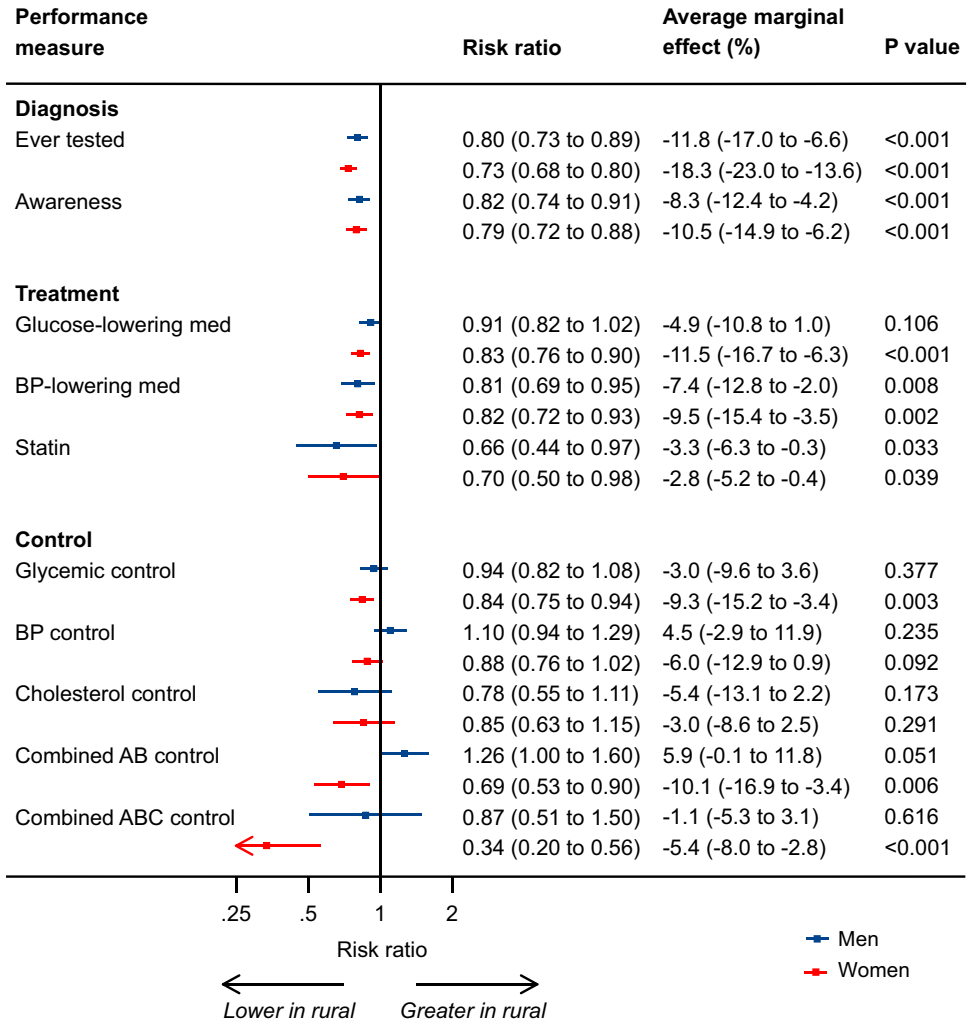


Figure 3—Differences in achievement of diabetes performance measures among rural versus urban (reference category) populations by sex. Results are generated from sex-stratified survey-weighted multivariable Poisson regression models with robust SEs adjusted for clustering at the level of the primary sampling unit and inclusion of covariates of rural versus urban residence and age. Error bars indicate 95% CIs. BP, blood pressure; med, medication.

individuals to engage in primary care; these individuals are then likely to be appropriately diagnosed, treated, and controlled; and the positive feedback loop continues as more individuals are diagnosed as they seek out trusted high-quality care. The *Lancet* Commission on Diabetes provides a health system strengthening roadmap for scaling up diabetes care in LMICs that includes investing in human resources, strengthening supply chains, redesigning primary care workflows using team-based approaches, and improving information systems (50). In rural areas, strategies to address unique challenges might include deployment of specialized nonphysician diabetes health workers (including community health workers), use of telemedicine, emphasis on simplified clinical protocols to deliver antihypertensive and statin therapy (8), implementation of point-of-care laboratory testing, incorporation of fixed-dose combination medications (polypills) into national formularies (51), and ensuring of access to insulin in rural primary care facilities through targeted investments in procurement, supply chains, and clinician training (52). Notably, many of these strategies are recommended in the WHO Hearts Technical Package for Cardiovascular Disease Management in Primary Health Care (53), and impressive implementation has been achieved in some regions of the world (54).

Our study has several limitations. First, we used each country's definition of rural or urban residence, and there were variations in definitions across countries (Supplementary Material). These definitions are constructed by national statistical offices and thus represent locally relevant classifications (26). Our approach has also been used in United Nations publications (25), the International Diabetes Federation Diabetes Atlas (1), and other studies using pooled survey data (32,55). Second, there was variation in the available diabetes biomarkers (glucose or HbA_{1c}), collection methods (capillary or venous), and accuracy and consistency of measurement devices across surveys. However, measurement variation does not systematically bias estimates of rural-urban differences, which was the main objective of this study. Third, there is a global trend toward increased urbanization, rising diabetes prevalence, and new initiatives to improve diabetes care, so our use of surveys conducted from 2009 to 2019 may not reflect the current status of diabetes performance measures in each country. Ongoing surveillance will

help document if and how these changes influence rural-urban diabetes patterns over the next decades. Fourth, the underlying surveys did not have complete data that permitted estimation of all diabetes performance measures for all included countries. Finally, it is possible that the differences in achievement of performance measures between men and women are partially attributable to collider stratification bias (56), a form of selection bias, because we defined the performance measures relating to control conditional upon a diabetes diagnosis.

In summary, we found that individuals with diabetes in rural compared with urban areas in LMICs were less likely to achieve performance measures for diagnosis, treatment, and control of diabetes and associated cardiovascular risk factors. Programs and policies aiming to strengthen global diabetes care must consider the unique challenges experienced by rural populations with diabetes.

Funding. D.F. was supported by a Pilot and Feasibility Grant funded by the Michigan Center for Diabetes Translational Research (National Institutes of Health [NIH] grant P30-DK092926) and fellowship funding from the Veterans Health Administration and National Clinician Scholars Program at the University of Michigan. P.G. was supported by the National Center for Advancing Translational Sciences of the NIH under award number KL2TR003143. J.A.S. was supported by grant T32DK007028 from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and by grant 5KL2TR002542–03 (Harvard Catalyst). J.M.-G. was supported by grant K23 DK125162 from the NIDDK.

The contents of this research are solely the responsibility of the authors and do not necessarily represent the official views of the National Institutes of Health.

Duality of Interest. D.F. and P.R. report volunteer affiliations with Wuqu' Kawoq, a nongovernmental health care organization providing clinical diabetes services in rural Guatemala, and they solicit funding for rural diabetes programs in this setting. R.A., through his institution, has received research grants from F. Hoffmann-La Roche, Novo Nordisk, and Novartis unrelated to the study and honoraria for lectures and presentations from F. Hoffmann-La Roche, Novartis, and Merck & Co. unrelated to the study. No other potential conflicts of interest relevant to this article were reported.

Author Contributions. D.F. conceived the idea for this study. D.F. led the statistical analysis with assistance from M.T. D.F. wrote the first draft of the manuscript with substantial revisions from M.K.A., P.R., and J.M.-G. D.F. and J.M.-G. verified the underlying data. P.G., M.T., S.V., J.I.D., M.K.A., and J.M.-G. led the data harmonization. All authors provided crucial input on multiple iterations of the manuscript. All authors had full access to the data and had final responsibility for submitting for publication. D.F. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

References

1. International Diabetes Federation. *IDF Diabetes Atlas*. 10th ed. Brussels, International Diabetes Federation, 2021
2. Popkin BM. Nutrition transition and the global diabetes epidemic. Curr Diab Rep 2015;15:64
3. Danaei G, Singh GM, Paciorek CJ, et al. The global cardiovascular risk transition: associations of four metabolic risk factors with national income, urbanization, and Western diet in 1980 and 2008. Circulation 2013;127:1493-502, 502e1-8
4. Zabetian A, Sanchez IM, Narayan KM, Hwang CK, Ali MK. Global rural diabetes prevalence: a systematic review and meta-analysis covering 1990-2012. Diabetes Res Clin Pract 2014;104:206–213
5. Strasser R, Kam SM, Regalado SM. Rural health care access and policy in developing countries. Annu Rev Public Health 2016;37:395–412
6. Scheil-Adlung X. *Global Evidence on Inequities in Rural Health Protection: New Data on Rural Deficits in Health Coverage for 174 Countries*. Geneva, International Labour Organization, 2015
7. Manne-Goehler J, Geldsetzer P, Agoudavi K, et al. Health system performance for people with diabetes in 28 low- and middle-income countries: A cross-sectional study of nationally representative surveys. PLoS Med 2019;16:e1002751
8. Basu S, Flood D, Geldsetzer P, et al. Estimated effect of increased diagnosis, treatment, and control of diabetes and its associated cardiovascular risk factors among low-income and middle-income countries: a microsimulation model. Lancet Glob Health 2021;9:e1539–e1552
9. Flood D, Seiglie JA, Dunn M, et al. The state of diabetes treatment coverage in 55 low-income and middle-income countries: a cross-sectional study of nationally representative, individual-level data in 680 102 adults. Lancet Healthy Longev 2021;2:e340–e351
10. Peck R, Mghamba J, Vanobberghen F, et al. Preparedness of Tanzanian health facilities for outpatient primary care of hypertension and diabetes: a cross-sectional survey. Lancet Glob Health 2014;2:e285–e292
11. Manne-Goehler J, Atun R, Stokes A, et al. Diabetes diagnosis and care in sub-Saharan Africa: pooled analysis of individual data from 12 countries. Lancet Diabetes Endocrinol 2016;4:903–912
12. Atun R, Davies JI, Gale EAM, et al. Diabetes in sub-Saharan Africa: from clinical care to health policy. Lancet Diabetes Endocrinol 2017;5:622–667
13. Gregg E, Buckley J, Ali M, et al. *Improving Health Outcomes of People With Diabetes Mellitus: Target Setting to Reduce the Global Burden of Diabetes Mellitus*. Geneva, World Health Organization, 2021
14. Hunt D, Hemmingsen B, Matzke A, et al. The WHO Global Diabetes Compact: a new initiative to support people living with diabetes. Lancet Diabetes Endocrinol 2021;9:325–327
15. World Health Organization. STEPS country reports. Accessed 13 April 2021. Available from https://www.who.int/teams/noncommunicable-diseases/surveillance/data
16. World Health Organization. NCD Microdata Repository. Accessed 19 July 2021. Available from https://extranet.who.int/ncdsmicrodata/index.php/catalog
17. Riley L, Guthold R, Cowan M, et al. The World Health Organization STEPwise approach to noncommunicable disease risk-factor surveillance: methods, challenges, and opportunities. Am J Public Health 2016;106:74–78
18. World Health Organization. Noncommunicable diseases global monitoring framework: indicator definitions and specifications. Accessed 10 January 2022. https://www.who.int/teams/ncds/surveillance/monitoring-capacity/gmf
19. World Health Organization. *WHO Package of Essential Noncommunicable (PEN) Disease Interventions for Primary Health Care*. Geneva, World Health Organization, 2020
20. World Health Organization. *Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycaemia: Report of a WHO/IDF Consultation*. Geneva, World Health Organization, 2006
21. World Health Organization. Use of Glycated Haemoglobin (HbA1c) in the Diagnosis of Diabetes Mellitus. Geneva, World Health Organization, 2011
22. Sacks DB, Arnold M, Bakris GL, et al. Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus. Clin Chem 2011;57:e1–e47
23. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. Lancet 2016;387:1513–1530
24. World Health Organization. *WHO STEPS Surveillance Manual*. Geneva, World Health Organization, 2020
25. Population Division, Department of Economic and Social Affairs, United Nations. *World Urbanization Prospects: The 2018 Revision*. New York, United Nations, 2018
26. Population Division, Department of Economic and Social Affairs, United Nations. *World Urbanization Prospects: The 2018 Revision Methodology*. New York, United Nations, 2018
27. World Health Organization. *Prevention of Cardiovascular Disease: Guidelines for Assessment and Management of Cardiovascular Risk*. Geneva, World Health Organization, 2007
28. Ali MK, Bullard KM, Gregg EW, Del Rio C. A cascade of care for diabetes in the United States: visualizing the gaps. Ann Intern Med 2014;161:681–689
29. Harrell FE Jr. *Regression Modeling Strategies*. 2nd ed. New York, Springer, 2015
30. Williams R. Using the margins command to estimate and interpret adjusted predictions and marginal effects. Stata J 2012;12:308–331. Available from https://doi.org/10.1177/1536867X1201200209
31. Wang H, Abbas KM, Abbasifard M, et al.; GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950-2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. Lancet 2020;396:1160–1203
32. NCD Risk Factor Collaboration (NCD-RisC). Rising rural body-mass index is the main driver of

the global obesity epidemic in adults. Nature 2019;569:260–264
33. The Lancet D. Endocrinology. Sex disparities in diabetes: bridging the gap. Lancet Diabetes Endocrinol 2017;5
34. Gakidou E, Mallinger L, Abbott-Klafter J, et al. Management of diabetes and associated cardiovascular risk factors in seven countries: a comparison of data from national health examination surveys. Bull World Health Organ 2011;89:172–183
35. Hu D, Fu P, Xie J, et al.; MS for the InterASIA Collaborative Group. Increasing prevalence and low awareness, treatment and control of diabetes mellitus among Chinese adults: the InterASIA study. Diabetes Res Clin Pract 2008;81:250–257
36. Price AJ, Crampin AC, Amberbir A, et al. Prevalence of obesity, hypertension, and diabetes, and cascade of care in sub-Saharan Africa: a cross-sectional, population-based study in rural and urban Malawi. Lancet Diabetes Endocrinol 2018;6: 208–222
37. Lerner AG, Bernabe-Ortiz A, Gilman RH, Smeeth L, Miranda JJ. The "rule of halves" does not apply in Peru: awareness, treatment, and control of hypertension and diabetes in rural, urban, and rural-to-urban migrants. Crit Pathw Cardiol 2013; 12:53–58
38. Stokes A, Berry KM, Mchiza Z, et al. Prevalence and unmet need for diabetes care across the care continuum in a national sample of South African adults: evidence from the SANHANES-1, 2011-2012. PLoS One 2017;12:e0184264
39. Aekplakorn W, Chariyalertsak S, Kessomboon P, et al.; Thai National Health Examination Survey IV Study Group. Prevalence and management of diabetes and metabolic risk factors in Thai adults: the Thai National Health Examination Survey IV, 2009. Diabetes Care 2011;34:1980–1985
40. Khatib R, McKee M, Shannon H, et al.; PURE study investigators. Availability and affordability of cardiovascular disease medicines and their effect on use in high-income, middle-income, and low-income countries: an analysis of the PURE study data. Lancet 2016;387:61–69
41. Attaei MW, Khatib R, McKee M, et al.; PURE study investigators. Availability and affordability of blood pressure-lowering medicines and the effect on blood pressure control in high-income, middle-income, and low-income countries: an analysis of the PURE study data. Lancet Public Health 2017;2:e411–e419
42. Chow CK, Ramasundarahettige C, Hu W, et al.; PURE investigators. Availability and affordability of essential medicines for diabetes across high-income, middle-income, and low-income countries: a prospective epidemiological study. Lancet Diabetes Endocrinol 2018;6:798–808
43. Hale NL, Bennett KJ, Probst JC. Diabetes care and outcomes: disparities across rural America. J Community Health 2010;35:365–374
44. Mercado CI, McKeever Bullard K, Gregg EW, Ali MK, Saydah SH, Imperatore G. Differences in U.S. rural-urban trends in diabetes ABCS, 1999-2018. Diabetes Care 2021;44:1766–1773
45. Aggarwal R, Chiu N, Loccoh EC, Kazi DS, Yeh RW, Wadhera RK. Rural-urban disparities: diabetes, hypertension, heart disease, and stroke mortality among Black and White adults, 1999-2018. J Am Coll Cardiol 2021;77:1480–1481
46. Mudaliar U, Kim WC, Kirk K, Rouse C, Narayan KM, Ali M. Are recommended standards for diabetes care met in Central and South America? A systematic review. Diabetes Res Clin Pract 2013;100:306–329
47. Shivashankar R, Kirk K, Kim WC, et al. Quality of diabetes care in low- and middle-income Asian and Middle Eastern countries (1993-2012): 20-year systematic review. Diabetes Res Clin Pract 2015;107:203–223
48. Cárdenas MK, Pérez-León S, Singh SB, et al. Forty years after Alma-Ata: primary health-care preparedness for chronic diseases in Mozambique, Nepal and Peru. Glob Health Action 2021;14: 1975920
49. Reich MR, Harris J, Ikegami N, et al. Moving towards universal health coverage: lessons from 11 country studies [published correction appears in Lancet 2016;387:750]. Lancet 2016;387:811–816
50. Chan JCN, Lim L-L, Wareham NJ, et al. The Lancet Commission on diabetes: using data to transform diabetes care and patient lives. Lancet 2021;396:2019–2082
51. Joseph P, Roshandel G, Gao P, et al.; Polypill Trialists' Collaboration. Fixed-dose combination therapies with and without aspirin for primary prevention of cardiovascular disease: an individual participant data meta-analysis. Lancet 2021;398: 1133–1146
52. Beran D, Lazo-Porras M, Mba CM, Mbanya JC. A global perspective on the issue of access to insulin. Diabetologia 2021;64:954–962
53. World Health Organization. *Hearts: Technical Package for Cardiovascular Disease Management in Primary Health Care*. Geneva, World Health Organization, 2016
54. Pan American Health Organization. *HEARTS in the Americas: Guide and Essentials for Implementation*. Washington, DC, Pan American Health Organization, 2022
55. Jaacks LM, Slining MM, Popkin BM. Recent underweight and overweight trends by rural-urban residence among women in low- and middle-income countries. J Nutr 2015;145: 352–357
56. Cole SR, Platt RW, Schisterman EF, et al. Illustrating bias due to conditioning on a collider. Int J Epidemiol 2010;39:417–420

Supplementary data

Appendix 1: Search process

The following is our comprehensive, two-step methodology for identifying, accessing, and pooling available national health surveys:

1. We identified all LMICs in which a World Health Organization (WHO) Stepwise Approach to Surveillance (STEPS) survey had been conducted.[1] We preferred STEPS surveys as they use a standardized questionnaire template and represent the WHO's official framework for conducting surveillance for noncommunicable diseases (NCD) at the population level.[2,3] Prior to 2019, we requested each STEPS survey from a list maintained on the WHO website.[4] The research team contacted the responsible party for each survey based on the information provided on this website. If the contact information was outdated or unavailable, the research team relied on publications utilizing STEPS data and electronic searches of the survey or contact name. For the Caribbean region, country involvement was facilitated by the Caribbean Public Health Agency (CARPHA). Beginning in 2019, we downloaded STEPS surveys from the WHO NCD Microdata Repository.[5] The final search date for STEPS surveys was April 1, 2021.

2. For countries in which no eligible STEPS survey was available, we conducted a systematic Google search in May 2020 to identify additional potentially eligible surveys. Our search strategy is described below:

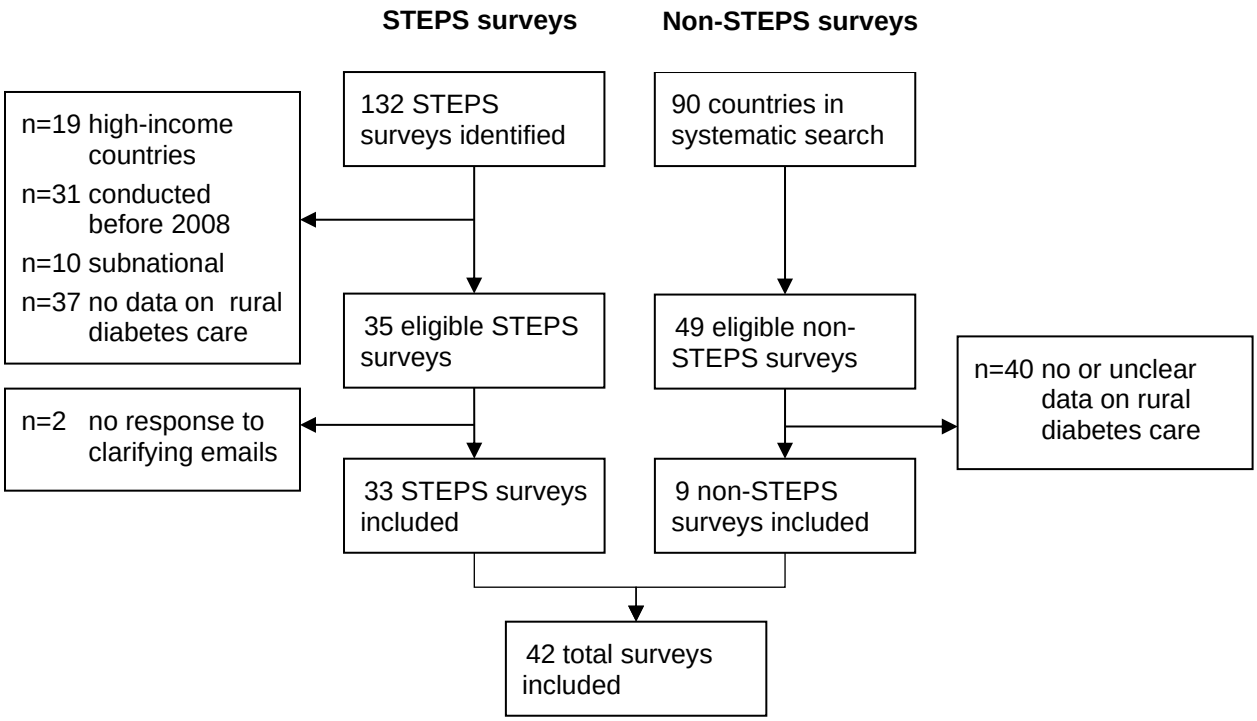
   Search engine: Google

   Search terms: "[country name]" AND ("population-based" OR household) AND ("blood glucose" OR "plasma glucose" OR "blood sugar" OR hemoglobin OR haemoglobin OR A1c OR HbA1c OR A1C OR Hb1c OR Hba1c OR HGBA1C OR "blood pressure" OR hypertension OR hypertensive OR cholesterol OR LDL OR HDL OR lipoprotein OR triglycerides OR triglyceride OR lipid OR lipids)

   Number of hits reviewed: We reviewed the hits until we identified an eligible survey. If we reviewed the first 50 hits (10 hits per page/5 pages reviewed) without identifying an eligible survey, we stopped reviewing the hits and determined the country to not have any eligible non-STEPS surveys.

   Search date: April 8, 2020

Appendix 2: Survey inclusion flow chart



Appendix 3: Data availability

The generic versions of the World Health Organization STEPwise approach to noncommunicable disease surveillance (WHO STEPS) instrument are available online (accessed June 29, 2021) at the following links:

Version 2.1:
https://www.who.int/ncds/surveillance/steps/STEPS_Instrument_v2.1.pdf

Version 3.2:
https://www.who.int/ncds/surveillance/steps/instrument/STEPS_Instrument_V3.2.pdf

Data included in this study are publicly available for 37 of the 42 included country surveys. Microdata can be downloaded at the following links:

Chile National Health Survey: https://www.minsal.cl/estudios_encuestas_salud/

China Health and Nutrition Survey: https://www.cpc.unc.edu/projects/china

El Salvador 2015 Encuesta Nacional de Enfermedades Crónicas No Transmisibles en Población Adulta de El Salvador (ENECA-ELS):
https://data.amerigeoss.org/gl/dataset/encuesta-nacional-de-enfermedades-cronicas

Indonesia Family Life Survey (IFLS): https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html

Mexico National Survey on Health and Nutrition (ENSANUT):
https://ensanut.insp.mx/encuestas/ensanut2018/descargas.php

Namibia Demographic and Health (DHS) Survey:
https://dhsprogram.com/methodology/survey/survey-display-363.cfm

STEPS Microdata repository: https://extranet.who.int/ncdsmicrodata/index.php/catalog/STEPS

For data that are not publicly accessible and for which we have arranged specific data-use agreements (surveys in Burkina Faso, Fiji, Iran, Romania, and South Africa), data will be made available from the authors upon reasonable request and with permission of the data owners.

Appendix 4: Country-specific sampling methods

Note: In order to ensure accuracy in reporting, these sampling methods are verbatim from the methods sections of the specified sources.

Afghanistan: STEPS 2018
In the sampling methodology districts are used as primary sampling units (PSUs), villages/blocks are the SSUs, and households within districts serves as TSUs. Based on the guidelines of the WHO, the total number of the PSUs within a sampling frame should be greater than 100 among which 50-100 PSUs should be randomly selected. The total number of districts in 34 provinces of Afghanistan is 417. From 417 districts 55districts were selected based on the available resources using Stepwise-Approach XLs form.

The total sample size was distributed proportionate to the size of the districts, then the sample size of the districts was divided by 15 (maximum number of the household to interviewed within an EA) and number of EAs within each district was calculated. Using the EPI sampling frame EAs were selected within each district. Within each EA the total number of the households were calculated and it was divided to calculate the sampling interval. The household with each randomly selected, within each household interview with a randomly selected male or female members was conducted.
Age range of participants included: 18-69 years
Source: Afghanistan STEPS 2018 Report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/782

Algeria: STEPS 2016-2017
A multi-stage cluster sample of households. One individual within the age range of the survey was selected per household. Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.
Different weight variables are available per Step:
wStep1 - for interview data
wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out. Additionally, some countries perform subsampling for Step 2 and/or Step 3. When no subsampling is done and response rates do not differ across Steps of the survey, the 3 weight variables will be the same.
Age range of participants included: 18-69 years
Source: no report or fact sheet available. Sampling information obtained from: https://extranet.who.int/ncdsmicrodata/index.php/catalog/91/study-description

Armenia: STEPS 2016
The STEPS survey of non-communicable disease (NCD) risk factors in Republic of Armenia was carried out from September 2016to December 2016. The Republic of Armenia carried out Step 1, Step 2, and Step3. Socio demographic and behavioral information was collected in Step 1. Physical measurements such as height, weight and blood pressure were collected in Step 2. Biochemical measurements were collected to assess blood glucose and cholesterol levels and urine analyze to assess salt intake levels in Step 3. The survey was a population-based survey of adults aged 18-69A cluster sample design was used to produce representative data for that

age range in Armenia. A total of2349adults participated in the survey. The overall response rate was42%.
Age range of participants included: 18-69 years
Source: Armenia STEPS Fact Sheet. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/102

Azerbaijan: STEPS 2017
A multi-stage cluster sample of households. One individual within the age range of the survey was selected per household. Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.
Different weight variables are available per Step:
wStep1 - for interview data
wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out. Additionally, some countries perform subsampling for Step 2 and/or Step 3. When no subsampling is done and response rates do not differ across Steps of the survey, the 3 weight variables will be the same.
Age range of participants included: 18-69 years
Source: no report or fact sheet available. Sampling information obtained from: https://extranet.who.int/ncdsmicrodata/index.php/catalog/127/studydescription#page=overview&tab=study-desc

Bangladesh: STEPS 2018
Sampling Procedure
A multistage complex sampling design was used to produce representative data for that age range in Bangladesh.
Response Rate
The overall response rate was 83.8%.
Weighting

Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.
Different weight variables are available per Step:
wStep1 - for interview data
wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out. Additionally, some countries perform subsampling for Step 2 and/or Step 3. When no subsampling is done and response rates do not differ across Steps of the survey, the 3 weight variables will be the same."Age range of participants included: 25 to 69 years
Source: https://extranet.who.int/ncdsmicrodata/index.php/catalog/770/study-description#page=overview&tab=study-desc
Source: National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. 2013. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.

Belarus: STEPS 2016-17

The sampling frame is a collection of data and materials from which are selected for the survey. The optimal sampling frame should be complete, accurate and current. Best of all, the above criteria are met by the results of the population census, which became the basis for constructing the sample for the STEPS study. Census population represents a representative territorial sampling frame in the form a hierarchical set of parcels grouped in a certain way. Plots censuses are, on average, about the same size. For each site there is a schematic map that provides a clear, non-overlapping demarcation of geographic districts, as well as information on the population and the number of households.

The largest in size is the census area, which includes several instructor sites. The smallest unit in the hierarchical structure of parcels by censuses - enumeration areas.A positive aspect of using enumeration areas as primary sampling units (PSUs) is that they have a small and approximately the same size (each includes about 100 HHs on average). Consequently this, the PSU is a territory within which it is possible to effectively organize field work. To conduct a population census, the territory of the Republic of Belarus was divided into almost 32 thousand enumeration areas. Due to the fact that the last population census in the Republic of Belarus was carried out in 2009, to update the sample, the current data of polyclinics were used, medical outpatient clinics, FAPs and rural Soviet accounting in rural areas.

Age range of participants included: 18-69 years

Source: Translated directly from the Belarus STEPS 2016 report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/100/related_materials

Benin: STEPS 2015

"The STEPS survey on risk factors for non-communicable diseases in Benin was conducted from October to December 2015. It was a population-based survey of adults aged 18 to 69 years. A 3-stage sampling frame was used to produce representative data for this age group in Benin. The information required for the investigation was collected electronically using a manual device. The survey was implemented by the National Program for the Fight against Non-Communicable Diseases (PNLMNT) of the Ministry of Health of Benin. A total of 5,126 adults participated in the STEPS survey conducted in Benin. The overall response rate was 98.6%. The 1st survey took place in 2008. A third survey is planned for 2020 if the financial situation allows it."

Age range of participants included: 18-69 years

Source: Translated directly from the Benin STEPS 2015 report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/107/download/1044

Bhutan: STEPS 2014

Sampling procedure

To achieve a nationally representative sample, a multistage sampling method was used to select enumeration areas, households and eligible participants at each of the selected households in three stages. The 2005 National Census was chosen as the basis for the sampling frame, with "Geogs" (blocks) in rural areas and towns in urban areas forming the primary sampling units (PSUs). Since the population distribution for urbanicity is 70:30 (rural:urban), 63 PSUs in rural and 14 PSUs in urban areas were chosen. PSUs were selected through the probability proportionate to size (PPS) sampling using the number of households in each PSU. Two secondary sampling units (SSUs) for every rural PSU and 4 SSUs for every urban PSU were selected. This led to the selection of 126 SSUs from rural and 56 SSUs from urban areas. This was also carried out by PPS sampling, using the number of households in each SSU. A total of 16 households from each SSU (both rural and urban) were selected using systematic random sampling. The sampling frame for this was the list of households with a

unique identification number (ID) developed by the enumerators for the survey. At the household level, the Kish sampling method was used to randomly select one eligible member (aged 18–69 years) of the household for the survey. The Kish method ranks eligible household members in order of decreasing age, starting with males and then females, and randomly selects a respondent using the automated program for Kish selection in the handheld personal digital assistant (PDA).
Age range of participants included: 18-69 years
Source: Bhutan STEPS report. Available at: https://www.who.int/ncds/surveillance/steps/bhutan/en/

Burkina Faso: STEPS 2013
"Sampling methodology: The study was conducted on a sample obtained from a three-stage cluster stratified as recommended by the WHO for STEPS screening surveys. risk factors for noncommunicable diseases. The sampling frame used was that derived from the general census of the population and habitat 2006 (RGPH 2006) and updated in 2010 during the survey Demographic and Health Survey of Burkina Faso (EDS-BF, 2010). This update concerned the enumeration areas (EAs) that correspond to the cluster as part of this study.
Selection of clusters: The choice of clusters was made according to a systematic random selection proportional to their size (in number of households) within strata (regions). To do this clusters were organized by stratum and place of residence (urban / rural). A total of 240 clusters of which 185 were in rural areas and 55 in urban areas were selected for the investigation.
Selection of households: Households were randomly drawn after an enumeration exhaustive list of all households in the cluster. A draw tool designed on Excel by the team. The technique was used in the field for selecting households to investigate. In total, 20 households in clusters were selected to participate in the study.
Selection of individuals: The choice of individuals was made randomly using Kish's method. In total, an individual aged 25 to 64 living in a selected household was fired for participate in the survey."
Age range of participants included: 25-64 years
Source, translated from: Rapport de l'enquete national sur la prevalence des principaux facteurs de risques communs aux maladies non transmissibles au Burkina Faso Enquete STEPS 2013. Available at: http://www.who.int/chp/steps/burkina_faso/en/.

Cambodia: STEPS 2010
"The initial planned sample size was designed to involve 5,760 persons in accordance with the NCD multi-stage cluster survey method (1.5 design effect, 95% confidence interval, 5% margin or error, and 50% baseline levels of the indicators) in order to provide an equivalent distribution of the participants in regards to age groups and gender after taking into consideration that the estimated potential rate for non-response in each group and refusals in the nest stages would equal to 20%. Estimates were obtained for each of the following eight age/sex groups: men ahed 25-34 years, 35-44 years, 45-54 years, and 55-64 years; and women aged 25-34 years, 35-44 years, 45-54 years, and 55-64 years.
The survey was designed to cover all geographical areas of Cambodia and a 3-stage sampling process as part of the multi-stage cluster sampling was carried out to randomly select the target population: random selection of communes (Khum in rural areas and its equivalent Sangkat in urban area) as primary sampling unit (PSU), followed by villages (Phum) for the second sampling unit (SSU), and by households for the elementary units (EU). Finally, all members of the randomly chose households aged 25-64 years were invited to participate in this survey. The selection process was performed identically for urban and rural areas in order to get a self-weighted estimate for the whole population of the country. A total of 180 clusters with 34 clusters from the urban area and 146 clusters from the rural area were randomly selected."

Age range of participants included: 25-64 years
Source: Cambodia STEPS 2010 survey report. Available at: https://www.who.int/ncds/surveillance/steps/cambodia/en/

Chile: NHS 2009-10
"The sampling frame was constituted from the Population and Housing Census 2002. The design of the study was transversal, with a random sample of complex type households (stratified and multi-stage by clusters) with national, regional and area representation rural / urban. The target population was adults older than or equal to 15 years. The survey had a response rate in the eligible population of 85%. The refusal rate was of 12%. 5,434 people were interviewed. A nurse performed clinical and examinations to 5,043 participants and 4,956 accepted laboratory tests (blood and urine). The total sample loss of the oversized sample was 28% (this including rejection, non-contact and other causes of random loss). The raw sample was designed with overrepresentation of some population groups (older adults, regions other than the Metropolitan Region and rural areas) to increase sample efficiency and homogenize the accuracy of the estimators. The expansion of the sample data is because it grants each participant the weight that corresponds to it according to the design sample and at the same time corrects the distortion of the raw sample, making it coincide with the census population projection for January 2010 for Chilean adults over 15 years of age."
Age range of participants included: 15 years or older
Source, translated from: Resumen Ejecutivo: Encuesta Nacional de Salud ENS Chile 2009-10. Available at: http://epi.minsal.cl/encuesta-ens-anteriores/.

China: CHNS 2009
"The China Health and Nutrition Survey is a longitudinal study across 228 communities within nine provinces of China. Surveys began in 1989, with subsequent surveys every 2–4 years, for a total of nine rounds between 1989 and 2011. The China Health and Nutrition Survey was designed to provide representation of rural, urban and suburban areas varying substantially in geography, economic development, public resources and health indicators,[13] and it is the only large-scale, longitudinal study of its kind in China. The original survey in 1989 used a multistage, random cluster design in eight provinces (Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou) to select a stratified probability sample; a ninth province, Heilongjiang, was added in 1997 using a similar sampling strategy. Essentially, two cities (one large and one small city—usually the provincial capital and a lower income city) and four counties (stratified by income: one high, one low and two middle income counties) were selected in each province. Within cities, two urban and two suburban communities were selected; within counties, one community in the capital city and three rural villages were chosen. Twenty households per community were then selected for participation. The study met the standards for the ethical treatment of participants and was approved by the Institutional Review Boards of the University of North Carolina at Chapel Hill and the Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention."
Age range of participants included: all ages
Source: Attard, Samantha M.; Herring, Amy H.; Wang, Huiling; Howard, Annie Green; Thompson, Amanda L.; Adair, Linda S.; Mayer-Davis, Elizabeth J.; & Gordon-Larsen, Penny. (2015). Implications of Iron Deficiency/Anemia on the Classification of Diabetes Using HbA1c. Nutrition & Diabetes, 5, e166.

El Salvador: ENECA-ELS 2015
The sample selection was carried out in a two-stage and probabilistic manner; the sample framework was the population census conducted in El Salvador in 2007. A cartographic update of the census segments conducted by Digestyc in 2015 was carried out and these were divided

into clusters, which were composed of 12 to 25 dwellings and finally to all persons in the dwellings that met the inclusion criteria.

The data collection process was carried out in two stages: in the first stage, each of the selected houses was visited, where all the members of the household who met the inclusion criteria were listed in a family file. The objective of the study was explained to the eligible persons and they were given the consent form to read it; the document was read to those who had difficulty reading and it was explained to them that they could withdraw from the study at any time if they chose to do so. Once the reading was finished, they were invited to participate in the study; those who accepted signed the informed consent form or placed their fingerprint, and then proceeded to conduct the survey.

If a person was ill at the time of the survey or had been diagnosed during the application of the survey, he/she was referred to a health facility. The actual fieldwork was conducted from October 2014 to March 2015. The second measurement was performed with a minimum interval of three months after the first one, in order to confirm the CKD. Thus in January 2015, the remeasurement was carried out, ending in March 2015.Out of a total of 1032 persons to be remeasured, 725 underwent such remeasurement. After the study, 4817 questionnaires that met all the required methodological conditions were completed. These were used to form the database for the analysis of the results. Estimates were made according to sex, 3 age groups (20 to 40, 41 to 60 and 60 and over), urban and rural area of residence and Minsal health regions.
Age range of participants included: ≥20 years
Source: Ministerio de Salud, 2015. Encuesta Nacional de Enfermedades Crónicas no transimibles en Población Adulta de El Salvador. San Salvador.[Translated]

Ethiopia: STEPS 2015:
According to the WHO step-wise approach to the surveillance of NCD risk factors, a community-based cross sectional study was carried out.
The target population for this survey included all men and women age15-69 years old who have been living at their place of residence for at least six months. This target population included all people who consider Ethiopia to be their primary place of residence. This definition included those individuals residing in Ethiopia regardless of their citizenship status. . People with the following characteristics were not included: those who were not a permanent resident of Ethiopia, and those who were institutionalized including people residing in hospitals, prisons, nursing homes, and other similar institutions or residents whose primary residences are military camps or dormitories. Furthermore, critically ill, mentally disabled and those with some type of physical disability that is not suitable for physical measurement were excluded from this study. In general, the target population of the study included individuals 15-69 years old and residing in all geographic areas of the country.
Age range of participants included: 15 to 69 years
Source: Ethiopia STEPS 2015 Report. Available at:
https://extranet.who.int/ncdsmicrodata/index.php/catalog/794

Fiji: EHS 2009
“The sample frame (188 800 people aged ≥40 years; 50.3% female; 49.4% Melanesian Fijian, 44.9% Indo-Fijian, and 5.7% of other ethnicity; 43.2% rural dwellers) included all 8 provinces of Viti Levu, Fiji’s main island, where 79.1% of the total population resides. Using an anticipated prevalence of vision impairment of 11.0% in the target population (actual was 11.4%; 95% confidence interval [CI] = 9.9% to 13.2%), absolute precision of ±2.2% (20% relative difference), with 95% confidence, a design effect of 1.4 and a response rate of 80%, the sample size was

determined to be 1354 persons. From the sample frame, 34 clusters of 40 people were required. Across Viti Levu, the clusters were selected through probability proportionate to size sampling, using national census data."
Age range of participants included: 40 to 90 years
Source: pasted verbatim from email exchange with study team.
Additional reference: Brian G, Ramke J, Maher L, Page A, Szetu J. The prevalence of diabetes among adults aged 40 years and over in Fiji. N Z Med J. 2010; 123(1327):68–75. PMID: 21358785

Georgia: STEPS 2016
"The STEPS survey of noncommunicable disease (NCD) risk factors in Georgia was carried out from June 2016 to September 2016. Georgia carried out Step 1, Step 2 and Step 3. Socio demographic and behavioural information was collected in Step 1. Physical measurements such as height, weight and blood pressure were collected in Step 2. Biochemical measurements were collected to assess blood glucose and cholesterol levels in Step 3. The survey was a population-based survey of adults aged 18-69. A Multi-stage cluster sampling design was used to produce representative data for that age range in Georgia. A total of 5554 adults participated in the survey. The overall response rate was 75.7%."
Age range of participants included: 18 to 69 years
Source: Georgia STEPS Survey 2016 Fact Sheet.
Available at: http://www.who.int/chp/steps/georgia/en/.

Guyana: STEPS 2016
"A response rate of 66.68% will be selected based on the experience and response rates of other surveys over the years such as the recent Demographic Health Survey 2009. [...] STEPS 3 involve taking blood samples from a proportion of the sample, in this case 50% of the sample, in order to measure raised blood glucose levels and abnormal blood lipids. [...] The STEPS sample will be prepared by the Bureau of Statistics Guyana following the recommended STEPS sample methodology. A multi-stage cluster sampling design will be used. Guyana is divided into 10 administrative regions and within the administrative regions there are seven towns and each region is further divided into enumeration districts. For the STEPS survey 288 enumeration districts will be selected using the population probability sampling method and from each enumeration district 12 households will be selected giving a total sample size of 3456. Further at the household level each participant will be randomly selected by the electronic tablet. For STEP 3 50% of the sample will be randomly selected to participate. A re-listing of some households may also be necessary, such as those interior region locations, in which case in addition to household listings, enumeration districts maps will also be provided so that a re-listing can be done where required."
Age range of participants included: 18 to 69 years
Source: STEPwise Approach to Chronic Disease risk factor surveillance (STEPS): Guyana's Implementation Plan. June 20, 2016. Ministry of Public Health, Guyana.

India: NFHS 2015-16
"The NFHS-4 sample was designed to provide estimates of all key indicators at the national and state levels, as well as estimates for most key indicators at the district level (for all 640 districts in India, as of the 2011 Census). The total sample size of approximately 572,000 households for India was based on the size needed to produce reliable indicator estimates for each district and for urban and rural areas in districts in which the urban population accounted for 30-70 percent of the total district population. The rural sample was selected through a two-stage sample design with villages as the Primary Sampling Units (PSUs) at the first stage (selected with probability proportional to size), followed by a random selection of 22 households in each PSU

at the second stage. In urban areas, there was also a two-stage sample design with Census Enumeration Blocks (CEB) selected at the first stage and a random selection of 22 households in each CEB at the second stage. At the second stage in both urban and rural areas, households were selected after conducting a complete mapping and household listing operation in the selected first-stage units."
Age range of participants included: women 15-49 years, men 15-54 years
Source: Ministry of Health and Family Welfare (MoHFW) - Government of India. India - National Family Health Survey 2015-2016. Report generated on: February 7, 2018.

Indonesia: IFLS 2014-15
"Because it is a longitudinal survey, IFLS5 drew its sample from IFLS1, IFLS2, IFLS2+, IFLS3 and IFLS4. The IFLS1 sampling scheme stratified on provinces and urban/rural location, then randomly sampled within these strata (see Frankenberg and Karoly, 1995, for a detailed description). Provinces were selected to maximize representation of the population, capture the cultural and socioeconomic diversity of Indonesia, and be cost effective to survey given the size and terrain of the country. For mainly cost-effectiveness reasons, 14 of the then existing 27 provinces were excluded.3 The resulting sample included 13 of Indonesia's 27 provinces containing 83% of the population: four provinces on Sumatra (North Sumatra, West Sumatra, South Sumatra, and Lampung), all five of the Javanese provinces (DKI Jakarta, West Java, Central Java, DI Yogyakarta, and East Java), and four provinces covering the remaining major island groups (Bali, West Nusa Tenggara, South Kalimantan, and South Sulawesi).
Within each of the 13 provinces, enumeration areas (EAs) were randomly chosen from a nationally representative sample frame used in the 1993 SUSENAS, a socioeconomic survey of about 60,000 households. The IFLS randomly selected 321 enumeration areas in the 13 provinces, over-sampling urban EAs and EAs in smaller provinces to facilitate urban-rural and Javanese–non-Javanese comparisons.
Within a selected EA, households were randomly selected based upon 1993 SUSENAS listings obtained from regional BPS office. A household was defined as a group of people whose members reside in the same dwelling and share food from the same cooking pot (the standard BPS definition). Twenty households were selected from each urban EA, and 30 households were selected from each rural EA. This strategy minimized expensive travel between rural EAs while balancing the costs of correlations among households. For IFLS1 a total of 7,730 households were sampled to obtain a final sample size goal of 7,000 completed households. This strategy was based on BPS experience of about 90% completion rates. In fact, IFLS1 exceeded that target and interviews were conducted with 7,224 households in late 1993 and early 1994. In IFLS1 it was determined to be too costly to interview all household members, so a sampling scheme was used to randomly select several members within a household to provide detailed individual information."
Age range of participants included: all ages
Source: Strauss, J., F. Witoelar, and B. Sikoki. "The Fifth Wave of the Indonesia Family Life Survey (IFLS5): Overview and Field Report". March 2016. WR-1143/1-NIA/NICHD.

Iran: STEPS 2016
"The sampling part, which includes determining the sample size and the cluster head, belongs to the pre-study phase and was planned in the form of a specific protocol for sample size and statistical sampling. All experts in the quality control team supervised the finding of samples and cluster heads.
In order to estimate the prevalence rate of the risk factors for non-communicable diseases in the country in 1395, a sampling method proportionate to the population was used, which is a common approach in survey studies. Therefore, the selected sample size was proportionated to the population of that province. On the other hand, for estimating the prevalence of the risk

factors in the province, in order to be on the safe side, the smallest sample size for achieving the predicted rates was calculated at 95%. This rate was equal to 384 samples, which was selected as the smallest sample size in the least populated province, Ilam. The required sample size for other provinces was therefore calculated according to the population of that province proportionate to the population of the reference province, Ilam. Besides, to control the non-response error, 10% was added to the calculated sample size in each province. In order to decrease costs and increase efficiency, for provinces with 800 samples or more, weights were given to their samples. Weight-giving is an effective method used in surveys in order to decrease the sample size. This was achieved in the selected provinces by considering the calculated sample size as half and the sampling weight as double. The total sample size was calculated to be 30150 and to achieve this sample size, sampling from 3015 clusters was required."
Age range of participants included: 18 and older
Source: Iran STEPS 2015 report.
Available at: https://www.who.int/ncds/surveillance/steps/STEPS_2016_Atlas_EN.pdf?ua=1

Iraq: STEPS 2015
"The sample frame consisted of the population of Iraq of (18+) years for both sexes residing in the urban and rural area. It was based on the results of listing and numbering operation for the year 2009 that covered all governorates. Due to the unstable conditions at the time of the survey three governorates (Naynawa, Salahaddin and Al-Anbar) were excluded. A major challenge confronted was the late demographic change due to population movement, displacement and migration. All permanent residents of (18+) years of age, who were resident in Iraq within one month at the time of implementation of the survey were considered eligible. A cross-sectional community based survey covering 15 governorates in Iraq. A Multi-stage cluster sampling technique was depended to select the minimum representative sample size to estimate the prevalence of the risk factors of noncommunicable disease through direct interview, physical examination and laboratory examination of blood samples of study participants. A total of 412 clusters were randomly selected each contain ten households. One subject from each household was randomly selected using KISH table to participate in the survey with a total sample size of 4120. The Sample was designed to provide estimates on a number of indicators on the situation of Noncommunicable diseases risk factors in Iraq at the national level. A national based rather than a governorate based sample is selected. A multi stage cluster sampling was used with stratification to urban and rural areas. Primary sampling units (PSUs) were the blocks, which consisted of 70 households or more before selection."
Age range of participants included: 18 years and older
Source: Iraq STEPS 2015 report.
Available at: https://www.who.int/ncds/surveillance/steps/Iraq_2015_STEPS_Report.pdf

Jordan: STEPS 2019
A national cross-sectional survey was conducted adopting a two-stage stratified-cluster sampling design. The margin error was (5%) and the confidence level was set at 95%. The Jordan Population and Housing Census 2015 was used as a sampling frame for Jordanians. A sample of 3000 households was randomly drawn to represent the Jordanian population. It was designed in a probability proportional to size (PPS) way to provide valid and reliable survey estimates across the entire Kingdom of Jordan - rural and urban areas, the twelve governorates and the smaller communities within. The sample also ensured reliable estimates in terms of geographical distribution, where Jordan was divided into three regions; north, centre, and south, also at governorate level. The north of Jordan covered Ajloun, Irbid, Jerash, and Mafraq, the centre region covered Amman, Balqa, Madaba, and Zarqa, and the south region covered Aqaba, Karak, Ma'an, and Tafieleh. Furthermore, each governorate was subdivided into area

units called census blocks, which were the Primary Sampling Units (PSU-Blocks) for this survey (on average a PSU comprises 50-70 households). The PSU-Blocks were then regrouped to form clusters. From each PSU, eight households were randomly drawn with an equal probability systematic selection. A household was defined as a group of people living in the same dwelling space who eat meals together, acknowledging the authority of a man or a woman as the head of the household. After the household selection and obtaining the permission of household residents to participate in the survey, all the eligible household members were entered into the STEPS program, which ran a random selection to choose one member household.
Age range of participants included: 18 to 69 years
Source: Jordan STEPS 2019 Report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/853

Kenya: STEPS 2015
"The 2015 Kenya STEPs survey was a national cross-sectional household survey designed to provide estimates for indicators on risk factors for non-communicable diseases for persons age 18 – 69 years. The sample was designed with a sample size of 6,000 individuals to allow national estimates by sex (male and female) and residence (urban and rural areas). The survey used the fifth National Sample Surveys and Evaluation Programme (NASSEP V) master sample frame that was developed and maintained by KNBS. The frame was developed using the Enumeration Areas (EAs) generated from the 2009 Kenya Population and Housing Census to form 5,360 clusters split into four equal sub-samples. A three-stage cluster sample design was adopted for the survey involving selection of clusters, households and eligible individuals. In the first stage, 200 clusters (100 urban and 100 rural) were selected from one sub-sample of NASSEP V frame. A uniform sample of 30 households from the listed households in each cluster was selected in the second stage of sampling. The last stage of sampling was done using Personal Digital Assistants (PDAs) at the time of survey, where one individual was randomly selected from all eligible listed household members using a programmed KISH method of sampling."
Age range of participants included: 18 to 69 years
Source: WHO: Kenya STEPwise Survey for Non Communicable Diseases Risk Factors 2015 Report. Available at: http://www.who.int/chp/steps/Kenya_2015_STEPS_Report.pdf?ua=1.

Kyrgyzstan: STEPS 2013
A multi-stage cluster sample of households. One individual within the age range of the survey was selected per household.
Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.
Different weight variables are available per Step:
wStep1 - for interview data
wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out.
Age range of participants included: 25 to 64 years
Source: no report or fact sheet available. Sampling information obtained from: https://extranet.who.int/ncdsmicrodata/index.php/catalog/271/study-description#page=overview&tab=study-desc

Lao People's Democratic Republic: STEPS 2013

A multi-stage cluster sample of households. One individual within the age range of the survey was selected per household. Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.
Different weight variables are available per Step:
wStep1 - for interview data
wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out. Additionally, some countries perform subsampling for Step 2 and/or Step 3. When no subsampling is done and response rates do not differ across Steps of the survey, the 3 weight variables will be the same.
Age range of participants included: 18 to 64 years
Source: no report or fact sheet available. Sampling information obtained from: https://extranet.who.int/ncdsmicrodata/index.php/catalog/588/study-description#page=sampling&tab=study-desc

Malawi: STEPS 2009
This was a national community based cross-sectional survey, using WHO STEPwise approach for assessing risk factors for chronic non-communicable diseases. The approach includes the use of a questionnaire for gathering demographic and behavioural information (Step 1), then moving to physical measurements (Step 2) and then biochemistry tests (Step 3). In addition, there are three modules of risk factor assessment, namely core, expanded and optional. The STEPS Survey instrument was adapted and tested by the core team and data collectors.
Age range of participants included: 18 to 69 years
Source: Malawi Steps 2009 Report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/629

Mexico: ENSANUT 2018
The ENSANUT 2018-19 is a national, urban and rural probabilistic survey. The units of analysis defined for the survey are the following: - Household is the set of people related by some kinship or not who usually sleep in a dwelling under the same roof, benefiting from a common income contributed by one or more of the household members. - Population aged 0 to 4 years (preschoolers)- Population aged 5 to 9 years (schoolchildren)- Population aged 10 to 19 years (adolescents)- Population aged 20 years and older (adults)- Utilizers

Once the PSUs and strata were constructed, the PSUs for the 2018-19 ENSANUT were selected in two stages: first, INEGI selected a master sample of PSUs with probability proportional to their number of dwellings in the year 2012, then, for the 2018-19 ENSANUT, a subsample of PSUs with equal probability was selected within each stratum. Finally, in each PSU, dwellings were selected with equal probability; on average, five dwellings were selected in each PSU of the high urban stratum and 20 dwellings were selected in the PSUs of the rural and urban complement strata.

Whenever possible, one adult, one adolescent, one schoolchild and one preschooler were selected from each household with equal probability. Also, whenever possible, up to two users of medical services during the last 15 days were selected in 40% of the dwellings, and in the remaining 60% of the dwellings, up to one user was selected.
Age range of participants included: All ages

Source: ENSANUT Report. Available at: https://ensanut.insp.mx/encuestas/ensanut2018/informes.php [Translated]

Moldova: STEPS 2013

"A total of 4807 randomly selected respondents participated in the survey. They were all aged 18–69 years, and the group comprised both sexes, as well as residents of all districts and the territorial administrative unit "Gagauz-Yeri", along with Chişinău and Balti municipalities. The survey did not cover the districts from the left bank of the Nistru River and the municipality of Bender. A two-stage cluster sampling procedure was carried out to select randomly participants from among the target population. Cluster sectors from the 2004 Moldova Population Census were used as a basic unit. Given the differences in lifestyle and disease status between populations in urban and rural areas, the target population was stratified into urban and rural areas of residence for the STEPS survey. At the first stage, within each stratum, primary sampling units (PSUs) (enumeration areas (EAs)) were selected systematically with probability proportional to the 2004 Population Census EAs (measure of size equal to the number of population in the EAs, provided by the census). Before selection, the census sectors were sorted geographically from north to south within each stratum, in order to ensure additional implicit stratification according to geographical criteria. A total of 400 clusters representing 400 EAs were selected from the 10 991 census EAs. These probabilistically selected clusters were used also in Moldova's DHS conducted in 2005, and the Multiple Indicator Cluster Surveys (MICS) conducted in 2012. Cartographic materials from the Population Census conducted in Moldova in 2004 were not available, thus it was not possible to use them for the STEPS survey. Therefore, for the first stage the probabilistic samples from the abovementioned surveys were used.

Out of the 400 selected clusters, 167 were rural and 233 were urban. The distribution of the sample of 400 PSUs (EAs) for the DHS/MICS surveys was inversely proportional to the number of population within each stratum, taking into account that the response rate is lower in urban areas than rural owing to the smaller average size of the households in urban areas compared with rural areas. Thus, disproportional allocation with oversampling for urban areas was applied in the STEPS survey. A final weighting adjustment procedure was carried out to enable estimates at national and urban/rural levels.

At the second stage, 15 households (secondary sampling units (SSUs)) were selected within each of the 400 PSUs. From the updated list of households used for the MICS 2012 survey, 15 households were selected randomly per cluster, using the Microsoft Excel® random sample tool. A total of 6000 individuals were selected from among the 400 clusters. The Kish method *(17)* was applied for the random selection of one individual aged 18–69 years from each household.

Age of participants included: 18-69 years

Source: Republic of Moldova STEPS 2013 report. Available at: https://www.who.int/ncds/surveillance/steps/Moldova_2013_STEPS_Report.pdf

Mongolia: STEPS 2019

A multistage stratified sampling design was used to produce representative data for that age range in Mongolia. A total of 6654 adults participated in the survey. Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population as compared to the target population.

Different weight variables are available per Step:

wStep1 - for interview data

wStep2 - for physical measures
wStep3 - for biochemical measures
This allows for differences in the weight calculation for each Step of the survey as the age-sex composition of the respondents to each Step can differ slightly due to refusal or drop out. Additionally, some countries perform subsampling for Step 2 and/or Step 3. When no subsampling is done and response rates do not differ across Steps of the survey, the 3 weight variables will be the same.
Source: No report available. Sampling information obtained from https://extranet.who.int/ncdsmicrodata/index.php/catalog/836/study-description#page=sampling&tab=study-desc

Morocco: STEPS 2017
One of the essential elements for establishing a probability sampling plan is the constitution an adequate sampling frame. For the purpose of the STEPS survey, the sampling frame used to meet the sampling need was the 2014 master sample, developed by the HCP based on data from the 2014 population and housing census. It has the advantage extrapolate the sample results to the target population and estimate the accuracy desired. The stratification of observation units belonging to any sampling frame makes it possible to design sampling plans ensuring optimal sample size; a significant reduction in costs and a substantial improvement in the accuracy of expected estimators. However, the choice of criteria allowing the population to be divided into homogeneous groups (strata) and having recent and reliable data on these criteria is a task that requires generally considerable efforts (updating the sampling frame) both in terms of methodological than that of data collection.

In Morocco, the particularity of cities containing several social categories for which, synthesizing the vector of heterogeneous demographic and socioeconomic behavior into a representative characteristic makes stratification a difficult task. The stratification adopted was geographical for the two environments according to the weight in terms of households, each of which has a specific stratification: For urban units, the criteria used were the administrative division into regions, provinces / prefectures and the dominant habitat type. As for the rural environment, the primary units were stratified according to the geographical criterion, and the type of relief dominant at the municipal level.
Age range of participants included: 18 years and older
Source: Morocco STEPS report [translated online]: https://extranet.who.int/ncdsmicrodata/index.php/catalog/544/study-description

Namibia: DHS 2013
“The sample for the 2013 NDHS was a stratified sample selected in two stages. In the first stage, 554 EAs were selected with a stratified probability proportional to size within the sampling frame. The EA size is the number of households residing in the EA and recorded in the 2011 NPHC. Stratification was achieved by separating each region into urban and rural areas. Therefore, the 13 regions were stratified into 26 sampling strata: 13 rural strata, and 13 urban strata. Samples were selected independently in each stratum, with a predetermined number of EAs selected as shown in Table A.3. Implicit stratification with proportional allocation was achieved at each of the lower administrative unit levels by sorting the sampling frame before the sample selection. Sorting was done according to the constituency and the EA code within a sampling stratum, and by using a probability proportional-to-size selection procedure.

After the selection of EAs and before the main survey, a household listing operation was carried out in all selected EAs, and the resulting lists of households served as a sampling frame for the selection of households in the second stage. Some of the selected EAs may large. To limit the

amount of work done to list each household, selected EAs with more than 200 households were segmented by the listing team in the field before the household listing. Only one segment was selected for the survey, with probability proportional to the segment size. Household listing was conducted only in the selected segment (see detailed instructions for segmentation in the DHS Manual for Household Listing). So a 2013 NDHS cluster is either an EA or a segment of an EA. In the second-stage selection, a fixed number of 20 households was selected in every urban cluster and rural cluster, by equal probability systematic sampling. A spreadsheet indicating the selected household numbers for each cluster was prepared. The survey interviewers interviewed only the pre-selected households. To prevent bias, no replacements and no changes of the pre-selected households were allowed in the implementing stages. In half of the selected households where there was no male survey, all women age 15-49 were interviewed; in the other half of the selected households where there was a male survey, all males and females age 15-64 were interviewed."
Age range of participants included: women 15 to 64 years
Source: The Nambia Ministry of Health and Social Services (MoHSS) and ICF International. 2014. The Namibia Demographic and Health Survey 2013. Windhoek, Namibia, and Rockville, Maryland, USA: MoHSS and ICF International.

Nepal: STEPS 2019
STEPS-2019 is national cross-sectional population-based household survey that used multi-stage cluster sampling design to sample households and eligible adult men and women (15-69 years of age) for questionnaire interview and physical examination (anthropometry, blood pressure measurement, blood glucose and cholesterol and urine sample for salt).

Survey population included men and women aged 15-69 years who have been the usual residents of the household for at least six months and have stayed in the household the night before the survey. People with the follow characteristics were not included: Those whose primary place of residence was in military base or group quarters, Those residing in hospitals, prisons, nursing homes and other institutions, Those too frail and mentally unfit to participate in the study, Those with any physical disability, Those unable or unwilling to give informed consent.

Sampling of Primary units (clusters):

This national representative sample was selected through multistage cluster sampling. Sampling frame consisting of the distribution of oldwards as in census 2011 was obtained from Central Bureau of Statistics (CBS). Then, in each of the province, the oldwards were compared with current classification of metropolitan, sub metropolitan, municipality, and rural municipalities and recorded as per new classification which has been recently updated by the government of Nepal. The location of the new classifications were matched with the oldwards and, finally, used as the sampling frame for selecting Primary Sampling Units (PSUs) for 2019 STEPS survey.

As a trade-off between survey costs and reducing the standard error, it was decided to sample 25 survey participants from each cluster, requiring sampling of 36.12 ~37 clusters in each of 7 provinces i.e. 259 clusters at national level.

Within each Province, the numbers of clusters were assigned to the three sub-strata in metropolitan, sub-metropolitan, municipality and rural municipality in proportion to the share of population in each of these 3 substrata in the total Province population.

Sampling of households and individuals from clusters:

A total of 25 households were sampled from each of the cluster. A sampling frame of the all households in the sampled PSUs was obtained through a complete household listing and mapping carried out in the sampled PSUs in September 6 to December 6 2018.

Sampling frame for selection of households from each PSU was prepared by conducting household listing and mapping. The team of enumerators visited the sampling PSUs and carried out a complete mapping of all the households in the PSU. If the sampled cluster were large, (if the population exceeds 300), cluster was segmented. In that case, field team started from northeast corner of each PSU and prepared an enumeration area of 300 household's with at least one person aged 15 years or more. Household listing questionnaire was used to list all of the household's members in selected PSUs. The listing was carried out electronically using Android ODK software. Mapping was done along with household listing. Drawing a location map of the cluster as well a detailed sketch map of all structures residing in the cluster was done These materials guided the interviewers to return to the pre-selected households for interview.

This lists of the households so prepared from all sampled PSUs served as the sampling frame for the selection of households in the next stage. From the prepare list, 25 households per PSU were sampled using equal systematic random sampling after determining the sampling interval by dividing the number of listed household by 25 and by randomly selecting the starting number between 0 and the sampling interval. From each of the selected, one adult member was sampled randomly for participation in the survey using the android tablet.
Age range of participants included: 15 to 69 years
Source: Nepal STEPS 2019 Report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/771

Romania: SEPHAR III 2015-2016
Like previous SEPHAR surveys, following a multi- stratified sampling procedure, a representative sample of 2000 Romanian adults aged between 18 and 80 years has been randomly selected from the database of the Romanian population general direction of data records following the principle of equality of chances of being enrolled in the study, regardless of the size of the place of residency.

The stratification criteria were: territorial regions (based on the recommendations of the National Institute of Statis- tics), type of residence (rural and urban), gender (men and women), and age groups (18–24, 25–34, 35–44, 45–54, 55– 64, and 65 – 80 years) using the data from the last Census available [8]. For an adult Romanian population of 16 269 839 adult citizens [8], of which 40.41% are estimated to be hypertensive patients based on SEPHAR II results [1], with a maximum error of 2.18% at a confidence level of 95%, the minimum required sample size was 1379 study participants.

Identification of the selected study participants respected the law for the protection of personal data of individuals, in the manner that we did not reach a person with a precise identity but only a person with certain demographic characteristics (a person of a certain sex, of an age within a certain age category from a certain locality). About 1 month previous to the study conduction in each locality, the selected study participants were informed about the survey conduction and their selection because of their demographic characteristics and were invited to send a response letter to the study organizers regarding their availability to participate in the study.

During the two study visits, scheduled at 4-day interval, all enrolled individuals were evaluated by: 71-item survey questionnaire, anthropometric, and BP measurements together with

investigations for target organ damage, blood, and urine sample collection after proper fasting time (8 – 14-h prior).

The SEPHAR III survey was conducted in two stages: the first between 16 and 23 November 2015 in the Bucharest– Ilfov region and the second between 15 February and 25 April 2016 in the remaining of the 82 survey sites (41 cities and 41 communes).

Response rate was calculated as the ratio between the total number of included study participants with eligible data for analysis and the total number of randomly selected study participants eligible for inclusion in the study that were approached by the study investigators.

Age range of participants included: 18 to 80 years
Source: Dorobantu M, Tautu O-F, Dimulescu D, Sinescu C, Gusbeth-Tatomir P, Arsenescu-Georgescu C, et al. Perspectives on hypertension's prevalence, treatment and control in a high cardiovascular risk East European country: data from the SEPHAR III survey. J Hypertens. 2018;36(3):690–700.

South Africa: SANHANES 2012
"The survey applied a multi-stage disproportionate, stratified cluster sampling approach. A total of 1000 census enumeration areas (EAs) from the 2001 population census were selected from a database of 86,000 EAs and mapped in 2007 using aerial photography to create the 2007 HSRC master sample to use as a basis for sampling of households. The selection of EAs was stratified by province and locality type. In the formal urban areas, race was also used as a third stratification variable (based on the predominant race group in the selected EA at the time of the 2001 census). The allocation of EAs to different stratification categories was disproportionate, in other words, over-sampling or over-allocation of EAs occurred in areas that were dominated by Indian, coloured or white race groups to ensure that the minimum required sample size in those smaller race groups were obtained. Based on the HSRC 2007 Master Sample, 500 Enumerator Areas (EAs) representative of the sociodemographic profile of South Africa were identified and a random sample of 20 visiting points (VPs) were randomly selected from each EA, yielding an overall sample of 10 000 VPs. EAs were sampled with probability proportional to the size of the EA using the 2001 census estimate of the number of VPs in the EA database as a measure of size (MOS). One of the tasks of SANHANES-1 was to recruit and establish a cohort of 5 000 households to be followed up over the coming years. The sampling consisted of: Multi-stage disproportionate, stratified cluster sampling approach; 500 EAs within which 20 VPs/households per EA were sampled; Main reporting domains: sex (male, female), age-group (< 2 years, 2–5 years, 6–14 years, 15–24 years, 25–49 years, 50 years and older), race group (black African, white, coloured, Indian), locality type (urban formal, urban informal, rural formal [including commercial farms] and rural informal], and province (Western Cape, Eastern Cape, Northern Cape, Free State, KwaZulu-Natal, North West, Gauteng, Mpumalanga, Limpopo)."
Age range of participants included: all ages; biomarker information collected on participants 6 years or older
Source: Human Sciences Research Council. SANHANES: Health and Nutrition. 2015. Available at: http://www.hsrc.ac.za/en/research-areas/Research_Areas_PHHSI/sanhanes-health-and-nutrition

Additional reference: Stokes A, Berry KM, McHiza Z, Parker WA, Labadarios D, Chola L, et al. Prevalence and unmet need for diabetes care across the care continuum in a national sample of South African adults: evidence from the SANHANES-1, 2011–2012. PLoS ONE. 2017; 12(10):e0184264. https://doi.org/10.1371/journal.pone.0184264 PMID: 28968435.

Sudan: STEPS 2016
A four-stage cluster sampling design was implemented. The four sampling stages were; 1) selection of states from the six regions 2) selection of clusters (a cluster was a Popular Administrative unit), 3) selection of households and 4) selection of eligible individuals. First Stage (State): Administratively Sudan is divided into 18 states which are grouped in six regions, (North, East, Khartoum, Central, Kordofan and Darfur region (Table 1). States were randomly selected from each region. No geographical areas or populations were excluded from the sampling frame. Thus 11 states were selected, probability proportional to the size, to represent the six regions. A list of the selected states is shown in Table 2.1. Second Stage (Cluster PAU): The Popular Administrative Units (PAU) is the smallest geographically border unit. These were defined as the 'cluster' in the region. Clusters were randomly sampled from all PAUs, from both urban and rural strata, according to probability proportional to size in each state, and urban/rural distribution. The PAUs inaccessible due to security conditions were not excluded from the sampling frame, because within certain areas the security status was continuously changing. However, it was planned that if a PAU was found to be inaccessible at survey time, it should be replaced. However, no replacement was required during this survey. Third Stage (Household): Within the selected PAUs, all households (HH) were included in the sampling frame. Accordingly (HH) were selected using systematic random methods.
Fourth Stage (Individual): The members of the household were first listed in the mobile application (customized software). The inclusion criteria for the listed members were: all individuals aged between 18 to 69 years, from both sexes, irrespective of his health status and living in the selected household for a minimum of 6 weeks. The application was then run and it randomly selected the individual who will be selected to participate in the study.
Age of participants included: 18-69 years.
Source: Sudan STEPS 2016 report. Available at: https://www.who.int/ncds/surveillance/steps/Sudan_STEPwise_SURVEY_final_2016.pdf?ua=1

Tanzania: STEPS 2012
"The STEPS survey in the United Republic of Tanzania was a population-based survey of adults aged 25-64. The study used both multistage cluster and random probability sampling procedures. Fifty of 119 total districts were randomly selected as primary sampling units (PSUs). Within these PSUs, enumeration areas (EAs) of > 50 households were randomly selected. Any EA with < 50 households was merged with a neighboring EA. Within the EAs, households were randomly selected from a list of all eligible households in the EA. A total of 5762 adults participated in the Tanzania STEPS survey. Within each selected household, the Kish method was used to select the STEPS participant. This procedure was followed until the predetermined sample was obtained for the enumeration area. The response rate for this survey was 94.7%."
Age range of participants included: 25 to 64 years
Source: Tanzania STEPS Survey Report. Available at: http://www.who.int/chp/steps/UR_Tanzania_2012_STEPS_Report.pdf?ua=1

Additional reference: Mayige M, Kagaruki G. Tanzania STEPS survey report. Dar es Salaam: National Institute of Medical Research; 2013.

Togo: STEPS 2010
"Those included in this survey are male or female subjects, living in urban or rural areas, aged 15 to 64 on the day of the survey, residing in the enumeration area for at least 6 months and having given their informed consent to participate in this study. [...] Three hundred clusters were randomly selected in a systematic draw with probability proportional to the size of the cluster (number of households) in the 4620 areas of enumeration of the DGSCN (General Directorate

of Statistics and National Accounts) sampling frame. In order to obtain the 4,800 households at the rate of 1 individual / household, 16 households per cluster were randomly selected at the second stage of survey. In each of the selected households, one individual was selected as a survey participant via the Kish Method. A household was defined as the group of persons, who regularly share the main meal (regardless of their relationship). Households were not replaced in the event of a refusal or two unsuccessful visits to the eligible person selected by Kish's method. If the selected person was unwell or not present at the time of the interview, the investigators either tried to find a new appointment or searched for the respondent."
Age range of participants included: 15 to 64 years
Source: Translated from WHO: The Final Report on the Togo STEPS Survey 2010. Available at: http://www.who.int/chp/steps/2010STEPS_Report_Togo_FR.pdf?ua=1.

Turkmenistan: STEPS 2018
Sample
The main purpose of the sample design for STEPS research in Turkmenistan - nationwide coverage and reflection of the situation in the country as a whole for measurable indicators. The survey was conducted among adults in Turkmenistan aged 18-69 years. (target population), who gave written informed consent, for exceptions: persons in the ranks of the National Armed Forces; population WHO STEPS Non-communicable disease risk assessment 26 www.who.int/chp/steps permanently residing (staying) in specialized institutions social and rehabilitation assistance, hospitals and other institutions health care, correctional facilities.

Method of sampling and stratification
The STEPS study was used to generate a sample set two-stage probability sampling method using stratification procedures and selection at each of the sampling stages. Geographical coverage - all regions of Turkmenistan: Akhal, Balkan, Dashoguz, Lebap and Mary provinces and the city of Ashgabat (the capital), which corresponds national administrative-territorial division. To ensure the uniformity of the distribution of the sample set across the country was stratification. Taking into account the division of each province into urban and rural
The total population was determined by 11 streets (the city of Ashgabat - only the city street, in velayatakh - 10 strat). The total sample size was distributed in proportion to the number households on the streets.

Age range of participants included: 18 to 69 years
Source: Translated from 2018 STEPS Survey Report. Available at: https://www.who.int/ncds/surveillance/steps/turkmenistan/en/

Uganda: STEPS 2014
Sample Design
The study methodology followed the World Health Organization's (WHO) STEP wise approach to surveillance (STEPS) which provides a standardized method for analyzing and disseminating data on risk factors for non-communicable diseases (NCDs). The sample for the Uganda NCDs was designed to provide Cardiovascular Diseases (CVD) prevalence's, smoking and tobacco use and alcohol consumption estimates for the country as a whole and for urban and rural areas separately. A two stage sampling design was used to draw the sample. At the first stage, Enumeration Areas (EAs) were drawn with Probability Proportional to Size (PPS), and at the second stage, households which were the ultimate sampling units were drawn using Simple Random Sampling (SRS). A total of 350EAs were selected from 2014 Uganda Population and Housing Census Mapping Frame. At the EA level, the target was 14 households.

Sample frame

The 2014 Uganda NCD survey used a sampling frame of the 2014 Population Census Mapping listing provided by the Uganda Bureau of Statistics (UBOS). The UBOS has an electronic file consisting of 78,950 Enumeration Areas (EAs) created for the 2014 Population and Housing Census. An EA is a geographic area consisting of a convenient number of dwelling units that serve as counting units for the census. Tables A.1 provides information on the distribution of EAs and households in the sampling frame by region and residence. The table shows that among the 78,950 EAs, 13,087 (22%) are in urban areas and 65,863 (78%) are in rural areas. The average size of an EA, measured in number of households, is 95 in an urban EA and 77 in a rural EA, with an overall average of 79.

Age range of participants included: 18 to 69 years
Source: Ministry of Health. Non-Communicable Disease Risk Factor Baseline Survey: Uganda 2014 Report. Available at:
https://www.who.int/ncds/surveillance/steps/Uganda_2014_STEPS_Report.pdf
Zx

Vietnam: STEPS 2015
At the same time of STEP survey, MOH also conduct the Global Adult Tobacco Survey (GATS) at the same scale, location, and study subjects (>15 years for GATS and 18-69 for STEPS). The sampling of STEPS was done in as part of the sampling for the (GATS) conducted in combination manner to save time and resources for these two surveys. Applied the multi-stages complex sampling process, the sampling process done by GSO was as follow: • Sampling of clusters (EA) In the first stage of sampling, the primary sampling unit (PSU) was an enumeration area (EA). There are about 170,000 EAs in the whole Viet Nam and the average number of households in each EA is different between urban and rural areas. An average number of households in an urban EA and a rural EA is 133 households and 120 households, respectively. Sample of EAs were selected from the master sample frame. The master sample frame was a cluster frame made by the GSO based on the frame of Population and Housing Census 2009 and updated with data of 2014. Based on the Population and Housing Census data 2009, GSO prepared a 15% of master sample to serve as a national survey sampling frame. The master sample frame contains 25,500 enumeration areas (EAs) from 706/708 districts of Viet Nam (2 island districts were excluded from the GSO master sample frame). The master sample frame of GSO was divided by two stratification variables: urbanization (1 = urban; 2 = rural) and district group (1 = district/town/city of province; 2 = plain and coastal district; 3 = mountainous, island district). It means that the master sample frame was divided into 6 sample frames or 6 strata. The probability proportional to size (PPS) sampling method was used to select sample of EAs from 6 strata of master sample frame. The final sample of GATS included 315 EAs in the urban and 342 EAs for the rural. From these 657 EAs, 315 EAs were systematically selected for STEPS.
Sampling of households At the second stage of sampling, 10% households in each EA were selected. Thus, 15 households from the selected urban EA and 14 households from the selected rural EA were chosen using simple systematic random sampling. The total households for STEPS 2015 were 4,651 households.
Sampling of individuals: One eligible person is then randomly selected from each selected household for the STEPS 1 interview. The selection of individual is automatically done by the PDA program after eligible household members are entered into the PDA. The selection probability of an eligible individual was calculated as a product of selection probability for each stage. The sampling base weight for an eligible individual was the inverse of the selection probability shown above.
Age range of participants included: 18 to 69 years

Source: National Survey on the Risk Factors of Non-communicable diseases (STEPS) Viet Nam Report 2015. Available at: https://www.who.int/ncds/surveillance/steps/viet_nam/en/

Zambia: STEPS 2017

To ensure that the sample reflected the entire country of Zambia, a multi-stage cluster sampling technique was used to select a nationally representative sample of adults in Zambia aged 18 to 69 years. It was decided to utilize the household listing from the Zambia PopulationBased HIV Impact Assessment (ZAMPHIA) - a household-based national survey that was conducted between March and August 2016 in order to measure the status of Zambia's national HIV response. ZAMPHIA offered the most pragmatic up to date and accessible national household listing to be used as the sampling frame for this survey. The ZAMPHIA survey included 60,581 households drawn from 1,103 clusters referred to in this report as standard enumeration area (SEA) (Table 2.4.1). Thus the sample drawn for the STEPS survey was a subsample of the households selected for the ZAMPHIA survey. In the first stage of sampling, SEAs were selected from each province using probability proportional to size (PPS). In the second stage, 15 households in rural SEAs and 20 households in urban SEAs were selected systematically using appropriate sampling interval based on the number of households in that SEA. These households constituted the final list of households for the STEPS survey prepared for the field investigators (FI). In the third stage, while the FI approached the household and sought consent, all eligible members in the household were entered into the Android-based devise used for the survey. The device then selected one member from the eligible members using a simple random sampling technique. The selected member was then interviewed having gone through the ethical process of consent after being provided with information on the survey. If the selected member was not available, a scheduled visit was made. If the selected member could not be reached after two scheduled visits he or she was considered as non-response. There was no replacement strategy so as to maintain the integrity and representativeness of the sample.

Age range of participants included: 18 to 69 years

Source: STEPS 2017 Report. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/620

Zanzibar: STEPS 2011

"The survey took place in June and July 2011, followed by data cleaning and analysis. One Principal Investigator and five assistant researchers coordinated the survey on site, checked completed questionnaires daily, and organized logistics. The six data collection teams consisted each of six interviewers, one supervisor, one laboratory technician and one driver. Interviewers were either health care workers or professional interviewers familiar with household surveys such as DHS. The sample size was calculated to be 2800 participants. Each interviewer did on average 3 – 4 interviews a day and was assisted on site by local village guides.

The study was a cross-sectional population based survey with a sample of a sufficient size with a power to determine the proportion of adults that are exposed to selected risk factors associated with NCDs; including those having raised BP, FBG or blood lipids, had experienced injuries or traumas in recent times, and/or were mentally unwell (anxiety, depression), as well as linking these conditions with one another and with the sociodemographic and economic information obtained. People reported to be permanent residents (spending on average maximum 3 nights per week outside the house, and not holding an address in another place) in the selected households and fulfilled the inclusion criteria were enrolled into the survey. A person could only appear once in the study. Therefore we classified a husband practicing polygamy to be listed in the household of his first wife but not to be a member in the household of the following wives. Inclusion criteria was age between 25 - 64 years, able to understand the

information given by the interviewer about the study prior to the beginning of the interview, signing of the informed consent for accepting participation. Exclusion criteria was inability to understand or comprehend the information given by data collector, inability to communicate through verbal expression for consent and for responding to the questionnaires, severe/terminal illness that hinders participation in the survey.

The target population is the entire population in Zanzibar whereby the whole of Zanzibar was selected as the survey site, and hence all districts included. The total population is estimated to be 1.2 million distributed unevenly between 10 districts. The sampling frame represented the entire population in Zanzibar. The sampling strategy used is a multi-stage cluster sampling with stratification. The ten districts are considered as different strata, and the total number of primary sampling units, PSU, is allocated proportionately across all strata. Each district is divided into smaller clusters. These clusters are the geographical and administrative units called Shehia11. The Shehia are divided into smaller clusters called zones (also called mitaa, vitongoji, or vijiji) which typically consist of 100-300 households. Zones smaller than that were merged to make up one larger cluster, and zones much larger were split in smaller clusters.

At the first stage clusters were selected using Simple Random Selection, SRS, from the list of clusters (Shehia) within each district. At the second stage clusters (zones) were randomly selected using probability proportionate to size (PPS). At the third stage households were randomly selected from the household lists provided by the administrative leader of the Shehia. The two last stages of sampling were done using the software STEPSsampling.xls from WHO. Finally participants were selected from the household using Kish method. The household lists were complete and included households with no eligible participants for the survey. Therefore an extra 7 households were sampled at third stage in each cluster for replacement in case a selected household had no eligible participants and had to be changed. This was done before data collectors went to the cluster.

Resources allowed for 100 PSU which was why 2800/100 = 28 households were selected from each PSU (and disproportionate from each SSU). A structured questionnaire was used, based on WHO STEPwise approach to chronic diseases risk factor surveillance.. After getting behavioural and socio-demographic information, anthropometric measurements (BP, height, weight, waist and hip circumference) was done the same day. Answers were recorded electronically during interview using a Personal Digital Assistant (PDA). Biochemical measurements (fasting blood glucose, triglyceride, and cholesterol levels) were done the next day at a central place in each study site according to appointment and were done by Laboratory technicians using dry chemistry for rapid and convenient results and to avoid suspicion surrounding sending away blood samples. Results were recorded electronically on site using a PDA, and participants received a paper copy of the results.

Every study site was visited one day for interviews. Sampled households/ participants were visited at least three times before recorded as non-respondent. The following day the site was visited for biochemical measurements. Laboratory technicians called participants who did not show up to ask them to set up appointment for the following day (at a new study site). After all study sites had been visited call-backs were made to all eligible participants (non-respondents) who's number we had obtained. A time and place near the participants was identified for data collection. Participants met fasting and started with having blood sample drawn, afterwards the interviews and anthropometric measurements were conducted. Laboratory technicians continued biochemistry measurements for another few days.
Age range of participants included: 25 to 69 years

Source: Zanzibar STEPS Survey Report, [online]
https://www.who.int/ncds/surveillance/steps/2011_Zanzibar_STEPS_Report.pdf

Appendix 5: Diabetes biomarker devices by country

Diabetes Biomarker	Country	Post Hoc Adjustment*
Point-of-care fasting capillary glucose		
Accutrend® Plus (Roche, Basel, Switzerland)	Cambodia, Chile, Guyana, Malawi, Togo, Zanzibar	Multiplied by 1.11
CardioCheck® PA (pts Diagnostics, Indianapolis, Indiana, USA)	Afghanistan, Belarus, Benin, Bhutan, Burkina Faso, Kenya, Moldova, Morocco, Nepal, Sudan, Turkmenistan, Uganda, Vietnam, Zambia	None
FreeStyle Optium H glucometer	India	Multiplied by 1.11
HemoCue® Glucose 201 Analyzer (HemoCue, Brea, California, USA)	Namibia, Tanzania	None
MultiCare-in© (Biochemical Systems International, Arezzo, Italy)	Georgia	None
Prima home test	Mongolia	None
Unknown	Algeria, Armenia, Azerbaijan, El Salvador, Kyrgyzstan, Laos	None
Laboratory-based assessment of fasting plasma glucose		
Central laboratory was used for processing	Bangladesh, Mexico	N/A
Cobas 6000 and C311 analyzer (Roche Diagnostics, Indianapolis, Indiana, USA)	Iran, Romania	N/A
Enzymatic assay (glucose oxidase)	Iraq	N/A
Hitachi 7600 modular chemistry analyzer (Hitachi, Tokyo, Japan)	China	N/A
CardioCheck PA Analyser	Ethiopia, Jordan	N/A
Hemoglobin A1c (HbA1c)		
Capillary sample DCA 2000+ analyzer (Siemens/Bayer, Munich, Germany)	Fiji	N/A
Dried blood spots using the Hemocue system	Indonesia	N/A
Plasma sample by Cobas C311 auto-analyzer (Roche kits)	Iran	N/A
Central laboratory	Mexico	N/A
Unknown	Guyana	N/A
Venous blood Cobas 6000	Romania	N/A

Venous blood using automated high-performance liquid chromatography	South Africa	N/A
Whole blood using Bio-Rad HLC-723 G7/D10/PDQ A1c	China	N/A

*Post hoc adjustment to convert from capillary to plasma equivalents. N/A=Not available.

Appendix 6: Blood pressure measurement devices by country

Country	Measurement device	Number of measurements	Interval between measurements
Afghanistan	Calibrated sphygmomanometer	3	3 minutes
Algeria	No report available	No report available	No report available
Armenia	No report available	No report available	No report available
Azerbaijan	Riester Ri-Champion Automatic Digital Monitor-1715	3	10 minutes
Bangladesh	Life Source UA-767 Plus Digital Monitor	3	10 minutes
Belarus	Boso-Medicus Uno	3	3 minutes
Benin	Boso Medicus Uno	3	3 minutes
Bhutan	Omron digital upper arm meter (model not specified)	3	5 minutes
Burkina Faso	Omron Digital Monitor HEM-705CP	3	10 minutes
Cambodia	NISSEI Digital Blood Pressure Monitor (Model DS-500)	3	N/A
Chile	Omron Digital Monitor HEM-742	3	2 minutes
China	Manual mercury sphygmomanometer	3	10 minutes
El Salvador	Not specified	Not specified	Not specified
Ethiopia	Boso-Medicus Uno	3	3 minutes
Fiji	Not applicable		
Georgia	Boso Medicus Uno	3	3 minutes
Guyana	Omron digital upper arm meter (model not specified)	3	3 minutes
India	Omron Digital Monitor HEM-8712	3	5 minutes
Indonesia	Omron Digital Monitor HEM-7203	3	First measurement taken at beginning of interview, subsequent two taken during the course of the interview
Iran	Beurer BM 20	3	5
Iraq	Not specified	Not specified	Not specified
Jordan	Omron M3	Not specified	Not specified
Kenya	Omron M2 Digital Monitor	3	3-5 minutes

Country	Measurement device	Number of measurements	Interval between measurements
Kyrgyzstan	No report available	No report available	No report available
Laos	No report available	No report available	No report available
Malawi	Omron M4-I	3	3-5 minutes
Mexico	Omron HEM-907 XL	“AHA protocol”	“AHA protocol”
Moldova	Boso-Medicus Uno	3	3 minutes
Mongolia	Not specified	Not specified	Not specified
Morocco	Spengler® ES 60	3	“a few minutes”
Namibia	Life Source Digital Monitor Model UA-767	3	Not specified
Nepal	Omron digital upper arm meter (model not specified)	3	3 minutes
Romania	A&D Medical UA-767PC Automatic Monitor	3	1 minute
South Africa	Omron M2 Digital Monitor	3	5 minutes
Sudan	Boso-Medicus Uno	3	3 minutes
Tanzania	Omron digital upper arm meter (model not specified)	3	Not specified
Togo	Omron digital upper arm meter (model not specified)	3	5 minutes
Turkmenistan	OMRON device	No report available	No report available
Uganda	Boso Medicus Uno	3	3-5 minutes
Vietnam	BOSO Device	Not specified	Not Specified
Zambia	Not specified	3	3-5 minutes
Zanzibar	Omron M2 Digital Monitor	3	5 minutes

N/A=Not available.

Appendix 7: Cholesterol measurement devices by country

Measurement	Country
CardioCheck PA	Afghanistan, Belarus, Benin, Bhutan, Burkina Faso, Ethiopia, Jordan, Kenya, Moldova, Mongolia*, Morocco, Nepal, Sudan, Turkmenistan, Uganda, Vietnam, Zambia
Central laboratory	Bangladesh, Guyana, Iraq, Iran, Mexico, Romania
SD LipidoCare Analyzer	Mongolia*
Unknown	Algeria, Armenia, Azerbaijan, Georgia, Kyrgyzstan

*The 2019 Mongolia STEPS survey reports using both CardioCheck PA and SD LipidoCare Analyzer to measure cholesterol (https://extranet.who.int/ncdsmicrodata/index.php/catalog/836).

Appendix 8: National definitions of area residence

Country	Urban and city definitions collated by United Nations[6]
Afghanistan	"Sixty-six localities and provincial centres."
Algeria	"For 1998 and 2008, agglomerations with 5,000 inhabitants or more, non-agricultural economic activity, connection to water supply network, connection to electricity network, connection to network of sanitation and additional conditions."
Armenia	"Cities and urban-type localities, officially designated as such, usually according to the number of inhabitants and predominance of non-agricultural workers and their families."
Azerbaijan	"Cities and urban-type localities, officially designated as such, usually according to the criteria of number of inhabitants and predominance of non-agricultural workers and their families."
Bangladesh	"Localities having a municipality (pourashava), town (shahar) committee or cantonment board. In general, urban areas are a concentration of 5,000 inhabitants or more in a continuous collection of houses where the community sense is well developed and the community maintains public utilities, such as roads, street lighting, water supply, sanitary arrangements, etc. These places are generally centres of trade and commerce where the labour force is mostly non-agricultural and literacy levels are high. An area that has urban characteristics but has fewer than 5,000 inhabitants may, in special cases, be considered urban."
Belarus	"Cities and urban-type localities (towns, semi-urban centres, industrial communities and health resort communities), officially designated as such."
Benin	"Localities with 10,000 inhabitants or more."
Bhutan	"Areas satisfying at least 4 out of the following 5 conditions: (1) 1,500 inhabitants or more; (2) 1,000 inhabitants or more per square kilometre; (3) more than 50 per cent of the population depends on economic activity outside of the primary (e.g., agriculture, livestock and forestry) sector; (4) area of the urban centre is 1.5 square kilometres or larger; and (5) identified potential for future growth of the urban centre, particularly in terms of its revenue base. As of 2005, there were 28 declared urban centres and 26 satellite towns."
Burkina Faso	"Cities and urban-type localities (communes), officially designated as such, according to socio-economic characteristics such as a non-agricultural economy."
Cambodia	"For 1998 and later, communes that meet at least one of the following criteria: (1) population density exceeding 200 persons per square kilometre, (2) percentage of male employment in agriculture below 50 per cent, or (3) 2,000 inhabitants or more."
Chile	"Populated centres with defined urban characteristics, such as certain public and municipal services."
China	"For 1982 and earlier, total population of cities and towns. Cities had 100,000 inhabitants or more or commanded special administrative, strategic, or economic importance. Towns were either settlements with

Country	Urban and city definitions collated by United Nations[6]
	3,000 inhabitants or more, of whom more than 70 per cent were registered as non-agricultural, or settlements with between 2,500 and 3,000 inhabitants, of whom more than 85 per cent were registered as non-agricultural. For 1990, all residents of urban districts in provincial and prefectural-level cities, the resident population of streets (jiedao) in county-level cities, and the population of all resident committees in towns. For 2000, population of city districts with average population density of at least 1,500 persons per square kilometre, population of suburban-district units and township-level units meeting certain criteria, such as having contiguous built-up area, being the location of the local government, or being a street (jiedao) or having a resident committee. For 2010, urban residents meeting the criterion defined by the National Bureau of Statistics of China in 2008, i.e., the criteria used in the 2000 census plus residents living in villages or towns in outer urban and suburban areas that are directly connected to municipal infrastructure and that receive public services from urban municipalities."
El Salvador	"For 2007, the head of the municipality, where the primary civil, religious and military authorities reside, and those areas having a continuous cluster of at least 500 dwellings, with street lighting service, basic schools, regular transportation service, paved or cobbled streets and telephone services. For 1971, areas where authorities of the municipality reside, as determined by those authorities."
Ethiopia	"Localities with 2,000 inhabitants or more."
Fiji	"Places with 1,000 inhabitants or more."
Georgia	"Cities and urban-type localities, officially designated as such, usually according to criteria surrounding the number of inhabitants and the predominance of non-agricultural workers and their families."
Guyana	"City of Georgetown (capital), and four other towns."
India	"Statutory places with a municipality, corporation, cantonment board or notified town area committee and places satisfying all of the following three criteria: (1) 5,000 inhabitants or more; (2) at least 75 per cent of male working population engaged in non-agricultural pursuits; and (3) at least 400 inhabitants per square kilometre."
Indonesia	"Municipalities (kotamadya), regency capitals (kabupaten) and other places with urban characteristics."
Iran	"For 1986 and later, districts with a municipality. Prior to 1986, all county centres (shahrestan) regardless of size and places with 5,000 inhabitants or more."
Iraq	"Municipality councils (Al-Majlis Al- Baldei)."
Jordan	"Localities with 5,000 inhabitants or more as well as the district and sub-district centres of each governorate irrespective of population size."
Kenya	"Municipalities, town councils, and other urban centres with 2,000 inhabitants or more. Due to substantial changes in the 1999 census delineations of urban areas, only the population of the "urban core" is considered to ensure consistency with previous censuses."

Country	Urban and city definitions collated by United Nations[6]
Kyrgyzstan	“Cities and urban-type localities, officially designated as such, usually according to criteria based on the number of inhabitants and predominance of non-agricultural workers and their families.”
Laos	“For 2005, areas within municipal vicinity with the centre of that municipality having 600 inhabitants or more, or at least 100 households. Further, the areas must have certain urban characteristics (roads, electricity, market function, tap water supply).”
Malawi	“Townships, town planning areas and district centres.”
Mexico	“Localities with 2,500 inhabitants or more.”
Moldova	“Cities and urban-type localities, officially designated as such, usually according to criteria based on the number of inhabitants and the predominance of non-agricultural workers and their families.”
Mongolia	“Ulaanbaatar (capital) and district centres.”
Morocco	“Localities officially designated as urban according to administrative divisions and entities that satisfy the quantitative criteria (minimum population threshold) and qualitative criteria (density of equipment, predominance of non-agricultural activities, etc.)”
Namibia	“The district headquarters and other settlements of rapid population growth with facilities that encourage people to engage in non- agricultural activities.”
Nepal	“For 1999 and later, a complex set of rules varying by ecological zones and based on annual revenue, population size and infrastructure is used. For 1981 and 1991, localities (panchayats) with 9,000 inhabitants or more. For 1961 and 1971, localities (panchayats) with 5,000 inhabitants or more.”
Romania	“Municipalities and towns with certain urban socio-economic characteristics.”
South Africa	“A classification based on dominant settlement type and land use. Cities, towns, townships, suburbs, etc., are typical urban settlements. Enumeration areas comprising informal settlements, hostels, institutions, industrial and recreational areas, and smallholdings within or adjacent to any formal urban settlement are classified as urban. The 1996 estimate was adjusted to comply with the 2001 census definition...”
Sudan	“Localities of administrative and/or commercial importance or with 5,000 inhabitants or more.”
Tanzania	“For 1978 and later, all regional and district headquarters, as well as all wards with urban characteristics (i.e., exceeding certain minimal level of size-density criteria and/or with many of their inhabitants in non-agricultural occupations). No specific numerical values of size and density are identified, and wards are defined as urban based on the decision of the District/Regional Census Committees. For 1957 and 1967, 16 gazetted townships.”
Togo	“For 1981 and later, 21 administrative centres of prefectures. For 1970 and earlier, seven urban communes.

Country	Urban and city definitions collated by United Nations[6]
Turkmenistan	“Cities and urban-type localities, officially designated as such, usually according to criteria based on the number of inhabitants and the predominance of non-agricultural workers and their families.”
Uganda	“For 2002 and later, gazetted cities, municipalities and towns with 2,000 inhabitants or more. For 1991 and earlier, cities, municipalities, towns, town boards and all trading centres with 1,000 inhabitants or more.”
Vietnam	“Places with 4,000 inhabitants or more.”
Zambia	“Localities with 5,000 inhabitants or more and with a majority of the labour force not in agricultural activities.”
Zanzibar	See Tanzania above.

Appendix 9: Summary of diabetes performance measures

Performance measure	Numerator	Denominator[a]	Number of countries
Diagnosis			
Ever tested	Individuals who ever had glucose measured by a health worker	Individuals with diabetes	35
Awareness of diagnosis	Individuals ever told by a health worker that they have diabetes	Individuals with diabetes	42
Treatment			
Glucose-lowering medication	Individuals using an oral glucose-lowering medication or insulin	Individuals with diabetes who have HbA1c ≥8.0% (FBG ≥9.2 mmol/L) or use an oral glucose-lowering medication or insulin	42
Blood pressure-lowering medication	Individuals using an antihypertensive medication	Individuals with diabetes and hypertension[b]	40
Statin	Individuals using a statin	Individuals age ≥40 years with diabetes	28
Control			
Glycemic control	Individuals with HbA1c <8.0% (FBG <9.2 mmol/L)	Individuals with diagnosed diabetes	42
Blood pressure control	Individuals with SBP <140 and DBP <90 mmHg	Individuals with diagnosed diabetes	41
Cholesterol control	Individuals (1) age <40 years with total cholesterol <190 mg/dL or (2) age ≥40 years and using statin	Individuals with diagnosed diabetes	28
Combined ABC control	Individuals with glycemic and blood pressure control	Individuals with diagnosed diabetes	41
Combined AB control	Individuals with glycemic, blood pressure, and cholesterol control	Individuals with diagnosed diabetes	28

[a]Diabetes was defined as use of a glucose-lowering drug (oral glucose-lowering medication or insulin) or an elevated biomarker meeting the WHO's criteria for diabetes: fasting plasma glucose (FPG) ≥7.0 mmol/l (126 mg/dl), random plasma glucose ≥11.1 mmol/l (200 mg/dl), or glycated hemoglobin (HbA1c) ≥6.5%. [b]Hypertension was defined as systolic blood pressure of 140 mmHg or higher, diastolic blood pressure of 90 mmHg or higher, or current use of an antihypertensive medication. Performance measures are generally consistent with recommendations in the WHO Package of Essential Noncommunicable Disease Interventions for Primary Health Care.[7] AB=glycemic and blood pressure control. ABC=glycemic, blood pressure, and cholesterol. DBP=diastolic blood pressure. FBG=fasting blood glucose. HbA1c=Glycated hemoglobin. SBP=systolic blood pressure.

Appendix 10: Unavailability of performance measures by country

Country	Ever tested	Awareness of diagnosis	Glucose-lowering medication	BP-lowering medication	Statin	Glycemic control	Blood pressure control	Lipid control	Combined AB control	Combined ABC control
Afghanistan										
Algeria										
Armenia										
Azerbaijan										
Bangladesh										
Belarus										
Benin										
Bhutan										
Burkina Faso										
Cambodia					X			X		X
Chile					X			X		X
China	X				X			X		X
El Salvador	X				X			X		X
Ethiopia										
Fiji	X			X	X		X	X	X	X
Georgia										
Guyana										
India	X				X			X		X
Indonesia	X				X			X		X
Iran										
Iraq										

Country	Ever tested	Awareness of diagnosis	Glucose-lowering medication	BP-lowering medication	Statin	Glycemic control	Blood pressure control	Lipid control	Combined AB control	Combined ABC control
Jordan										
Kenya										
Kyrgyzstan										
Laos					X			X		X
Malawi					X			X		X
Mexico	X									
Moldova										
Mongolia										
Morocco										
Namibia					X			X		X
Nepal										
Romania	X			X						
South Africa					X			X		X
Sudan										
Tanzania					X			X		X
Togo					X			X		X
Turkmenistan										
Uganda										
Vietnam										
Zambia										
Zanzibar					X			X		X
Countries with data	**35**	**42**	**42**	**40**	**28**	**42**	**41**	**28**	**41**	**28**

The “X” refers to a diabetes performance measure that is unavailable in the country’s survey. BP=blood pressure.

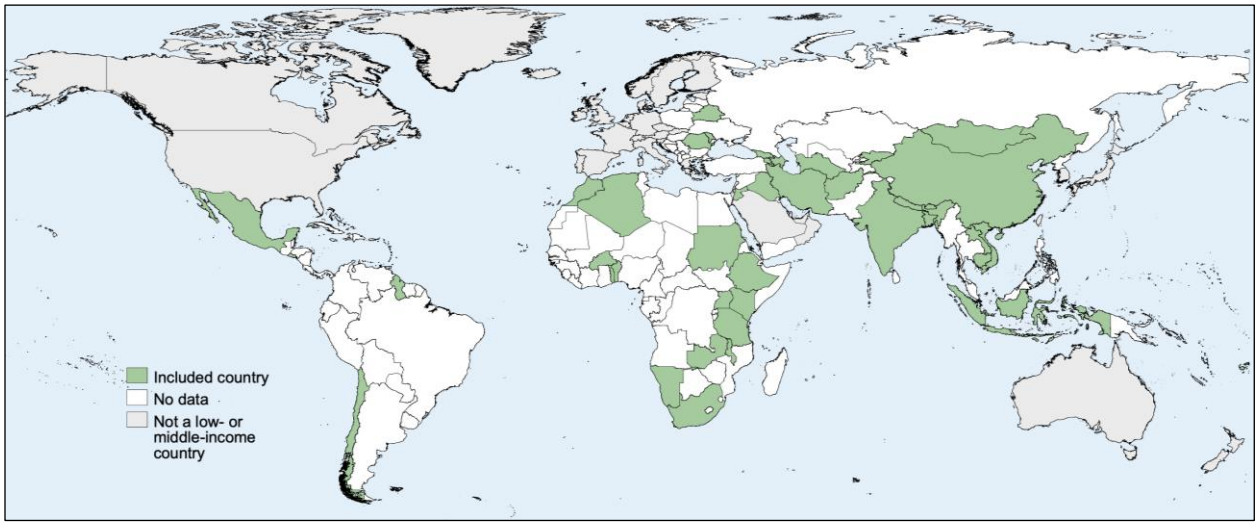
Appendix 11: Details on missing data by country

Country	Rural	Testing	Awareness of diagnosis	Glucose-lowering medication[a]	Blood pressure-lowering medication[a]	Statin[a]	Glycemic control	Blood pressure control	Lipid control
Afghanistan	0	0	0	0	0	0	0	0.6	0.6
Algeria	0	0.4	0.4	0.4	0.4	0.4	0	0.9	0.2
Armenia	0	0	0	0	0	0	0	2.7	0
Azerbaijan	0	0	0	0	0	0	0	0	0
Bangladesh	0	0	0	0	0	0	0	0	0
Belarus	0	0	0	0	0	0	0	0	0
Benin	0	0	0	0	0	0	0	0	3.3
Bhutan	0	0	0	0	0	0	0	0	0
Burkina Faso	0	0	0	0	12.1	0	0	0	0
Cambodia	0	0	0	0	0	N/A	0	0	N/A
Chile	0	0.5	0.5	0.5	0.5	N/A	0	0.4	N/A
China	0	N/A	0.2	0.2	0.2	N/A	0	0	N/A
El Salvador	0	N/A	0	0	0	N/A	0	0.4	N/A
Ethiopia	0	0	0	0	0	0	0	0	0
Fiji	0	N/A	0	0	N/A	N/A	0	N/A	N/A
Georgia	0	0	0	0	0	0	0	0	0
Guyana	0	0	0	0	0	0	0	1.2	0
India	0	N/A	1.4	0	0.2	N/A	0	0.1	N/A
Indonesia	0.1	N/A	0.7	0.7	0.7	N/A	0	1	N/A
Iran	0	1.4	1.4	1.4	1.3	1.4	0	0.6	0.2
Iraq	0	21.7	21.7	21.7	12.7	0	0	0.3	0

Country	Rural	Testing	Awareness of diagnosis	Glucose-lowering medication[a]	Blood pressure-lowering medication[a]	Statin[a]	Glycemic control	Blood pressure control	Lipid control
Jordan	0	0	0	0	0	0	0	2.7	0
Kenya	0	0	0	0	0.9	0	0	0	0
Kyrgyzstan	0	0	0	0	0	0	0	0	0
Laos	0	0	0	0	0	N/A	0	0	N/A
Malawi	0	0	0	0	0	N/A	0	0	N/A
Mexico	0	N/A	0	4.9	0	0	0	0.8	0.3
Moldova	0	0.9	0.9	0.9	0.9	0.9	0	0	0
Mongolia	0	0	0	0	0	0	0	0	0.6
Morocco	0	0	0	0	0	0	0	0	0
Namibia	0	0	0	0	0	N/A	0	0	N/A
Nepal	0	0	0	0	0	0	0	0	0
Romania	0	N/A	0	0	0	0	0	0	0
South Africa	2	8.6	8.6	8.6	8.6	N/A	0	6	N/A
Sudan	0	0	0	0	0	0	0	0	0
Tanzania	0	0.7	0.7	0.7	0.7	N/A	0	0	N/A
Togo	0	1.1	1.1	1.1	0	N/A	0	14.3	N/A
Turkmenistan	0	0	0	0	0	0	0	0	0
Uganda	0	0	0	0	0	0	0	7.1	0
Vietnam	0	0.9	0.9	0.9	0.9	0.9	0	0	0
Zambia	0	0	0	0	0	0	0	0	0
Zanzibar	0	0	0	0	0	N/A	0	0	N/A
Overall	**0**	**1.8**	**1.4**	**0.8**	**0.6**	**0.2**	**0**	**0.4**	**0.1**

[a]Refers to missingness among all individuals with diabetes in the sample. Note that missingness does not include data unavailability. N/A=Not available.

Appendix 12: Map of included countries



Countries included in the analysis but not easily visible on this map include Benin, El Salvador, Fiji, and Zanzibar.

Appendix 13: Sample characteristics

Characteristic	Total sample		Sample with diabetes		Sample with diagnosed diabetes	
	n	Weighted % (95% CI)[a]	n	Weighted % (95% CI)[a]	n	Weighted % (95% CI)[a]
Age[b]						
<30 years	320,277	30.3 (29.6-30.9)	3,863	11.0 (9.8-12.4)	1,026	4.3 (3.2-5.8)
30-39 years	246,851	23.8 (23.4-24.2)	7,513	15.4 (14.0-16.9)	2,810	9.2 (7.2-11.7)
40-49 years	208,369	21.4 (21.1-21.7)	14,226	24.4 (23.2-25.6)	6,862	22.2 (20.4-24.0)
50-59 years	41,975	15.5 (15.3-15.8)	5,565	28.8 (27.5-30.1)	3,209	37.5 (35.0-40.1)
60-69 years	22,638	9.0 (8.4-9.6)	4,237	28.8 (27.5-30.1)	2,787	26.8 (24.5-29.2)
Sex						
Male	171,331	49.3 (48.8-49.8)	9,962	48.1 (46.5-49.7)	4,556	45.4 (42.6-48.2)
Female	668,779	50.7 (50.2-51.2)	25,442	51.9 (50.3-53.5)	12,138	54.6 (51.8-57.4)
Education						
No schooling	229,041	17.5 (16.6-18.4)	8,995	18.6 (17.2-20.0)	3,617	15.4 (13.5-17.5)
Primary education	145,989	31.0 (29.5-32.5)	8,083	33.5 (31.5-35.6)	4,084	31.5 (28.7-34.4)
Secondary or above	463,202	51.5 (49.6-53.4)	18,094	47.9 (45.6-50.3)	8,865	53.2 (50.1-56.3)
Rural vs. urban residence						
Urban	283,216	45.7 (44.5-46.9)	17,588	53.0 (51.3-54.6)	9,478	61.5 (59.4-63.5)
Rural	556,810	54.3 (53.1-55.5)	17,803	47.0 (45.4-48.7)	7,210	38.5 (36.5-40.6)
Overall	**840,110**	**100**	**35,404**	**100**	**16,694**	**100**

[a]Estimates account for survey design and equal country weighting. [b]Age is depicted in categories in this table but is maintained as a continuous variable in all regression analyses in this study.

Appendix 14: Rural versus urban residence among study sample

Country	Rural sample, n	Urban sample, n	Rural sample of total sample, unweighted %	Rural sample of total sample, weighted %
Afghanistan	1,605	1,731	48.1	43.7
Algeria	1,943	3,925	33.1	33.5
Armenia	606	1,140	34.7	33.4
Azerbaijan	1,177	1,450	44.8	46.3
Bangladesh	3,682	3,265	53.0	79.7
Belarus	2,377	2,359	50.2	45.8
Benin	2,490	2,320	51.8	48.5
Bhutan	1,860	807	69.7	69.3
Burkina Faso	3,155	790	80.0	75.5
Cambodia	4,136	890	82.3	83.0
Chile	593	3,457	14.6	12.6
China	5,352	2,216	70.7	70.7
El Salvador	1,978	2,125	48.2	43.1
Ethiopia	5,662	2,049	73.4	81.8
Fiji	658	531	55.3	55.3
Georgia	1,596	1,559	50.6	52.4
Guyana	596	228	72.3	73.4
India	462,075	196,634	70.1	63.5
Indonesia	2,271	3,182	41.6	48.3
Iran	6,222	11,772	34.6	29.3
Iraq	764	2,758	21.7	24.0
Jordan	623	2,703	18.7	15.5
Kenya	2,040	1,934	51.3	61.2
Kyrgyzstan	1,485	997	59.8	66.2
Laos	1,655	738	69.2	69.4
Malawi	2,464	341	87.8	88.8
Mexico	3,937	7,464	34.5	21.6
Moldova	1,680	1,986	45.8	57.1
Mongolia	2,135	3,861	35.6	36.8
Morocco	1,669	2,611	39.0	35.5
Namibia	1,735	1,509	53.5	53.4
Nepal	4,420	641	87.3	90.9

Country	Rural sample, n	Urban sample, n	Rural sample of total sample, unweighted %	Rural sample of total sample, weighted %
Romania	689	996	40.9	40.9
South Africa	1,351	2,431	35.7	30.1
Sudan	4,333	2,119	67.2	63.3
Tanzania	3,622	1,001	78.3	68.9
Togo	2,473	711	77.7	62.0
Turkmenistan	1,912	1,833	51.1	52.0
Uganda	2,502	906	73.4	81.1
Vietnam	1,669	1,346	55.4	65.1
Zambia	2,148	1,183	64.5	54.0
Zanzibar	1,470	717	67.2	53.4
Overall	**556,810**	**283,216**	**66.3**	**54.3 (53.1 to 55.5)[a]**

[a]Estimate (95% CI) using equal country weights.

Appendix 15: Proportion of diabetes population living in rural or urban areas

Country	Rural sample with diabetes, n	Urban sample with diabetes, n	Proportion of diabetes population who are rural, unweighted %	Proportion of diabetes population who are rural, weighted %
Afghanistan	119	279	29.9	33.2
Algeria	162	547	22.8	23.7
Armenia	38	95	28.6	24.5
Azerbaijan	81	188	30.1	29.3
Bangladesh	257	415	38.2	67.8
Belarus	124	140	47.0	42.2
Benin	113	190	37.3	30.8
Bhutan	42	33	56.0	55.0
Burkina Faso	70	29	70.7	68.9
Cambodia	91	61	59.9	63.3
Chile	60	337	15.1	14.6
China	318	181	63.7	63.7
El Salvador	141	217	39.4	33.5
Ethiopia	119	105	53.1	70.5
Fiji	277	232	54.4	54.4
Georgia	127	135	48.5	52.5
Guyana	102	27	79.1	79.5
India	12,137	8,397	59.1	53.6
Indonesia	167	260	39.1	44.5
Iran	376	1,030	26.7	22.5
Iraq	119	493	19.4	24.2
Jordan	77	407	15.9	14.8
Kenya	43	64	40.2	48.6
Kyrgyzstan	93	60	60.8	61.6
Laos	88	42	67.7	66.5
Malawi	20	6	76.9	76.3
Mexico	578	1,252	31.6	17.7
Moldova	136	183	42.6	53.3
Mongolia	186	393	32.1	32.7
Morocco	162	410	28.3	25.2
Namibia	80	138	36.7	36.2
Nepal	247	86	74.2	83.7

Country	Rural sample with diabetes, n	Urban sample with diabetes, n	Proportion of diabetes population who are rural, unweighted %	Proportion of diabetes population who are rural, weighted %
Romania	87	103	45.8	45.8
South Africa	120	347	25.7	29.3
Sudan	268	285	48.5	46.3
Tanzania	93	49	65.5	60.2
Togo	69	20	77.5	60.7
Turkmenistan	127	134	48.7	53.3
Uganda	21	21	50.0	62.7
Vietnam	40	69	36.7	49.5
Zambia	173	89	66.0	56.3
Zanzibar	55	39	58.5	41.1
Overall	**17,803**	**17,588**	**50.3**	**47.0 (45.4 to 48.6)[b]**

[a]The sum of the rural and urban diabetes population in these columns (n=35,391) differs from the total sample with diabetes in the analysis (n=35,404) because there were n=29 respondents with diabetes who were missing the variable for area of residence. [b]Estimate (95% CI) using equal country weights.

Appendix 16: Number of respondents with diabetes and diabetes prevalence by country

Country	Sample with diabetes, n	Prevalence of diabetes among rural population, weighted %	Prevalence of diabetes among urban population, weighted %
Afghanistan	398	9.0 (6.6-12.1)	14.2 (11.0-18.0)
Algeria	709	7.1 (6.1-8.3)	11.6 (10.7-12.6)
Armenia	133	5.2 (3.6-7.5)	7.5 (5.7-9.8)
Azerbaijan	269	4.6 (3.6-5.8)	9.5 (8.0-11.3)
Bangladesh	672	6.9 (5.8-8.2)	12.6 (10.8-14.8)
Belarus	264	4.3 (3.5-5.3)	5.0 (4.1-6.0)
Benin	303	3.9 (3.1-5.0)	8.5 (7.0-10.2)
Bhutan	75	1.8 (1.2-2.8)	3.4 (2.1-5.4)
Burkina Faso	99	2.5 (1.9-3.3)	3.5 (2.3-5.4)
Cambodia	152	1.9 (1.5-2.4)	5.3 (4.0-7.0)
Chile	397	9.8 (6.4-14.8)	8.6 (7.3-10.2)
China	499	5.9 (5.3-6.6)	8.2 (7.1-9.4)
El Salvador	358	7.4 (6.1-8.9)	11.2 (9.7-12.9)
Ethiopia	224	1.9 (1.5-2.4)	3.5 (2.7-4.7)
Fiji	509	42.1 (38.4-45.9)	43.7 (39.5-48.0)
Georgia	262	5.9 (4.7-7.3)	6.0 (4.9-7.3)
Guyana	129	14.4 (11.4-17.9)	10.2 (6.4-15.9)
India	20,534	3.4 (3.3-3.6)	5.2 (5.0-5.5)
Indonesia	428	7.3 (6.2-8.7)	9.9 (8.7-11.2)
Iran	1,406	6.4 (5.8-7.0)	8.7 (8.2-9.3)
Iraq	612	14.7 (11.5-18.6)	14.5 (13.0-16.2)
Jordan	484	12.1 (8.8-16.3)	12.5 (10.9-14.4)
Kenya	107	1.5 (1.0-2.1)	2.5 (1.4-4.2)
Kyrgyzstan	153	5.1 (4.0-6.4)	6.2 (4.0-9.3)
Laos	130	3.7 (2.8-4.7)	5.3 (3.8-7.4)
Malawi	26	0.8 (0.5-1.3)	1.9 (0.8-4.5)
Mexico	1,830	14.2 (12.8-15.7)	17.9 (16.6-19.3)
Moldova	319	5.7 (4.6-6.9)	6.6 (5.4-8.0)
Mongolia	579	7.9 (6.7-9.3)	9.4 (8.4-10.6)
Morocco	572	7.9 (6.6-9.3)	12.7 (11.5-14.1)
Namibia	218	4.2 (3.3-5.3)	8.4 (6.9-10.2)
Nepal	333	5.6 (4.7-6.6)	11.1 (8.0-15.2)

Country	Sample with diabetes, n	Prevalence of diabetes among rural population, weighted %	Prevalence of diabetes among urban population, weighted %
Romania	190	12.6 (10.3-15.3)	10.3 (8.6-12.4)
South Africa	479	8.6 (7.0-10.6)	10.8 (9.3-12.5)
Sudan	553	4.9 (4.2-5.8)	9.8 (8.5-11.3)
Tanzania	142	2.5 (1.9-3.3)	3.6 (1.9-6.8)
Togo	89	2.7 (2.0-3.4)	2.8 (1.7-4.6)
Turkmenistan	261	6.0 (4.9-7.3)	5.7 (4.6-6.9)
Uganda	42	1.1 (0.7-1.9)	2.8 (1.7-4.7)
Vietnam	109	2.1 (1.5-3.0)	4.3 (3.3-5.6)
Zambia	262	7.1 (6.0-8.3)	6.4 (4.9-8.4)
Zanzibar	94	2.7 (2.0-3.7)	4.5 (2.8-6.9)
Overall	**35,404**	**6.0 (5.5-6.4)[a]**	**9.4 (8.9-9.9) [a]**

[a]Estimate (95% CI) using equal country weights. Note that the age range of the underlying surveys differs by country; these estimates are not age adjusted, and thus they are not directly comparable among countries.

Appendix 17: Age-adjusted proportion of individuals with diabetes achieving performance measures

	Estimate, % (95% CI)	
Goal	**Urban**	**Rural**
Testing	64.7 (62.1 to 67.3)	49.1 (46.5 to 51.7)
Awareness	48.5 (45.9 to 51.2)	39.0 (35.7 to 42.4)
Glucose-lowering medication	61.6 (57.9 to 65.2)	53.1 (49.7 to 56.5)
Blood pressure-lowering medication	44.8 (41.7 to 47.9)	37.2 (33.8 to 40.5)
Statin	9.4 (8.2 to 10.6)	6.7 (5.2 to 8.1)
Glycemic control	56.0 (52.5 to 59.5)	48.2 (43.7 to 52.6)
Blood pressure control	48.7 (45.2 to 52.1)	45.7 (41.3 to 50.1)
Cholesterol control	23.2 (19.1 to 27.3)	17.9 (14.2 to 21.6)
AB control	29.0 (25.5 to 32.5)	23.1 (19.4 to 26.8)
ABC control	9.5 (5.9 to 13.2)	3.8 (2.2 to 5.3)

Appendix 18: Population of individuals achieving and not achieving goal

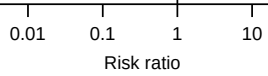
Goal	Population size, thousands (95% CI)			
	Urban, achievement	**Urban, no achievement**	**Rural, achievement**	**Rural, no achievement**
Testing	293 (282 to 303)	136 (126 to 147)	149 (140 to 157)	175 (166 to 183)
Awareness	221 (210 to 233)	208 (196 to 219)	117 (107 to 128)	206 (195 to 217)
Glucose-lowering medication	174 (161 to 186)	92 (81 to 103)	88 (82 to 94)	73 (66 to 81)
Blood pressure-lowering medication	119 (111 to 127)	126 (117 to 135)	58 (52 to 64)	98 (91 to 106)
Statin	37 (33 to 42)	282 (272 to 293)	13 (11 to 16)	209 (199 to 220)
Glycemic control	121 (110 to 131)	101 (91 to 111)	56 (49 to 65)	61 (54 to 68)
Blood pressure control	102 (93 to 112)	113 (106 to 121)	56 (48 to 65)	58 (53 to 64)
Cholesterol control	51 (45 to 58)	176 (164 to 189)	22 (18 to 26)	101 (89 to 114)
AB control	57 (50 to 65)	162 (152 to 172)	28 (22 to 35)	88 (81 to 96)
ABC control	19 (15 to 24)	206 (193 to 218)	6 (4 to 8)	117 (105 to 129)

Appendix 19: Age-adjusted proportion of individuals with diabetes achieving performance measures by sex

	Estimate, % (95% CI)			
Goal	**Urban men**	**Rural men**	**Urban women**	**Rural women**
Testing	59.8 (56.1 to 63.5)	48.0 (44.0 to 52.0)	68.9 (65.6 to 72.2)	50.6 (47.5 to 53.7)
Awareness	45.8 (42.4 to 49.3)	37.5 (33.5 to 41.5)	51.1 (47.9 to 54.2)	40.5 (36.7 to 44.4)
Glucose-lowering medication	57.3 (52.2 to 62.3)	52.4 (47.5 to 57.3)	65.9 (61.7 to 70.1)	54.4 (50.2 to 58.7)
Blood pressure-lowering medication	38.1 (33.9 to 42.4)	30.8 (26.4 to 35.1)	51.6 (47.0 to 56.3)	42.2 (37.7 to 46.7)
Statin	9.7 (7.6 to 11.8)	6.3 (4.5 to 8.2)	9.2 (7.9 to 10.6)	6.5 (4.5 to 8.5)
Glycemic control	51.6 (46.6 to 56.7)	48.6 (42.2 to 55.1)	58.4 (54.1 to 62.7)	49.1 (43.6 to 54.5)
Blood pressure control	45.0 (39.5 to 50.6)	49.5 (43.4 to 55.6)	50.6 (45.7 to 55.5)	44.6 (39.1 to 50.1)
Cholesterol control	24.8 (19.0 to 30.6)	19.4 (13.6 to 25.1)	20.6 (16.4 to 24.8)	17.5 (12.6 to 22.4)
AB control	22.4 (18.1 to 26.8)	28.3 (23.2 to 33.5)	32.6 (27.5 to 37.7)	22.4 (16.9 to 28.0)
ABC control	8.5 (4.8 to 12.2)	7.4 (3.1 to 11.7)	8.2 (5.3 to 11.1)	2.7 (1.2 to 4.3)

Appendix 20: Differences in achievement of ever tested among rural versus urban (reference category) populations with diabetes by country

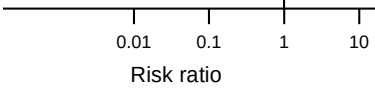
Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Afghanistan	1.12 (0.83 to 1.51)	0.471	6.7 (-11.6 to 25.0)	57.5 (45.0 to 70.0)	64.2 (50.2 to 78.2)
Azerbaijan	1.04 (0.88 to 1.23)	0.664	2.6 (-9.3 to 14.5)	69.0 (60.7 to 77.4)	71.7 (60.4 to 82.9)
Chile	1.03 (0.80 to 1.33)	0.803	2.6 (-17.8 to 22.9)	77.3 (70.1 to 84.6)	79.9 (60.8 to 98.9)
Iraq	1.01 (0.93 to 1.10)	0.854	0.7 (-7.1 to 8.6)	91.4 (87.9 to 94.9)	92.1 (85.0 to 99.2)
Moldova	0.98 (0.85 to 1.14)	0.837	-1.2 (-12.9 to 10.4)	81.0 (72.9 to 89.1)	79.8 (71.3 to 88.3)
Jordan	0.98 (0.87 to 1.11)	0.781	-1.6 (-12.8 to 9.6)	90.7 (85.7 to 95.7)	89.1 (79.0 to 99.2)
Laos	0.98 (0.72 to 1.33)	0.872	-1.6 (-20.7 to 17.6)	62.5 (47.0 to 77.9)	60.9 (49.0 to 72.8)
Iran	0.97 (0.93 to 1.02)	0.208	-2.5 (-6.3 to 1.4)	90.4 (88.6 to 92.2)	87.9 (84.5 to 91.3)
Georgia	0.96 (0.83 to 1.10)	0.535	-3.7 (-15.3 to 8.0)	81.9 (73.9 to 89.8)	78.2 (69.5 to 86.9)
Belarus	0.94 (0.89 to 1.01)	0.081	-5.5 (-11.5 to 0.6)	98.8 (96.6 to 100.0)	93.3 (87.9 to 98.7)
Togo	0.93 (0.48 to 1.82)	0.841	-1.9 (-20.9 to 17.1)	29.3 (12.7 to 45.8)	27.4 (15.1 to 39.7)
Algeria	0.92 (0.83 to 1.03)	0.155	-5.9 (-13.9 to 2.0)	78.8 (75.1 to 82.5)	72.9 (65.7 to 80.0)
Mongolia	0.88 (0.71 to 1.09)	0.234	-6.1 (-15.9 to 3.7)	51.0 (44.9 to 57.2)	44.9 (36.9 to 52.9)
Guyana	0.88 (0.77 to 1.01)	0.065	-11.3 (-23.2 to 0.6)	93.8 (85.7 to 100.0)	82.4 (73.4 to 91.4)
Bangladesh	0.87 (0.76 to 1.01)	0.066	-9.3 (-19.0 to 0.3)	73.4 (67.5 to 79.3)	64.1 (55.7 to 72.5)
Armenia	0.87 (0.64 to 1.17)	0.357	-9.1 (-28.0 to 9.8)	69.3 (56.1 to 82.5)	60.2 (43.3 to 77.1)
South Africa	0.86 (0.68 to 1.08)	0.202	-9.2 (-22.9 to 4.5)	65.7 (58.2 to 73.3)	56.5 (45.1 to 67.9)
Vietnam	0.78 (0.53 to 1.15)	0.213	-15.3 (-38.4 to 7.7)	70.6 (56.4 to 84.8)	55.3 (36.7 to 73.9)
Cambodia	0.77 (0.62 to 0.96)	0.020	-18.4 (-33.6 to -3.2)	81.4 (70.0 to 92.8)	63.0 (51.9 to 74.1)
Morocco	0.75 (0.64 to 0.89)	<0.001	-17.8 (-27.2 to -8.3)	71.6 (66.5 to 76.7)	53.8 (45.5 to 62.1)
Sudan	0.72 (0.60 to 0.86)	<0.001	-19.1 (-28.9 to -9.2)	68.2 (61.1 to 75.2)	49.1 (41.6 to 56.7)
Kyrgyzstan	0.72 (0.52 to 1.00)	0.050	-19.7 (-39.9 to 0.6)	69.9 (53.1 to 86.7)	50.2 (38.4 to 62.0)
Malawi	0.64 (0.16 to 2.61)	0.520	-12.9 (-58.6 to 32.9)	36.0 (0.0 to 79.4)	23.1 (3.5 to 42.7)
Turkmenistan	0.61 (0.47 to 0.78)	<0.001	-26.4 (-39.0 to -13.9)	67.7 (57.9 to 77.5)	41.3 (32.0 to 50.5)
Nepal	0.61 (0.42 to 0.89)	0.010	-21.2 (-39.4 to -3.1)	54.0 (37.0 to 71.0)	32.8 (25.2 to 40.4)
Namibia	0.59 (0.45 to 0.78)	<0.001	-28.2 (-41.4 to -15.1)	69.4 (60.1 to 78.6)	41.2 (30.6 to 51.8)
Tanzania	0.57 (0.27 to 1.19)	0.133	-23.9 (-60.4 to 12.6)	55.3 (21.3 to 89.2)	31.4 (19.0 to 43.7)
Bhutan	0.48 (0.25 to 0.91)	0.026	-33.4 (-59.5 to -7.3)	64.2 (43.6 to 84.9)	30.8 (12.7 to 49.0)
Kenya	0.47 (0.29 to 0.76)	0.003	-39.4 (-61.3 to -17.5)	73.9 (57.1 to 90.6)	34.4 (18.7 to 50.2)
Zanzibar	0.33 (0.18 to 0.59)	<0.001	-47.1 (-70.7 to -23.5)	70.0 (49.2 to 90.8)	22.9 (11.1 to 34.8)
Benin	0.29 (0.13 to 0.67)	0.004	-12.6 (-19.8 to -5.4)	17.8 (11.7 to 24.0)	5.2 (1.2 to 9.2)
Ethiopia	0.25 (0.14 to 0.48)	<0.001	-40.2 (-55.1 to -25.3)	53.8 (39.5 to 68.1)	13.6 (5.0 to 22.3)
Uganda	0.24 (0.08 to 0.78)	0.019	-49.4 (-79.4 to -19.4)	65.2 (39.0 to 91.4)	15.8 (0.0 to 33.9)
Zambia	0.22 (0.11 to 0.42)	<0.001	-24.8 (-37.1 to -12.6)	31.8 (20.0 to 43.5)	6.9 (3.2 to 10.7)
Burkina Faso	0.11 (0.03 to 0.35)	<0.001	-35.8 (-55.1 to -16.5)	40.1 (21.2 to 59.0)	4.3 (0.0 to 9.1)



See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

Appendix 21: Differences in achievement of awareness of diagnosis among rural versus urban (reference category) populations with diabetes by country

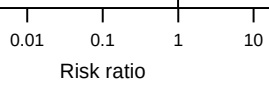
Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Afghanistan	1.26 (0.88 to 1.79)	0.202	12.2 (-6.4 to 30.8)	47.3 (34.2 to 60.3)	59.4 (45.3 to 73.5)
Chile	1.15 (0.85 to 1.56)	0.352	9.3 (-11.2 to 29.7)	60.3 (51.9 to 68.7)	69.6 (50.4 to 88.7)
El Salvador	1.14 (0.98 to 1.32)	0.089	9.4 (-1.5 to 20.2)	67.6 (60.4 to 74.9)	77.0 (68.9 to 85.1)
Moldova	1.11 (0.84 to 1.47)	0.450	5.0 (-8.0 to 18.1)	44.1 (34.8 to 53.3)	49.1 (39.1 to 59.1)
Armenia	1.10 (0.69 to 1.75)	0.684	4.3 (-16.7 to 25.2)	42.4 (29.2 to 55.5)	46.6 (28.5 to 64.7)
Romania	1.10 (0.94 to 1.28)	0.228	7.3 (-4.5 to 19.0)	74.6 (66.1 to 83.1)	81.8 (73.7 to 90.0)
Jordan	1.04 (0.88 to 1.23)	0.639	3.2 (-10.4 to 16.8)	80.5 (74.4 to 86.5)	83.7 (71.6 to 95.8)
Laos	1.03 (0.72 to 1.48)	0.855	1.7 (-16.8 to 20.2)	50.8 (34.8 to 66.8)	52.6 (40.2 to 64.9)
Belarus	1.02 (0.86 to 1.21)	0.832	1.4 (-11.2 to 13.9)	71.5 (63.1 to 79.9)	72.9 (63.7 to 82.1)
Georgia	1.01 (0.83 to 1.25)	0.898	0.9 (-12.9 to 14.7)	66.4 (57.0 to 75.8)	67.3 (57.4 to 77.2)
Iraq	1.01 (0.86 to 1.20)	0.877	0.9 (-10.3 to 12.1)	66.7 (60.8 to 72.6)	67.6 (56.8 to 78.4)
Algeria	0.97 (0.84 to 1.12)	0.689	-1.8 (-10.6 to 7.0)	62.8 (58.5 to 67.0)	61.0 (53.2 to 68.8)
Mexico	0.97 (0.87 to 1.08)	0.530	-2.1 (-8.8 to 4.5)	62.0 (57.7 to 66.3)	59.9 (54.4 to 65.3)
Vietnam	0.96 (0.62 to 1.49)	0.857	-2.1 (-25.1 to 20.9)	53.5 (39.4 to 67.5)	51.4 (32.4 to 70.3)
Iran	0.96 (0.89 to 1.02)	0.192	-3.4 (-8.6 to 1.7)	78.6 (76.1 to 81.2)	75.2 (70.7 to 79.6)
Fiji	0.94 (0.73 to 1.20)	0.605	-2.1 (-10.3 to 6.0)	34.2 (28.1 to 40.2)	32.0 (26.5 to 37.5)
Azerbaijan	0.92 (0.72 to 1.18)	0.502	-4.5 (-17.6 to 8.5)	55.6 (47.1 to 64.1)	51.1 (39.3 to 62.8)
Mongolia	0.90 (0.64 to 1.27)	0.556	-2.3 (-10.0 to 5.3)	24.1 (19.2 to 28.9)	21.7 (15.6 to 27.9)
South Africa	0.84 (0.62 to 1.15)	0.280	-7.8 (-21.4 to 5.9)	49.9 (41.8 to 58.1)	42.2 (31.1 to 53.3)
Sudan	0.84 (0.69 to 1.02)	0.071	-8.5 (-17.6 to 0.5)	51.6 (44.9 to 58.3)	43.1 (35.8 to 50.4)
India	0.83 (0.78 to 0.88)	<0.001	-8.3 (-11.2 to -5.4)	48.2 (45.8 to 50.5)	39.9 (38.2 to 41.6)
Guyana	0.81 (0.64 to 1.03)	0.084	-14.8 (-31.8 to 2.3)	78.9 (64.7 to 93.1)	64.1 (53.0 to 75.2)
Togo	0.78 (0.33 to 1.82)	0.561	-5.1 (-22.8 to 12.6)	23.1 (8.0 to 38.2)	18.0 (6.6 to 29.4)
Bangladesh	0.74 (0.58 to 0.93)	0.010	-15.0 (-25.6 to -4.4)	57.1 (50.2 to 63.9)	42.0 (33.3 to 50.8)
Morocco	0.71 (0.57 to 0.88)	0.002	-15.9 (-24.8 to -6.9)	54.2 (48.8 to 59.5)	38.3 (30.7 to 45.9)
Cambodia	0.71 (0.51 to 0.98)	0.036	-18.9 (-36.6 to -1.2)	64.3 (50.0 to 78.6)	45.5 (34.0 to 56.9)
China	0.67 (0.53 to 0.84)	<0.001	-14.9 (-23.7 to -6.2)	45.3 (38.0 to 52.6)	30.4 (25.4 to 35.4)
Kyrgyzstan	0.66 (0.43 to 1.00)	0.052	-20.5 (-42.3 to 1.3)	59.8 (40.9 to 78.6)	39.3 (27.9 to 50.6)
Kenya	0.56 (0.23 to 1.36)	0.200	-16.5 (-43.9 to 10.9)	37.7 (13.1 to 62.4)	21.3 (7.9 to 34.6)
Malawi	0.56 (0.14 to 2.29)	0.403	-15.2 (-57.2 to 26.7)	34.7 (0.0 to 74.6)	19.4 (0.7 to 38.1)
Indonesia	0.56 (0.36 to 0.88)	0.011	-13.9 (-23.2 to -4.6)	31.6 (25.7 to 37.6)	17.7 (10.5 to 24.9)
Tanzania	0.55 (0.26 to 1.17)	0.122	-24.0 (-59.9 to 11.8)	53.7 (20.2 to 87.2)	29.7 (17.4 to 41.9)
Namibia	0.52 (0.35 to 0.77)	0.001	-25.5 (-38.9 to -12.0)	52.9 (42.9 to 62.8)	27.4 (17.5 to 37.3)
Bhutan	0.52 (0.24 to 1.10)	0.087	-24.2 (-50.8 to 2.3)	50.3 (28.8 to 71.8)	26.1 (9.1 to 43.0)
Nepal	0.50 (0.32 to 0.76)	0.001	-23.0 (-39.6 to -6.4)	45.6 (29.5 to 61.6)	22.6 (16.0 to 29.1)
Turkmenistan	0.49 (0.29 to 0.82)	0.007	-14.0 (-24.0 to -3.9)	27.5 (19.0 to 36.1)	13.5 (7.7 to 19.4)
Benin	0.43 (0.17 to 1.07)	0.069	-5.7 (-11.2 to -0.1)	9.9 (5.3 to 14.4)	4.2 (0.8 to 7.7)
Uganda	0.38 (0.12 to 1.16)	0.087	-27.5 (-52.9 to -2.1)	44.1 (22.7 to 65.5)	16.6 (0.0 to 35.2)
Zanzibar	0.32 (0.17 to 0.61)	<0.001	-36.3 (-56.3 to -16.2)	53.3 (34.0 to 72.6)	17.0 (6.6 to 27.4)
Ethiopia	0.26 (0.14 to 0.51)	<0.001	-36.1 (-50.9 to -21.4)	49.1 (34.9 to 63.3)	13.0 (4.4 to 21.6)
Zambia	0.24 (0.11 to 0.51)	<0.001	-17.9 (-29.0 to -6.7)	23.4 (12.7 to 34.1)	5.5 (2.1 to 9.0)
Burkina Faso	0.21 (0.05 to 0.89)	0.035	-14.5 (-30.9 to 1.9)	18.2 (2.3 to 34.2)	3.8 (0.0 to 8.3)



See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

Appendix 22: Differences in achievement of glucose-lowering medication among rural versus urban (reference category) populations with diabetes by country

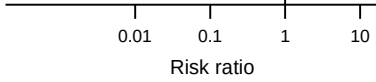
Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
El Salvador	1.49 (0.88 to 2.52)	0.134	9.4 (-3.2 to 22.0)	19.1 (11.9 to 26.3)	28.5 (18.1 to 38.9)
Ethiopia	1.26 (0.85 to 1.88)	0.248	16.9 (-13.2 to 46.9)	64.1 (48.4 to 79.7)	80.9 (55.0 to 100.0)
Armenia	1.23 (0.90 to 1.68)	0.189	10.7 (-5.4 to 26.8)	46.5 (31.9 to 61.1)	57.2 (40.6 to 73.8)
Moldova	1.20 (0.88 to 1.63)	0.240	10.6 (-7.0 to 28.3)	53.3 (40.6 to 66.1)	64.0 (51.2 to 76.8)
Georgia	1.19 (0.97 to 1.47)	0.089	13.2 (-1.7 to 28.0)	67.5 (56.5 to 78.6)	80.7 (71.0 to 90.4)
Guyana	1.17 (0.78 to 1.74)	0.447	11.0 (-16.0 to 38.0)	66.1 (41.0 to 91.1)	77.1 (66.1 to 88.0)
Fiji	1.15 (0.91 to 1.46)	0.242	7.9 (-5.2 to 20.9)	51.5 (42.0 to 61.1)	59.4 (50.4 to 68.4)
Chile	1.10 (0.82 to 1.49)	0.526	7.0 (-15.1 to 29.0)	68.2 (57.4 to 79.1)	75.2 (56.7 to 93.7)
Tanzania	1.10 (0.56 to 2.13)	0.783	4.7 (-28.7 to 38.1)	48.7 (17.6 to 79.8)	53.4 (26.7 to 80.1)
Romania	1.07 (0.67 to 1.72)	0.765	2.9 (-16.5 to 22.3)	39.6 (25.3 to 54.0)	42.5 (27.3 to 57.8)
Iran	1.04 (0.97 to 1.12)	0.280	3.2 (-2.6 to 8.9)	74.5 (71.5 to 77.6)	77.7 (72.8 to 82.6)
Algeria	1.02 (0.90 to 1.15)	0.749	1.5 (-7.7 to 10.7)	75.7 (71.3 to 80.1)	77.2 (69.2 to 85.2)
Togo	1.02 (0.40 to 2.57)	0.966	0.6 (-27.9 to 29.1)	30.5 (7.0 to 54.0)	31.1 (5.8 to 56.4)
India	0.99 (0.97 to 1.00)	0.119	-1.1 (-2.5 to 0.3)	97.4 (96.5 to 98.2)	96.3 (95.2 to 97.4)
Jordan	0.97 (0.82 to 1.14)	0.687	-2.9 (-17.0 to 11.2)	90.6 (85.2 to 96.1)	87.7 (74.6 to 100.0)
Iraq	0.94 (0.77 to 1.15)	0.563	-4.2 (-18.2 to 9.8)	74.5 (67.8 to 81.1)	70.3 (57.0 to 83.5)
Mongolia	0.92 (0.65 to 1.32)	0.658	-3.9 (-21.2 to 13.3)	51.1 (40.6 to 61.6)	47.2 (32.7 to 61.7)
Azerbaijan	0.91 (0.72 to 1.15)	0.427	-6.2 (-21.1 to 8.8)	68.1 (58.3 to 78.0)	61.9 (48.4 to 75.5)
Burkina Faso	0.91 (0.11 to 7.21)	0.920	-2.9 (-64.8 to 58.9)	31.8 (0.0 to 67.0)	28.9 (0.0 to 76.4)
Bangladesh	0.91 (0.77 to 1.07)	0.244	-5.9 (-15.7 to 3.9)	63.1 (55.7 to 70.5)	57.2 (47.9 to 66.5)
Belarus	0.91 (0.80 to 1.02)	0.098	-8.8 (-19.0 to 1.4)	93.1 (88.0 to 98.2)	84.3 (75.5 to 93.0)
Vietnam	0.90 (0.62 to 1.32)	0.598	-7.0 (-33.2 to 19.1)	74.0 (57.8 to 90.2)	67.0 (46.5 to 87.5)
Namibia	0.86 (0.67 to 1.11)	0.243	-10.7 (-28.4 to 7.1)	77.7 (65.6 to 89.9)	67.1 (53.8 to 80.4)
South Africa	0.86 (0.68 to 1.08)	0.196	-11.1 (-27.2 to 5.1)	77.1 (68.2 to 85.9)	66.0 (51.8 to 80.2)
Laos	0.85 (0.60 to 1.22)	0.373	-9.8 (-32.0 to 12.3)	66.3 (46.5 to 86.1)	56.5 (40.5 to 72.5)
Morocco	0.84 (0.69 to 1.02)	0.080	-11.6 (-23.9 to 0.7)	70.9 (64.9 to 76.9)	59.3 (48.4 to 70.3)
Nepal	0.83 (0.47 to 1.46)	0.509	-9.2 (-38.3 to 19.9)	53.1 (25.9 to 80.2)	43.9 (32.1 to 55.7)
Sudan	0.78 (0.64 to 0.96)	0.020	-14.7 (-26.6 to -2.8)	67.9 (60.0 to 75.9)	53.2 (43.9 to 62.5)
Afghanistan	0.77 (0.50 to 1.21)	0.258	-14.6 (-38.6 to 9.3)	65.0 (51.3 to 78.8)	50.4 (30.6 to 70.2)
China	0.75 (0.63 to 0.90)	0.001	-18.5 (-29.6 to -7.3)	74.2 (65.9 to 82.6)	55.8 (48.0 to 63.5)
Indonesia	0.72 (0.44 to 1.20)	0.212	-10.7 (-26.1 to 4.7)	38.9 (30.6 to 47.2)	28.2 (15.0 to 41.3)
Kyrgyzstan	0.70 (0.47 to 1.05)	0.082	-21.9 (-46.3 to 2.5)	73.5 (55.0 to 91.9)	51.5 (35.3 to 67.8)
Cambodia	0.67 (0.47 to 0.96)	0.029	-24.0 (-44.2 to -3.8)	73.4 (59.3 to 87.4)	49.4 (34.3 to 64.5)
Benin	0.67 (0.24 to 1.93)	0.456	-7.9 (-27.1 to 11.2)	24.2 (12.2 to 36.2)	16.3 (0.7 to 31.9)
Turkmenistan	0.66 (0.42 to 1.06)	0.083	-16.3 (-34.3 to 1.7)	48.5 (34.3 to 62.8)	32.2 (19.7 to 44.7)
Bhutan	0.55 (0.27 to 1.13)	0.101	-25.4 (-53.7 to 3.0)	56.5 (28.5 to 84.5)	31.1 (7.5 to 54.7)
Kenya	0.46 (0.23 to 0.93)	0.032	-39.9 (-68.9 to -10.9)	73.9 (53.4 to 94.3)	34.0 (10.5 to 57.4)
Zambia	0.43 (0.16 to 1.19)	0.101	-26.1 (-55.8 to 3.7)	45.8 (21.8 to 69.8)	19.7 (3.0 to 36.5)
Zanzibar	0.37 (0.09 to 1.61)	0.181	-25.7 (-56.5 to 5.1)	41.0 (15.1 to 66.9)	15.3 (0.0 to 37.3)
Uganda	0.33 (0.05 to 2.28)	0.215	-45.3 (-114.8 to 24.2)	67.2 (12.8 to 100.0)	21.9 (0.0 to 58.3)



See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

Appendix 23: Differences in achievement of blood pressure-lowering medication among rural versus urban (reference category) populations with diabetes by country

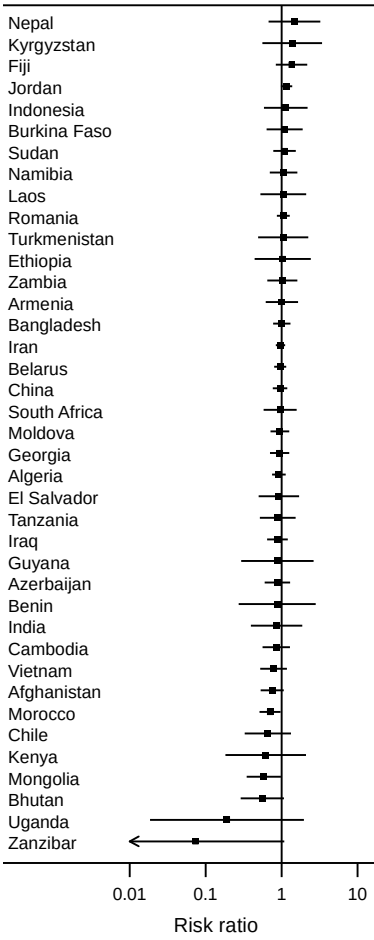
Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Ethiopia	2.68 (1.07 to 6.70)	0.035	28.2 (-2.4 to 58.8)	16.8 (5.4 to 28.2)	45.0 (16.1 to 73.8)
Chile	1.77 (1.21 to 2.59)	0.003	34.6 (9.8 to 59.5)	44.9 (33.3 to 56.4)	79.5 (57.6 to 100.0)
Guyana	1.56 (0.77 to 3.15)	0.212	23.2 (-8.7 to 55.1)	41.6 (14.6 to 68.5)	64.8 (49.0 to 80.5)
Iran	1.15 (1.01 to 1.32)	0.034	8.2 (0.4 to 16.0)	53.4 (49.3 to 57.6)	61.6 (55.0 to 68.3)
El Salvador	1.11 (0.90 to 1.39)	0.331	7.7 (-8.0 to 23.5)	67.7 (57.7 to 77.6)	75.4 (62.9 to 87.9)
Mexico	1.09 (0.92 to 1.28)	0.336	4.3 (-4.5 to 13.0)	49.7 (44.1 to 55.3)	53.9 (46.6 to 61.2)
Armenia	1.08 (0.50 to 2.29)	0.848	2.8 (-26.3 to 31.9)	36.5 (21.5 to 51.5)	39.3 (14.6 to 64.0)
Jordan	1.05 (0.84 to 1.33)	0.650	4.1 (-14.0 to 22.2)	75.3 (67.3 to 83.4)	79.4 (63.0 to 95.9)
Azerbaijan	1.05 (0.77 to 1.43)	0.767	2.6 (-14.8 to 20.0)	54.2 (43.7 to 64.7)	56.8 (42.0 to 71.6)
Belarus	1.00 (0.82 to 1.24)	0.963	0.4 (-14.4 to 15.1)	70.6 (61.1 to 80.0)	70.9 (59.7 to 82.1)
Iraq	0.98 (0.73 to 1.31)	0.874	-1.3 (-16.7 to 14.2)	54.0 (46.5 to 61.6)	52.8 (38.5 to 67.1)
Mongolia	0.93 (0.73 to 1.18)	0.562	-4.1 (-17.8 to 9.6)	59.8 (50.9 to 68.6)	55.7 (44.4 to 66.9)
Kyrgyzstan	0.91 (0.50 to 1.65)	0.753	-3.0 (-22.2 to 16.2)	33.2 (16.6 to 49.7)	30.1 (18.2 to 42.1)
South Africa	0.88 (0.66 to 1.18)	0.400	-6.7 (-22.1 to 8.7)	57.8 (48.2 to 67.5)	51.1 (38.5 to 63.7)
Namibia	0.88 (0.67 to 1.15)	0.355	-9.0 (-27.7 to 9.8)	75.2 (63.4 to 87.0)	66.3 (51.4 to 81.1)
Nepal	0.86 (0.42 to 1.77)	0.675	-3.9 (-22.9 to 15.1)	27.4 (10.8 to 44.0)	23.5 (14.1 to 32.8)
Indonesia	0.82 (0.44 to 1.53)	0.530	-4.3 (-17.1 to 8.6)	23.7 (15.8 to 31.6)	19.5 (9.1 to 29.9)
Algeria	0.82 (0.64 to 1.05)	0.112	-9.5 (-20.6 to 1.5)	52.2 (46.6 to 57.8)	42.7 (32.8 to 52.5)
Benin	0.82 (0.35 to 1.90)	0.636	-3.4 (-17.0 to 10.1)	18.6 (10.3 to 27.0)	15.2 (3.5 to 26.9)
Georgia	0.81 (0.60 to 1.10)	0.177	-12.1 (-29.3 to 5.1)	64.3 (53.0 to 75.6)	52.2 (39.5 to 64.9)
India	0.81 (0.69 to 0.94)	0.007	-6.4 (-11.0 to -1.8)	33.5 (29.9 to 37.1)	27.1 (24.2 to 30.1)
Zambia	0.81 (0.35 to 1.87)	0.618	-4.2 (-21.1 to 12.7)	22.0 (8.4 to 35.6)	17.8 (7.4 to 28.2)
Turkmenistan	0.81 (0.56 to 1.17)	0.251	-10.1 (-27.1 to 6.9)	52.0 (40.1 to 64.0)	41.9 (29.2 to 54.6)
Cambodia	0.76 (0.45 to 1.28)	0.295	-15.5 (-44.2 to 13.3)	64.0 (43.5 to 84.4)	48.5 (28.5 to 68.5)
Afghanistan	0.75 (0.48 to 1.18)	0.214	-16.9 (-42.8 to 8.9)	68.6 (50.5 to 86.6)	51.6 (32.1 to 71.2)
Laos	0.75 (0.36 to 1.55)	0.427	-12.6 (-44.3 to 19.1)	49.7 (24.6 to 74.7)	37.1 (16.5 to 57.7)
Moldova	0.74 (0.55 to 1.00)	0.052	-14.0 (-27.8 to -0.2)	54.5 (43.8 to 65.2)	40.5 (30.3 to 50.8)
China	0.74 (0.57 to 0.96)	0.025	-14.1 (-26.8 to -1.4)	54.5 (43.9 to 65.2)	40.4 (33.1 to 47.7)
Togo	0.67 (0.08 to 5.57)	0.694	-6.5 (-40.7 to 27.8)	19.9 (0.0 to 49.5)	13.4 (0.0 to 38.4)
Zanzibar	0.67 (0.16 to 2.75)	0.568	-7.3 (-34.2 to 19.6)	21.8 (0.0 to 44.9)	14.5 (0.8 to 28.3)
Sudan	0.66 (0.45 to 0.96)	0.031	-11.8 (-22.0 to -1.6)	34.8 (27.1 to 42.4)	23.0 (15.5 to 30.4)
Kenya	0.61 (0.15 to 2.59)	0.501	-9.1 (-38.9 to 20.7)	23.7 (0.0 to 52.5)	14.5 (0.0 to 29.7)
Bhutan	0.48 (0.20 to 1.17)	0.105	-29.3 (-61.0 to 2.5)	56.8 (32.1 to 81.5)	27.5 (5.4 to 49.6)
Bangladesh	0.48 (0.31 to 0.75)	0.001	-31.1 (-46.5 to -15.7)	59.9 (49.9 to 69.9)	28.8 (16.9 to 40.7)
Morocco	0.42 (0.27 to 0.67)	<0.001	-20.9 (-29.8 to -11.9)	36.2 (29.8 to 42.7)	15.4 (8.9 to 21.9)
Tanzania	0.42 (0.11 to 1.68)	0.217	-18.2 (-44.1 to 7.7)	31.6 (10.0 to 53.2)	13.4 (0.0 to 30.5)
Burkina Faso	0.42 (0.06 to 2.92)	0.365	-14.5 (-42.0 to 13.1)	25.1 (2.3 to 47.9)	10.6 (0.0 to 30.5)
Vietnam	0.39 (0.14 to 1.06)	0.064	-28.4 (-53.0 to -3.8)	46.6 (27.5 to 65.6)	18.2 (1.0 to 35.3)
Uganda	0.13 (0.01 to 1.23)	0.071	-39.8 (-72.7 to -7.0)	45.8 (15.1 to 76.4)	5.9 (0.0 to 18.8)



See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

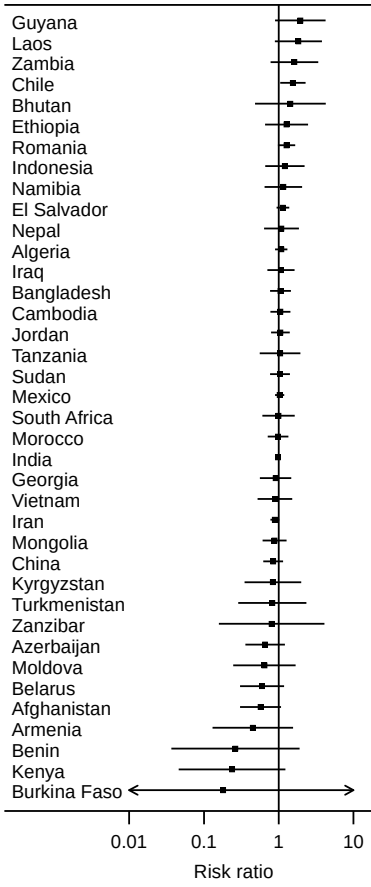
Appendix 24: Differences in achievement of glycemic control among rural versus urban (reference category) populations with diabetes by country

Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Nepal	1.47 (0.67 to 3.22)	0.330	18.0 (-14.2 to 50.2)	38.1 (10.4 to 65.9)	56.1 (39.8 to 72.4)
Kyrgyzstan	1.38 (0.56 to 3.41)	0.484	7.7 (-13.0 to 28.4)	20.5 (4.1 to 36.9)	28.2 (13.8 to 42.6)
Fiji	1.35 (0.84 to 2.17)	0.217	8.5 (-4.8 to 21.7)	24.3 (15.1 to 33.5)	32.7 (22.8 to 42.6)
Jordan	1.16 (0.98 to 1.37)	0.089	11.3 (-2.2 to 24.7)	71.0 (64.2 to 77.7)	82.3 (70.5 to 94.0)
Indonesia	1.13 (0.58 to 2.20)	0.711	4.6 (-20.6 to 29.7)	34.5 (23.2 to 45.8)	39.1 (16.7 to 61.5)
Burkina Faso	1.09 (0.63 to 1.89)	0.635	7.7 (-39.9 to 55.3)	81.1 (41.9 to 100.0)	88.8 (35.5 to 100.0)
Sudan	1.09 (0.78 to 1.54)	0.605	3.5 (-9.8 to 16.7)	37.2 (28.2 to 46.1)	40.7 (31.0 to 50.4)
Namibia	1.06 (0.70 to 1.61)	0.783	3.5 (-22.2 to 29.3)	59.0 (45.9 to 72.1)	62.6 (40.6 to 84.6)
Laos	1.05 (0.52 to 2.10)	0.887	2.1 (-26.6 to 30.8)	40.7 (17.6 to 63.7)	42.7 (26.0 to 59.4)
Romania	1.05 (0.86 to 1.27)	0.622	3.6 (-10.7 to 17.9)	72.0 (61.9 to 82.0)	75.5 (65.3 to 85.8)
Turkmenistan	1.05 (0.49 to 2.24)	0.904	2.2 (-34.2 to 38.6)	46.5 (26.5 to 66.5)	48.7 (19.5 to 77.9)
Ethiopia	1.03 (0.44 to 2.42)	0.943	1.8 (-48.8 to 52.4)	58.2 (32.8 to 83.7)	60.0 (22.7 to 97.4)
Zambia	1.02 (0.65 to 1.61)	0.932	1.4 (-31.8 to 34.6)	71.9 (49.3 to 94.5)	73.3 (46.5 to 100.0)
Armenia	1.01 (0.62 to 1.65)	0.973	0.5 (-30.3 to 31.3)	62.3 (45.2 to 79.4)	62.8 (36.4 to 89.3)
Bangladesh	1.00 (0.77 to 1.31)	0.974	0.3 (-14.7 to 15.2)	56.5 (46.3 to 66.7)	56.7 (44.9 to 68.6)
Iran	0.96 (0.84 to 1.11)	0.607	-1.8 (-8.7 to 5.1)	50.5 (47.0 to 54.1)	48.7 (42.8 to 54.6)
Belarus	0.96 (0.80 to 1.15)	0.631	-3.4 (-17.1 to 10.3)	77.4 (68.4 to 86.4)	74.1 (63.3 to 84.8)
China	0.95 (0.77 to 1.19)	0.668	-3.1 (-17.2 to 11.1)	66.3 (56.0 to 76.7)	63.2 (53.5 to 72.9)
South Africa	0.95 (0.58 to 1.57)	0.850	-2.1 (-24.2 to 19.9)	45.6 (33.2 to 58.0)	43.5 (25.3 to 61.7)
Moldova	0.95 (0.71 to 1.26)	0.706	-3.5 (-21.8 to 14.8)	66.1 (53.0 to 79.3)	62.6 (49.9 to 75.4)
Georgia	0.94 (0.70 to 1.26)	0.667	-4.0 (-22.3 to 14.3)	65.2 (53.5 to 77.0)	61.2 (47.3 to 75.1)
Algeria	0.92 (0.75 to 1.13)	0.422	-4.8 (-16.4 to 6.7)	59.4 (54.1 to 64.7)	54.6 (44.4 to 64.8)
El Salvador	0.92 (0.50 to 1.69)	0.781	-1.7 (-13.4 to 10.0)	20.3 (13.1 to 27.4)	18.6 (9.1 to 28.1)
Tanzania	0.89 (0.52 to 1.53)	0.662	-6.7 (-36.9 to 23.6)	59.6 (31.0 to 88.1)	52.9 (24.9 to 80.8)
Iraq	0.88 (0.64 to 1.20)	0.423	-7.1 (-23.6 to 9.5)	58.8 (51.4 to 66.2)	51.7 (36.9 to 66.6)
Guyana	0.88 (0.29 to 2.63)	0.814	-3.6 (-35.6 to 28.3)	29.9 (0.9 to 58.8)	26.2 (12.6 to 39.8)
Azerbaijan	0.88 (0.60 to 1.29)	0.502	-6.7 (-25.8 to 12.4)	54.5 (44.0 to 65.1)	47.8 (31.7 to 63.9)
Benin	0.87 (0.27 to 2.80)	0.815	-7.3 (-67.9 to 53.2)	58.3 (33.5 to 83.1)	50.9 (0.0 to 100.0)
India	0.86 (0.39 to 1.87)	0.699	-0.3 (-1.9 to 1.3)	2.1 (0.6 to 3.5)	1.8 (1.1 to 2.4)
Cambodia	0.85 (0.56 to 1.29)	0.434	-9.4 (-33.0 to 14.2)	62.1 (45.1 to 79.1)	52.7 (35.8 to 69.6)
Vietnam	0.78 (0.52 to 1.17)	0.227	-18.3 (-46.0 to 9.5)	83.6 (64.4 to 100.0)	65.4 (38.2 to 92.5)
Afghanistan	0.75 (0.53 to 1.07)	0.110	-21.3 (-45.2 to 2.5)	85.9 (74.5 to 97.2)	64.5 (43.5 to 85.5)
Morocco	0.70 (0.51 to 0.97)	0.030	-17.3 (-31.1 to -3.4)	58.2 (51.3 to 65.1)	40.9 (28.8 to 53.1)
Chile	0.66 (0.33 to 1.32)	0.238	-18.8 (-45.6 to 7.9)	54.9 (43.3 to 66.6)	36.1 (11.9 to 60.2)
Kenya	0.62 (0.18 to 2.09)	0.428	-22.4 (-76.0 to 31.3)	58.4 (20.8 to 96.1)	36.0 (0.1 to 72.0)
Mongolia	0.58 (0.35 to 0.98)	0.041	-24.0 (-43.4 to -4.7)	57.4 (46.8 to 68.1)	33.4 (17.0 to 49.7)
Bhutan	0.56 (0.29 to 1.07)	0.077	-39.6 (-75.0 to -4.3)	89.2 (69.4 to 100.0)	49.6 (17.6 to 81.6)
Uganda	0.19 (0.02 to 1.96)	0.127	-62.4 (-150.7 to 25.8)	77.1 (0.0 to 100.0)	14.7 (0.0 to 43.4)
Zanzibar	0.07 (0.00 to 1.08)	0.057	-54.1 (-91.9 to -16.3)	58.4 (24.4 to 92.3)	4.3 (0.0 to 15.0)



See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

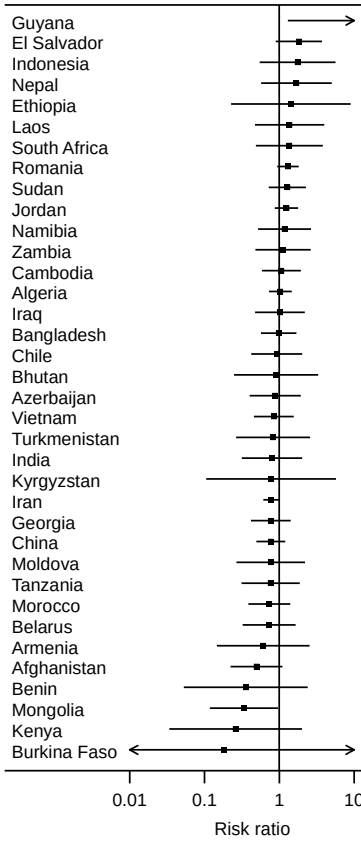
Appendix 25: Differences in achievement of blood pressure control among rural versus urban (reference category) populations with diabetes by country



Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Guyana	1.95 (0.89 to 4.24)	0.092	35.6 (3.7 to 67.4)	37.6 (9.4 to 65.8)	73.2 (58.8 to 87.6)
Laos	1.83 (0.89 to 3.77)	0.099	28.1 (0.1 to 56.0)	33.8 (11.1 to 56.5)	61.9 (45.8 to 78.0)
Zambia	1.62 (0.78 to 3.37)	0.189	27.7 (-12.2 to 67.6)	44.7 (17.0 to 72.4)	72.4 (42.9 to 100.0)
Chile	1.54 (1.04 to 2.28)	0.030	28.1 (0.5 to 55.8)	51.7 (39.8 to 63.6)	79.8 (55.4 to 100.0)
Bhutan	1.43 (0.48 to 4.24)	0.506	15.9 (-32.2 to 64.0)	36.9 (6.0 to 67.8)	52.8 (15.4 to 90.2)
Ethiopia	1.27 (0.66 to 2.47)	0.469	11.3 (-19.7 to 42.3)	41.5 (18.4 to 64.6)	52.8 (26.9 to 78.7)
Romania	1.27 (0.97 to 1.66)	0.078	14.1 (-1.4 to 29.7)	52.0 (41.0 to 63.0)	66.1 (54.9 to 77.4)
Indonesia	1.21 (0.66 to 2.21)	0.539	7.4 (-17.5 to 32.3)	35.5 (24.1 to 46.9)	42.9 (20.6 to 65.2)
Namibia	1.15 (0.65 to 2.05)	0.626	6.5 (-20.9 to 33.9)	42.7 (29.3 to 56.1)	49.2 (25.3 to 73.1)
El Salvador	1.13 (0.93 to 1.38)	0.205	8.8 (-4.9 to 22.6)	65.5 (56.5 to 74.4)	74.3 (63.8 to 84.8)
Nepal	1.09 (0.63 to 1.86)	0.762	4.5 (-24.5 to 33.5)	52.9 (27.5 to 78.3)	57.5 (41.9 to 73.0)
Algeria	1.08 (0.89 to 1.31)	0.425	4.1 (-6.2 to 14.5)	51.2 (45.9 to 56.6)	55.4 (46.2 to 64.5)
Iraq	1.07 (0.71 to 1.63)	0.743	2.9 (-15.1 to 20.9)	40.6 (33.0 to 48.2)	43.5 (27.2 to 59.9)
Bangladesh	1.05 (0.76 to 1.45)	0.749	2.9 (-14.8 to 20.6)	53.5 (41.6 to 65.4)	56.4 (43.5 to 69.3)
Cambodia	1.05 (0.77 to 1.43)	0.742	3.6 (-17.8 to 25.0)	67.7 (52.1 to 83.3)	71.3 (55.8 to 86.7)
Jordan	1.05 (0.79 to 1.40)	0.733	3.0 (-14.7 to 20.7)	58.8 (50.8 to 66.8)	61.8 (46.0 to 77.7)
Tanzania	1.04 (0.56 to 1.95)	0.892	2.3 (-31.8 to 36.5)	53.2 (22.5 to 84.0)	55.5 (21.8 to 89.3)
Sudan	1.04 (0.76 to 1.41)	0.810	1.6 (-11.5 to 14.8)	42.1 (32.8 to 51.4)	43.7 (34.2 to 53.1)
Mexico	1.03 (0.89 to 1.18)	0.695	1.7 (-6.7 to 10.1)	58.6 (53.7 to 63.6)	60.3 (53.5 to 67.1)
South Africa	0.99 (0.60 to 1.64)	0.983	-0.2 (-18.3 to 17.9)	36.5 (25.2 to 47.9)	36.3 (20.1 to 52.6)
Morocco	0.98 (0.71 to 1.35)	0.896	-1.0 (-15.6 to 13.6)	46.8 (40.0 to 53.6)	45.8 (32.6 to 59.1)
India	0.98 (0.92 to 1.04)	0.500	-1.4 (-5.7 to 2.8)	68.3 (65.0 to 71.6)	66.8 (64.2 to 69.4)
Georgia	0.91 (0.56 to 1.47)	0.688	-3.5 (-20.7 to 13.7)	37.8 (26.0 to 49.6)	34.3 (21.6 to 47.0)
Vietnam	0.89 (0.52 to 1.52)	0.665	-6.6 (-36.5 to 23.2)	60.7 (41.7 to 79.7)	54.0 (27.6 to 80.5)
Iran	0.88 (0.77 to 1.02)	0.082	-6.3 (-13.3 to 0.6)	55.2 (51.7 to 58.7)	48.8 (42.9 to 54.8)
Mongolia	0.88 (0.61 to 1.27)	0.488	-7.6 (-28.3 to 13.2)	62.1 (51.9 to 72.4)	54.6 (36.8 to 72.3)
China	0.84 (0.62 to 1.14)	0.265	-8.5 (-23.4 to 6.5)	53.5 (42.4 to 64.6)	45.1 (35.1 to 55.0)
Kyrgyzstan	0.83 (0.35 to 2.00)	0.681	-5.8 (-35.3 to 23.6)	35.4 (7.6 to 63.1)	29.5 (12.9 to 46.2)
Turkmenistan	0.82 (0.29 to 2.34)	0.706	-4.8 (-29.7 to 20.1)	26.6 (10.0 to 43.2)	21.8 (4.2 to 39.4)
Zanzibar	0.80 (0.16 to 4.08)	0.785	-5.1 (-42.7 to 32.6)	25.8 (0.0 to 54.3)	20.7 (0.0 to 45.8)
Azerbaijan	0.66 (0.36 to 1.21)	0.174	-13.5 (-31.0 to 4.0)	39.4 (29.1 to 49.6)	25.8 (11.6 to 40.1)
Moldova	0.64 (0.25 to 1.68)	0.366	-6.7 (-20.8 to 7.3)	18.8 (8.3 to 29.4)	12.1 (2.3 to 22.0)
Belarus	0.60 (0.30 to 1.18)	0.135	-10.1 (-23.1 to 2.9)	25.0 (14.7 to 35.4)	15.0 (6.6 to 23.3)
Afghanistan	0.57 (0.30 to 1.07)	0.081	-22.0 (-44.7 to 0.7)	51.3 (32.8 to 69.8)	29.3 (11.8 to 46.7)
Armenia	0.45 (0.13 to 1.56)	0.203	-21.4 (-49.3 to 6.5)	38.8 (19.3 to 58.3)	17.5 (0.0 to 37.1)
Benin	0.26 (0.04 to 1.90)	0.177	-33.5 (-67.9 to 0.9)	45.5 (18.9 to 72.0)	12.0 (0.0 to 34.8)
Kenya	0.24 (0.05 to 1.23)	0.085	-16.7 (-36.6 to 3.2)	21.9 (2.0 to 41.7)	5.2 (0.0 to 13.3)
Burkina Faso	0.18 (0.00 to 141.80)	0.474	-66.8 (-277.8 to 144.3)	81.5 (0.0 to 100.0)	14.7 (0.0 to 88.7)

See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

Appendix 26: Differences in achievement of AB control among rural versus urban (reference category) populations with diabetes by country



Country	Risk ratio	P value	Average marginal effect (%)	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Guyana	11.47 (1.30 to 101.08)	0.029	20.5 (6.5 to 34.5)	2.0 (0.0 to 6.0)	22.5 (9.2 to 35.8)
El Salvador	1.83 (0.89 to 3.73)	0.098	8.0 (-2.5 to 18.6)	9.7 (5.1 to 14.3)	17.7 (8.2 to 27.2)
Indonesia	1.75 (0.54 to 5.64)	0.343	9.3 (-13.3 to 31.9)	12.4 (5.0 to 19.7)	21.7 (0.7 to 42.6)
Nepal	1.69 (0.57 to 5.01)	0.340	12.1 (-9.8 to 33.9)	17.5 (0.0 to 35.3)	29.5 (14.6 to 44.4)
Ethiopia	1.43 (0.23 to 9.01)	0.701	8.1 (-34.8 to 51.0)	19.0 (0.0 to 40.1)	27.2 (0.0 to 57.6)
Laos	1.37 (0.47 to 3.98)	0.556	7.9 (-17.1 to 33.0)	21.3 (1.8 to 40.9)	29.3 (14.2 to 44.3)
South Africa	1.36 (0.48 to 3.81)	0.558	5.2 (-13.2 to 23.7)	14.5 (4.2 to 24.8)	19.7 (3.1 to 36.4)
Romania	1.30 (0.93 to 1.81)	0.119	12.4 (-3.1 to 28.0)	41.4 (30.6 to 52.1)	53.8 (42.0 to 65.5)
Sudan	1.28 (0.72 to 2.27)	0.397	4.4 (-5.8 to 14.6)	15.7 (9.0 to 22.5)	20.1 (12.5 to 27.8)
Jordan	1.24 (0.87 to 1.79)	0.234	10.9 (-8.2 to 30.0)	44.5 (36.2 to 52.8)	55.4 (38.2 to 72.7)
Namibia	1.17 (0.52 to 2.65)	0.696	4.4 (-19.1 to 28.0)	25.6 (15.5 to 35.6)	30.0 (8.8 to 51.2)
Zambia	1.12 (0.48 to 2.63)	0.783	5.5 (-35.3 to 46.3)	45.0 (17.2 to 72.8)	50.5 (19.1 to 82.0)
Cambodia	1.06 (0.58 to 1.94)	0.837	2.4 (-20.8 to 25.6)	37.5 (21.1 to 53.9)	39.9 (23.4 to 56.5)
Algeria	1.03 (0.73 to 1.47)	0.862	0.9 (-9.3 to 11.1)	28.3 (23.4 to 33.1)	29.2 (20.2 to 38.2)
Iraq	1.02 (0.47 to 2.19)	0.963	0.4 (-16.8 to 17.6)	22.1 (15.3 to 29.0)	22.5 (6.7 to 38.4)
Bangladesh	0.98 (0.57 to 1.69)	0.940	-0.6 (-17.0 to 15.7)	30.2 (19.5 to 41.0)	29.6 (17.8 to 41.4)
Chile	0.92 (0.42 to 2.02)	0.842	-2.4 (-25.4 to 20.6)	31.2 (20.0 to 42.5)	28.8 (8.6 to 49.0)
Bhutan	0.91 (0.25 to 3.32)	0.879	-3.3 (-47.3 to 40.7)	35.7 (4.6 to 66.8)	32.4 (1.2 to 63.6)
Azerbaijan	0.88 (0.40 to 1.93)	0.747	-2.4 (-16.7 to 11.9)	19.9 (11.8 to 28.0)	17.5 (5.6 to 29.4)
Vietnam	0.84 (0.46 to 1.55)	0.579	-8.6 (-38.3 to 21.1)	54.9 (35.7 to 74.0)	46.3 (20.2 to 72.3)
Turkmenistan	0.83 (0.26 to 2.58)	0.738	-3.8 (-26.0 to 18.3)	21.9 (7.2 to 36.6)	18.1 (1.0 to 35.2)
India	0.80 (0.31 to 2.02)	0.632	-0.3 (-1.8 to 1.1)	1.6 (0.2 to 3.0)	1.3 (0.8 to 1.7)
Kyrgyzstan	0.78 (0.11 to 5.73)	0.803	-1.4 (-13.3 to 10.4)	6.4 (0.0 to 16.7)	4.9 (0.0 to 10.5)
Iran	0.78 (0.61 to 0.99)	0.040	-6.8 (-12.9 to -0.7)	30.7 (27.4 to 33.9)	23.9 (18.7 to 29.0)
Georgia	0.77 (0.42 to 1.42)	0.397	-6.6 (-21.6 to 8.4)	28.6 (18.0 to 39.2)	22.0 (11.0 to 33.0)
China	0.77 (0.49 to 1.20)	0.247	-8.3 (-22.5 to 5.9)	36.0 (25.2 to 46.8)	27.7 (18.7 to 36.7)
Moldova	0.77 (0.27 to 2.20)	0.621	-3.4 (-16.7 to 9.9)	14.6 (4.9 to 24.4)	11.2 (1.5 to 21.0)
Tanzania	0.76 (0.31 to 1.87)	0.551	-10.1 (-44.7 to 24.4)	43.1 (7.8 to 78.4)	33.0 (5.2 to 60.7)
Morocco	0.73 (0.39 to 1.40)	0.347	-6.4 (-18.5 to 5.7)	24.1 (18.0 to 30.2)	17.7 (7.1 to 28.3)
Belarus	0.73 (0.32 to 1.65)	0.449	-4.7 (-16.7 to 7.4)	17.4 (8.1 to 26.7)	12.7 (4.5 to 21.0)
Armenia	0.61 (0.15 to 2.54)	0.491	-10.2 (-37.3 to 16.9)	26.1 (7.3 to 44.9)	15.9 (0.0 to 35.7)
Afghanistan	0.50 (0.22 to 1.10)	0.084	-21.5 (-44.1 to 1.0)	42.6 (23.5 to 61.8)	21.1 (5.4 to 36.8)
Benin	0.36 (0.05 to 2.40)	0.276	-22.8 (-55.3 to 9.7)	35.3 (10.1 to 60.6)	12.6 (0.0 to 35.7)
Mongolia	0.34 (0.12 to 0.96)	0.042	-26.0 (-43.3 to -8.6)	39.1 (28.1 to 50.1)	13.2 (0.0 to 26.4)
Kenya	0.26 (0.03 to 2.00)	0.189	-9.4 (-23.6 to 4.8)	12.7 (0.0 to 26.8)	3.3 (0.0 to 9.8)
Burkina Faso	0.18 (0.00 to 141.80)	0.474	-66.8 (-277.8 to 144.3)	81.5 (0.0 to 100.0)	14.7 (0.0 to 88.7)

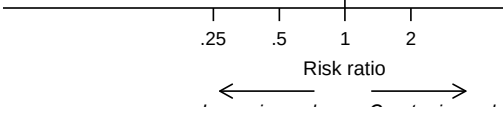
See availability by survey in Table 1 and Appendix 7. Sample sizes also were insufficient to run the models for the following performance measures and surveys: BP lowering meds (Malawi excluded), glycemic control (Malawi and Togo excluded), and BP control and combined AB control (Malawi, Togo, and Uganda excluded).

Appendix 27: Sensitivity analyses 1 (unadjusted proportions)

	Estimate, % (95% CI)	
Goal	**Urban**	**Rural**
Testing	68.3 (65.8-70.7)	46.0 (43.3-48.7)
Awareness	51.6 (48.9-54.2)	36.3 (33.0-39.6)
Glucose-lowering medication	63.0 (59.2-66.7)	51.4 (47.8-54.9)
Blood pressure-lowering medication	47.1 (44.0-50.2)	34.8 (31.3-38.4)
Statin	10.7 (9.5-12.1)	5.5 (4.4-6.8)
Glycemic control	55.8 (52.3-59.3)	48.5 (43.7-53.3)
Blood pressure control	46.9 (43.5-50.3)	48.3 (43.6-53.1)
Cholesterol control	21.9 (18.4-26.0)	19.6 (15.1-25.0)
AB control	28.1 (24.8-31.6)	24.3 (20.5-28.5)
ABC control	8.4 (5.8-11.9)	4.5 (3.0-6.8)

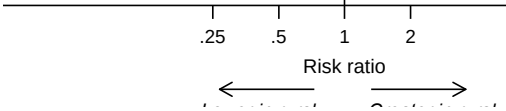
Appendix 28: Sensitivity analyses 2 (less strict glycemic target of HbA1c <8.0% [FPG <9.2 mmol/L]) – Differences in achievement of diabetes performance measures among rural versus urban (reference category) populations

Outcome	Risk ratio	Average marginal effect (%)	P value	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Diagnosis					
Ever tested	0.76 (0.71 to 0.81)	-15.6 (-19.2 to -11.9)	<0.001	64.7 (62.1 to 67.3)	49.1 (46.5 to 51.7)
Awareness	0.80 (0.74 to 0.87)	-9.5 (-12.7 to -6.2)	<0.001	48.5 (45.9 to 51.2)	39.0 (35.7 to 42.4)
Treatment					
Glucose-lowering med	0.84 (0.77 to 0.90)	-8.6 (-12.4 to -4.9)	<0.001	52.4 (49.1 to 55.7)	43.7 (40.9 to 46.5)
BP-lowering med	0.83 (0.75 to 0.91)	-7.6 (-11.5 to -3.8)	<0.001	44.8 (41.7 to 47.9)	37.2 (33.8 to 40.5)
Statin	0.71 (0.55 to 0.92)	-2.7 (-4.6 to -0.8)	0.009	9.4 (8.2 to 10.6)	6.7 (5.2 to 8.1)
Control					
Glycemic control	0.90 (0.79 to 1.03)	-4.0 (-9.1 to 1.1)	0.127	41.1 (37.4 to 44.9)	37.2 (33.0 to 41.3)
BP control	0.94 (0.84 to 1.05)	-2.9 (-8.2 to 2.3)	0.277	48.7 (45.2 to 52.1)	45.7 (41.3 to 50.1)
Cholesterol control	0.77 (0.61 to 0.98)	-5.3 (-10.2 to -0.5)	0.033	23.2 (19.1 to 27.3)	17.9 (14.2 to 21.6)
Combined AB control	0.75 (0.59 to 0.94)	-6.0 (-10.8 to -1.2)	0.014	23.5 (19.6 to 27.3)	17.5 (14.4 to 20.6)
Combined ABC control	0.52 (0.31 to 0.85)	-3.1 (-5.3 to -0.8)	0.010	6.3 (4.4 to 8.3)	3.3 (1.9 to 4.7)



Appendix 29: Sensitivity analyses 3 (population weights) – Differences in achievement of diabetes performance measures among rural versus urban (reference category) populations

Outcome	Risk ratio	Average marginal effect (%)	P value	Urban adjusted proportion (%)	Rural adjusted proportion (%)
Diagnosis					
Ever tested	0.77 (0.71 to 0.85)	-15.5 (-20.6 to -10.3)	<0.001	67.9 (64.8 to 71.0)	52.4 (48.5 to 56.4)
Awareness	0.76 (0.68 to 0.83)	-11.4 (-15.3 to -7.5)	<0.001	46.6 (43.7 to 49.6)	35.3 (32.3 to 38.2)
Treatment					
Glucose-lowering med	0.88 (0.82 to 0.95)	-9.0 (-14.2 to -3.9)	<0.001	76.5 (72.6 to 80.4)	67.5 (63.2 to 71.8)
BP-lowering med	0.78 (0.67 to 0.90)	-9.5 (-15.1 to -4.0)	<0.001	43.2 (38.8 to 47.5)	33.6 (29.7 to 37.5)
Statin	0.77 (0.56 to 1.06)	-2.5 (-5.3 to 0.3)	0.110	10.8 (9.4 to 12.3)	8.3 (5.7 to 11.0)
Control					
Glycemic control	0.94 (0.81 to 1.10)	-2.4 (-8.5 to 3.7)	0.445	41.6 (37.7 to 45.6)	39.2 (34.2 to 44.3)
BP control	0.94 (0.83 to 1.07)	-3.2 (-9.8 to 3.4)	0.344	55.8 (51.6 to 59.9)	52.6 (47.9 to 57.3)
Cholesterol control	0.77 (0.60 to 0.97)	-5.7 (-10.7 to -0.8)	0.029	24.5 (20.9 to 28.2)	18.8 (14.7 to 22.9)
Combined AB control	0.80 (0.59 to 1.08)	-4.5 (-10.4 to 1.4)	0.139	22.4 (18.2 to 26.5)	17.9 (13.9 to 21.9)
Combined ABC control	0.37 (0.19 to 0.71)	-6.8 (-11.1 to -2.6)	0.003	10.9 (7.3 to 14.4)	4.0 (1.8 to 6.3)



Appendix 30: STROBE checklist

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **This information is provided in the Title and Abstract.**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **This information is provided throughout the Abstract.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **This information is provided throughout the Introduction.**
Objectives	3	State specific objectives, including any prespecified hypotheses **This information is stated in the final paragraph of the Introduction.**
Methods		
Study design	4	Present key elements of study design early in the paper **Study design is presented throughout the Methods section and in Appendix 1.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **This information is provided in the first paragraph of the Methods section and in Appendices 1-2.**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **This information is provided in the second and third paragraph of the Methods section and in Appendices 1-2.**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **This information is provided in the Methods under the Outcomes and Statistical Analysis subsections and in Table 1.**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **This information is provided in the Methods under the Data Sources and Outcomes subsections and in Appendices 2-6.**
Bias	9	Describe any efforts to address potential sources of bias **This information is described in the Methods under the Statistical Analysis subsection.**
Study size	10	Explain how the study size was arrived at **This information is provided in the Methods under the Sample and definitions subsection and in Appendices 1-2.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **This information is described in the Methods under the Statistical Analysis subsection and in Appendix 1.**

Statistical methods	12	*a*) Describe all statistical methods, including those used to control for confounding **This information is provided in the Methods, throughout the Statistical Analysis subsection.**
		(*b*) Describe any methods used to examine subgroups and interactions **This information is provided in the Methods, throughout the Statistical Analysis subsection.**
		(*c*) Explain how missing data were addressed **This information is provided in the Methods in the second paragraph of the Statistical Analysis subsection.**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **This information is provided in the Methods under the Sample subsection, and in Appendix 1.**
		(*e*) Describe any sensitivity analyses **This information is provided in the Methods under the Sensitivity analysis subsection**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **This information is reported in the Results under the Survey and sample characteristics subsection and in Appendices 1-2.**
		(b) Give reasons for non-participation at each stage **This information is reported in Appendix 1.**
		(c) Consider use of a flow diagram **This information is reported in Appendix 1.**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **This information is provided in Table 2, in the Results under the Survey and sample characteristics subsection and in Appendix 10.**
		(b) Indicate number of participants with missing data for each variable of interest **This information is provided in Appendix 8.**
Outcome data	15*	Report numbers of outcome events or summary measures **This information is provided in Figure 1.**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **This information is provided in the Statistical analysis subsection of the methods, in Results, in Figure 2, and in the Sensitivity analysis appendices (Appendices 21-24).**
		(*b*) Report category boundaries when continuous variables were categorized **No continuous variables are categorized.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **In addition to risk ratios, we present absolute differences (using average marginal effects) and predictive margins throughout the Results section and Appendices.**

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **This information is provided in the Results section under the Sensitivity analyses subsection, and in Appendix 21-24.**
Discussion		
Key results	18	Summarise key results with reference to study objectives **This information is provided throughout the Discussion.**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **This information is provided in the second-to-last paragraph the Discussion.**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **This information is provided throughout the Discussion.**
Generalisability	21	Discuss the generalisability (external validity) of the study results **This information is provided throughout the Discussion.**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **This information is provided in the Funding Support and Disclosures sections**

Supplementary references

1. Riley L, Guthold R, Cowan M, et al. The World Health Organization STEPwise approach to noncommunicable disease risk-factor surveillance: methods, challenges, and opportunities. *Am J Public Health* 2016; 106(1): 74–8.

2. WHO. HEARTS Technical package for cardiovascular disease management in primary health care: systems for monitoring. Geneva: World Health Organization, 2018.

3. WHO. Noncommunicable diseases global monitoring framework: indicator definitions and specifications. 2014. https://www.who.int/nmh/ncd-tools/indicators/GMF_Indicator_Definitions_Version_NOV2014.pdf (accessed January 10, 2022).

4. World Health Organization. STEPS Country Reports. 2021. https://www.who.int/ncds/surveillance/steps/reports/en/ (accessed April 13, 2021).

5. World Health Organization. NCD Microdata Repository. 2021. https://extranet.who.int/ncdsmicrodata/index.php/catalog (accessed July 19, 2021).

6. United Nations, Department of Economic and Social Affairs, Population Division. World Urbanization Prospects: The 2018 Revision. New York: United Nations, 2018.

7. WHO. WHO package of essential noncommunicable (PEN) disease interventions for primary health care. Geneva: World Health Organization, 2020.