

https://dspace.org/

Data Resource Profile: The Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC)

Jennifer Manne-Goehler; Michaela Theilmann; David Flood; Maja E Marcus; Glennis Andall-Brereton ...

2022-12-13
https://hdl.handle.net/10539/38287

Downloaded from a DSpace repository. https://dspace.org/

International Journal of Epidemiology, 2022, e337–e349
https://doi.org/10.1093/ije/dyac125
Advance Access Publication Date: 28 June 2022
Data Resource Profile

Data Resource Profile

Data Resource Profile: The Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC)

Jennifer Manne-Goehler [1,2,3,*,†] Michaela Theilmann,[4,†] David Flood,[5] Maja E Marcus,[6] Glennis Andall-Brereton,[7] Kokou Agoudavi,[8] William Andres Lopez Arboleda,[4] Krishna K Aryal,[9] Brice Bicaba,[10] Pascal Bovet,[11,12] Luisa Campos Caldeira Brant,[13] Garry Brian,[14] Grace Chamberlin,[3] Geoffrey Chen,[3] Albertino Damasceno [15,16,17] Maria Dorobantu [18] Matthew Dunn,[5] Cara Ebert,[19] Farshad Farzadfar,[20] Mongal Singh Gurung,[21] David Guwatudde,[22] Corine Houehanou,[23] Dismand Houinato,[23] Nahla Hwalla,[24] Jutta M Adelin Jorgensen,[25] Khem B Karki,[26] Demetre Labadarios,[27] Nuno Lunet,[15,16] Deborah Carvalho Malta,[28,29] João S Martins,[30] Mary T Mayige,[31] Roy Wong McClure,[32] Sahar Saeedi Moghaddam,[33] Kibachio J Mwangi,[34,35] Omar Mwalim,[36] Bolormaa Norov [37] Sarah Quesnel-Crooks,[7] Sabrina Rhode,[4] Jacqueline A Seiglie,[1,2] Abla Sibai [38] Bahendeka K Silver,[39,40] Lela Sturua,[41,42] Andrew Stokes,[43] Adil Supiyev,[44] Lindiwe Tsabedze,[45] Zhaxybay Zhumadilov,[46] Lindsay M Jaacks,[47,48,49,†] Rifat Atun,[50,51,†] Justine I Davies,[52,53,54,†] Pascal Geldsetzer,[4,55,†] Sebastian Vollmer [6,†] and Till W Bärnighausen[4,50,56,†]

[1]Division of Infectious Diseases, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA, [2]Harvard Center for Population and Development Studies, Harvard University, Boston, MA, USA, [3]Medical Practice Evaluation Center, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA, [4]Faculty of Medicine and University Hospital, Heidelberg Institute of Global Health, Heidelberg University, Heidelberg, Germany, [5]University of Michigan, Ann Arbor, MI, USA, [6]Department of Economics and Centre for Modern Indian Studies, University of Goettingen, Göttingen, Germany, [7]Caribbean Public Health Agency, Port of Spain, Trinidad and Tobago, [8]Togo Ministry of Health, Lome, Togo, [9]Nepal Health Sector, Programme 3, Monitoring Evaluation and Operational Research Project, Abt Associates, Kathmandu, Nepal, [10]Institut Africain de Santé Publique, Ouagadougou, Burkina Faso, [11]Ministry of Health, Victoria, Seychelles, [12]University Center for Primary Care and Public Health (Unisanté), Lausanne, Switzerland, [13]Internal Medicine Department, School of Medicine, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, [14]The Fred Hollows Foundation New Zealand, Auckland, New Zealand, [15]EPIUnit, Institute of Public Health, University of Porto, Porto, Portugal, [16]Department of Public and Forensic Health Sciences and Medical Education, Faculty of Medicine, University of Porto, Porto, Portugal, [17]Faculty of Medicine, Eduardo Mondlane University, Maputo, Mozambique, [18]Department of Cardiology, Emergency Hospital of Bucharest, Bucharest,

© The Author(s) 2022; all rights reserved. Published by Oxford University Press on behalf of the International Epidemiological Association

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Romania, [19]RWI-Leibniz Institute for Economic Research, Essen (Berlin, Office), Germany, [20]Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran, [21]Health Research and Epidemiology Unit, Ministry of Health, Thimphu, Bhutan, [22]Department of Epidemiology and Biostatistics, School of Public Health, Makerere University, Kampala, Uganda, [23]Laboratory of Epidemiology of Chronic and Neurological Diseases, Faculty of Health Sciences, University of Abomey-Calavi, Godomey, Benin, [24]Faculty of Agricultural and Food Sciences, American University of Beirut, Beirut, Lebanon, [25]Department of Public Health, University of Copenhagen, Copenhagen, Denmark, [26]Department of Community Medicine and Public Health, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal, [27]Faculty of Medicine and Health Sciences, Stellenbosch University, Stellenbosch, South Africa, [28]Department of Maternal-Child Nursing and Public Health, School of Nursing, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, [29]Graduate Program in Nursing, School of Nursing, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, [30]Faculty of Medicine and Health Sciences, National University of East Timor, Rua, Jacinto Candido, Dili, Timor-Leste, [31]National Institute for Medical Research, Dar es Salaam, Tanzania, [32]Epidemiology Office and Surveillance, Caja Costarricense de Seguro Social, San Jose, Costa Rica, [33]Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran, [34]Division of Non-Communicable Diseases, Ministry of Health, Nairobi, Kenya, [35]Faculté de médecine, Université de Genève, Geneva, Switzerland, [36]Zanzibar Ministry of Health, Mnazi Mmoja, Zanzibar, [37]Nutrition Department, National Center for Public Health, Ulaanbaatar, Mongolia, [38]Epidemiology and Population Health Department, Faculty of Health Sciences American University of Beirut, Beirut, Lebanon, [39]St. Francis Hospital, Nsambya, Kampala, Uganda, [40]Uganda Martyrs University, Kampala, Uganda, [41]Non-Communicable Diseases Department, National Center for Disease Control and Public Health, Tbilisi, Georgia, [42]Petre Shotadze Tbilisi Medical Academy, Tbilisi, Georgia, [43]Department of Global Health, Boston University School of Public Health, Boston, MA, USA, [44]Laboratory of Epidemiology and Public Health, Center for Life Sciences, Nazarbayev University, Astana, Kazakhstan, [45]Ministry of Health, Mbabane, Eswatini, [46]Nazarbayev University School of Medicine, Nur-Sultan city, Kazakhstan, [47]Global Academy of Agriculture and Food Security, The University of Edinburgh, Easter Bush Campus, Midlothian, EH25 9RG, UK, [48]Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA, USA, [49]Public Health Foundation of India, New Delhi, India, [50]Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA, USA, [51]Department of Global Health and Social Medicine, Harvard Medical School, Harvard University, Boston, MA, USA, [52]MRC/Wits Rural Public Health and Health Transitions Research Unit, School of Public Health, University of Witwatersrand, Johannesburg, South Africa, [53]Institute of Applied Health Research, University of Birmingham, Birmingham, UK, [54]Centre for Global Surgery, Department of Global Health, Stellenbosch University, Stellenbosch, South Africa, [55]Division of Primary Care and Population Health, Department of Medicine, Stanford University, Stanford, CA, USA and [56]Africa Health Research Institute, Somkhele and Durgban, South Africa

*Corresponding author. Division of Infectious Diseases, Brigham and Women's Hospital, Harvard Medical School, 75 Francis Street, Boston, MA 02115, USA. E-mail: jmanne@post.harvard.edu

†These authors contributed equally to this work.

Received 9 December 2021; Editorial decision 5 May 2022; Accepted 24 May 2022

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Key Features

- Though more than four in five deaths due to cardiovascular disease (CVD) occur in low-income and middle-income countries, there have been few data sources that allow for empirical estimation of key relationships relevant to the epidemiology, health behaviour and health services of CVD risk factors at the level of the individual. The Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC) is a novel data resource that fills this gap.
- The HPACC dataset currently consists of 76 nationally representative, population-based surveys conducted in or after 2005 of adults aged $\geq$15 years. For 46 countries, surveys are available in multiple years.
- The dataset currently includes 1 269 542 individual participants.
- The HPACC dataset includes demographic and socioeconomic variables; anthropometric and biological measures of disease status; data on health service utilization for hypertension, diabetes and hyperlipidemia; and self-reported information on health behaviours relevant for CVD. We are constantly updating and curating the dataset and are expanding it to include data on mental health, cervical cancer, HIV and injuries, where available.
- The HPACC collaboration includes a global team of physicians, epidemiologists, economists, demographers, and health policymakers. Most surveys contained in the dataset are publicly available; the harmonized, de-identified data and an accompanying dictionary can be requested from the corresponding author (Jennifer Manne-Goehler: jmanne@post.harvard.edu).

Data resource basics

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality globally.[1] In recent decades, a rising prevalence of major CVD risk factors including diabetes, hypertension and hyperlipidemia has been observed in many low- and middle-income countries (LMICs) where CVD was not previously considered a major health priority. As economic development drives urbanization and changes in lifestyles in many LMICs, this trend is expected to continue.[2–4] Although ~80% of CVD deaths now occur in LMICs,[5] there are few data sources that allow empirical estimation of key CVD indicators and relationships relevant to epidemiology, health behaviour, and health services. In this profile, we provide an overview of a novel data resource for the study of CVD risk factors in LMICs, entitled the Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC).

HPACC was initiated in 2016 by researchers at the University of Göttingen, Harvard University and Heidelberg University, in collaboration with in-country partners, with the objective to gather and harmonize household survey data on CVD and its risk factors. The HPACC dataset comprises nationally representative, population-based, individual-level surveys conducted in 2005 or later that are collated and then harmonized. The harmonization process is guided by the World Health Organization STEPwise approach to Surveillance (STEPS) survey instrument. This process is complex and includes aligning variable definitions across surveys such as income and asset data, checking data quality and ensuring consistency especially for biomarker measures, documenting variable skip patterns and confirming sample weights. To date, our efforts have resulted in a dataset covering 76 LMICs (Figure 1) and including data from 1 269 542 participants. These 76 countries represent 4.4 billion adults, which is 79% of the LMIC and 65% of the global adult population. The dataset is dynamic and new surveys are added as they become available. Furthermore, in many countries, eligible surveys are conducted periodically, at least once every 5–10 years. For the most part, these repeat surveys consist of a subsequent cross-section of the population but do not follow the same participants longitudinally. The current version of the HPACC dataset includes the most recent data in a cross-sectional harmonization but there is an ongoing effort to expand the dataset to include repeated cross-sections where available. Availability of repeat surveys by country is provided in detail in Table 1. The dataset is not publicly available, but access can be granted upon request.

The dataset was collated by an international group of collaborators to meet the need for rigorous, nationally representative evidence on key epidemiological relationships and health system performance relating to CVD risk factors in these understudied country contexts (Table 2). Its structure allows the comparison of population groups across the socio-economic and demographic spectra within and across countries. Furthermore, it yields results that are representative of the entire national population of the countries where the included surveys took place.

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

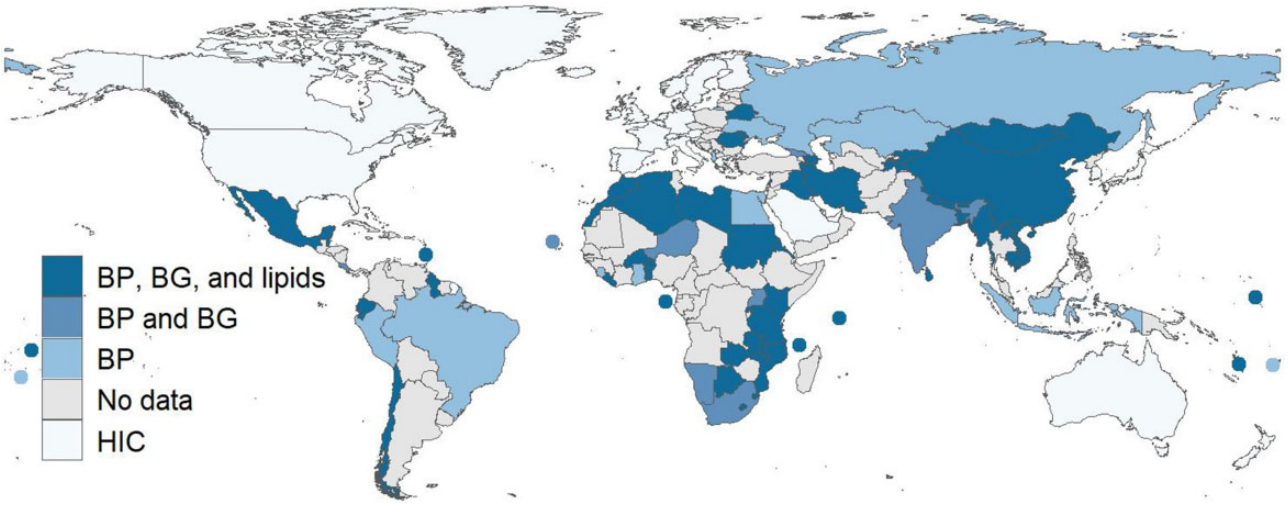

Figure 1 Map of geographic coverage of biomarker data on cardiovascular risk factors in the HPACC data set. Fiji had information on blood glucose but not blood pressure. Countries marked as high-income countries were consistently classified as high-income from 2005 to 2020 by the World Bank. The following countries are represented by dots: Cabo Verde, Comoros, Fiji, Kiribati, Marshall Islands, Samoa, São Tomé and Principe, Seychelles, Solomon Islands, St. Vincent and the Grenadines, Tonga, Vanuatu. BP, blood pressure; BG, blood glucose; HIC, high-income country. The map was generated using the ggplot2 package in R.

Data collected

Survey inclusion criteria and search methodology

A systematic search and vetting process is used to identify eligible surveys for harmonization and inclusion in the HPACC data set. The inclusion criteria are detailed in Table 2. In brief, the survey needs to have been conducted in a LMIC in or after 2005. Furthermore, individual-level data from surveys representative of a country's adult population need to be available and include either a blood pressure, blood glucose or lipid measurement. The first systematic search was conducted in 2016. The search was updated in 2021, identifying additional surveys conducted in 2010 or later.

We use a four-part search methodology to screen surveys for inclusion in the dataset (Figure 2). First, all countries in which a World Health Organization (WHO) Stepwise Approach to Non-Communicable Disease (NCD) Risk-Factor Surveillance (STEPS) survey has been conducted are identified.[6] All eligible STEPS survey data are requested from the WHO STEPS data repository.[7] Prior to 2019, when these were not available from a repository, data requests were made directly to the country survey team. Second, a search of three well-regarded survey resources—the Demographic and Health Surveys (DHS),[8] the WHO Study on global AGEing and Adult Health (SAGE)[9] and the Gateway to Global Aging studies[10]—is conducted. Third, we search three other commonly used summary resources—the NCD Risk-Factor Collaboration (NCD RisC),[11] the Global Health Data Exchange (GHDx)[12] and the International Diabetes Federation (IDF) Diabetes Atlas.[13] If these yield a potentially eligible survey, we perform a Google search to confirm and request the most recent survey data from the designated point of contact. Fourth, a systematic Google search is conducted using pre-specified search terms (Figure 2) and the first 30 returned results are reviewed. If two surveys are available for a particular country, we prioritize either the most recent survey and/or the one that contains a larger number of variables of interest. To access non-publicly available survey data that we identify at any step during the search process, we contact each survey's lead investigator(s) at least twice to invite them to share data and participate as an HPACC collaborator. Repeat surveys are included based on the same search methodology and eligibility criteria, as new data become available. The data set is updated periodically when new surveys are released. Table 1 indicates the countries for which repeat surveys are already available and the years in which the repeat survey was conducted.

Survey instruments

The HPACC dataset contains 57 STEPS surveys. The STEPS survey instrument is designed to help countries build and strengthen their surveillance capacity by obtaining core data on established chronic disease risk factors. These surveys are the official approach developed by the WHO for monitoring NCD risk factors in adults at the population level and include questionnaires, physical measurements and biochemical measurements, with 'core', 'expanded' and 'optional' modules to allow flexibility by country capacity and interest. The 'core' self-reported

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Table 1 Survey type and year, sample size, response rate and available measures and indicators by country

Country	Survey type	Sample size	Survey year	Response rate	Blood pressure	Diabetes measure	Lipid measure	Health services	Diet	Physical activity	Tobacco and alcohol	HH wealth	Repeat data available
Americas													
Belize	Non-STEPS	2435	2005–2006	82.6	✓	✓	✓	✓	✓	✓	✓	✗	✓
Brazil	Non-STEPS	64 308	2013	91.9	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chile	Non-STEPS	5293	2009–2010	85.0	✓	✓	✓	✓	✓	✓	✓	✗	✓
Costa Rica	STEPS	3627	2010	87.8	✓	✓	✓	✓	✓	✓	✓	✗	✓
Ecuador	STEPS	4638	2018	69.4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grenada	STEPS	1129	2009–2011	67.8	✓	✗	✗	✓	✓	✓	✓	✓	✓
Guyana	STEPS	2655	2016	77.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Mexico	Non-STEPS	30 009	2009–2012	90.0	✓	✓	✓	✓	✗	✗	✓	✓	✓
Peru	Non-STEPS	31 061	2012	99.0	✓	✗	✗	✓	✗	✗	✓	✓	✓
St. Vincent and the Grenadines	STEPS	3506	2013	67.8	✓	✓	✓	✓	✓	✓	✓	✓	✗
Europe													
Albania	Non-STEPS	6664	2008	97.5	✓	✗	✗	✓	✗	✗	✓	✓	✓
Azerbaijan	STEPS	2801	2017	97.3	✓	✓	✓	✓	✓	✓	✓	✓	✓
Belarus	STEPS	5010	2016	87.1	✓	✓	✓	✓	✓	✓	✓	✗	✗
Georgia	STEPS	4204	2016	75.7	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kazakhstan	Non-STEPS	12 645	2012	92.0	✓	✗	✗	✓	✗	✗	✓	✓	✗
Kyrgyzstan	STEPS	2623	2013	100.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Moldova	STEPS	4807	2013	83.5	✓	✓	✓	✓	✓	✓	✓	✓	✗
Romania	Non-STEPS	1970	2015–2016	69.1	✓	✓	✓	✓	✗	✗	✓	✓	✓
Russian Federation	Non-STEPS	4355	2007–2008	67.0	✓	✗	✗	✓	✓	✓	✓	✓	✗
Tajikistan	STEPS	2717	2016	94.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ukraine	Non-STEPS	9664	2007	95.1	✓	✗	✗	✓	✗	✗	✓	✓	✓
South East Asia													
Bangladesh	STEPS	8185	2018	83.3	✓	✓	✓	✓	✓	✓	✓	✗	✓
Bhutan	STEPS	2812	2014	96.9	✓	✓	✓	✓	✓	✓	✓	✓	✓
India	Non-STEPS	757 655	2015–2016	97.6	✓	✓	✗	✓	✗	✗	✓	✓	✓
Indonesia	Non-STEPS	32 710	2014	90.5	✓	✓	✗	✓	✗	✗	✓	✓	✓
Myanmar	STEPS	8271	2014	94.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Nepal	STEPS	5593	2019	86.4	✓	✓	✗	✓	✓	✓	✓	✗	✓
Sri Lanka	STEPS	5188	2014	72.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Timor-Leste	STEPS	2609	2014	96.3	✓	✓	✓	✓	✓	✓	✓	✓	✗
Western Pacific													
Cambodia	STEPS	5433	2010	96.3	✓	✓	✓	✓	✓	✓	✓	✓	✗
China	Non-STEPS	16 837	2009	88.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fiji	Non-STEPS	1377	2009	80.0	✗	✓	✗	✓	✗	✗	✓	✗	✓
Kiribati	STEPS	2156	2015	55.0	✓	✓	✓	✓	✓	✓	✓	✓	✓

(Continued)

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Table 1 Continued

Country	Survey type	Sample size	Survey year	Response rate	Blood pressure	Diabetes measure	Lipid measure	Health services	Diet	Physical activity	Tobacco and alcohol	HH wealth	Repeat data available
Laos	STEPS	2542	2013	99.2	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marshall Islands	Non-STEPS	3005	2017	92.3	✓	✓	✓	✓	✓	✗	✓	✓	✓
Mongolia	STEPS	6013	2013	97.4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Samoa	STEPS	1766	2013	64.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solomon Islands	STEPS	2525	2015	58.4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tokelau	STEPS	554	2014	70.0	✓	✓	✓	✓	✓	✓	✓	✗	✓
Tonga	STEPS	3858	2017	85.7	✓	✗	✓	✓	✓	✓	✓	✗	✓
Tuvalu	STEPS	1155	2015	76.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Vanuatu	STEPS	4643	2011	94.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Vietnam	STEPS	3758	2015	97.4	✓	✓	✓	✓	✓	✓	✓	✗	✓
Africa													
Algeria	STEPS	6989	2016	93.8	✓	✓	✓	✓	✓	✓	✓	✓	✗
Benin	STEPS	5126	2015	98.6	✓	✓	✓	✓	✓	✓	✓	✓	✓
Botswana	STEPS	4070	2014	63.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Burkina Faso	STEPS	4704	2013	99.1	✓	✓	✓	✓	✓	✓	✓	✗	✗
Cabo Verde	STEPS	1760	2007	99.4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Comoros	STEPS	5460	2011	96.5	✓	✓	✗	✓	✓	✓	✓	✓	✗
Eritrea	STEPS	6265	2010	97.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gambia	STEPS	4103	2010	77.9	✓	✗	✗	✓	✓	✓	✓	✓	✗
Ghana	Non-STEPS	5110	2007–2008	86.0	✓	✗	✗	✓	✓	✓	✓	✓	✓
Kenya	STEPS	4472	2015	93.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Lesotho	STEPS	2310	2012	80.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Liberia	STEPS	1872	2011	87.1	✓	✓	✗	✓	✓	✓	✓	✓	✗
Malawi	STEPS	5206	2009	95.5	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mozambique	STEPS	3304	2005	98.4	✓	✓	✓	✓	✓	✓	✓	✗	✓
Namibia	Non-STEPS	4403	2013	95.8	✓	✓	✗	✓	✓	✗	✓	✓	✓
Niger	STEPS	2757	2007	91.3	✓	✓	✗	✓	✓	✓	✓	✓	✗
Rwanda	STEPS	7226	2012	99.8	✓	✓	✓	✓	✓	✓	✓	✓	✗
São Tomé and Principe	STEPS	2457	2009	95.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Seychelles	Non-STEPS	1240	2013	73.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sierra Leone	STEPS	4997	2009	90.0	✓	✗	✗	✓	✓	✓	✓	✗	✗
South Africa	Non-STEPS	8582	2016	81.3	✓	✓	✗	✓	✗	✗	✓	✓	✓
Swaziland	STEPS	3531	2014	76.0	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tanzania	STEPS	5599	2012	94.7	✓	✓	✓	✓	✓	✓	✓	✓	✗
Togo	STEPS	4353	2010	91.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Uganda	STEPS	3987	2014	92.2	✓	✓	✓	✓	✗	✗	✓	✓	✗
Zambia	STEPS	4302	2017	74.0	✓	✓	✓	✓	✓	✓	✓	✓	✗

(Continued)

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Table 1 Continued

Country	Survey type	Sample size	Survey year	Response rate	Blood pressure	Diabetes measure	Lipid measure	Health services	Diet	Physical activity	Tobacco and alcohol	HH wealth	Repeat data available
Zanzibar	STEPS	2488	2011	91.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Eastern Mediterranean													
Egypt	Non-STEPS	14 862	2015	98.3	✓	✗	✗	✓	✗	✗	✓	✓	✓
Iran	STEPS	30 541	2016	98.4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Iraq	STEPS	4060	2015	98.8	✓	✓	✓	✓	✓	✓	✓	✗	✗
Lebanon	STEPS	1899	2017	65.9	✓	✓	✓	✓	✓	✓	✓	✓	✓
Libya	STEPS	3590	2009	73.0	✓	✓	✓	✓	✓	✓	✓	✗	✗
Morocco	STEPS	5429	2017	89.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Sudan	STEPS	7722	2016	95.0	✓	✓	✓	✓	✓	✓	✓	✓	✗
Sample total	..	1 269 542	2005–2019	90.5[a]	76	65	57	77	65	63	77	62	

HH wealth, household wealth; STEPS, STEPwise Approach to Non-Communicable Disease Risk-Factor Surveillance.

[a]Median response rate.

Albania, Egypt, Fiji, Indonesia, Mexico, Peru, Romania, Uganda and Ukraine only collect data on tobacco use.

Repeat data are already pooled for the following countries and years: Bangladesh 2011 and 2018, Benin 2015 and 2018, Bhutan 2014 and 2019, Brazil 2013 and 2019, Ecuador 2012 and 2018, Chile 2009–2010 and 2016–2017, China 2009 and 2015, Fiji 2009 and 2011, Mexico 2009–2012 and 2018–2019, Kyrgyz Republic 2012 and 2013, Lebanon 2008–2009 and 2017, Lesotho 2012 and 2014, Mongolia 2009 and 2013, Mozambique 2005 and 2015, Nepal 2013 and 2019, São Tomé and Príncipe 2009 and 2019, South Africa 2012 and 2016, India 2015–2016 and 2017–2019.

measures include data on demographic characteristics, tobacco and alcohol use, dietary behaviour (fruit and vegetable intake), physical activity and history of raised blood pressure, diabetes, raised total cholesterol, heart disease and stroke. In addition, there are 20 non-STEPS surveys in the HPACC data set. Among these, the DHS instrument is frequently used. The DHS, in partnership with country governments, are nationally representative household surveys that collect data on a wide range of health-related monitoring and impact evaluation indicators.[14] The standard surveys have large sample sizes (usually >5000 participants) and are conducted, on average, once every 5 years. Although they have historically focused on maternal and child health and more recently HIV, later surveys have increasingly incorporated questions about health behaviour, nutrition and tobacco use. These recent DHS have also begun to measure blood pressure and incorporate biomarkers for diabetes, consistently with the HPACC inclusion criteria.

Survey design, clustering and weighting

Most surveys in the HPACC dataset use multi-stage cluster random sampling of respondents and almost all provide detailed documentation on the applied sampling strategy. In all analyses, sampling weights account for item non-response and are rescaled to allow either population-size weighting or equal weighting for each country, depending on the primary research question of interest.

Thematic content and measures

Demographic and socio-economic characteristics

All surveys included in the HPACC dataset contain information on participants' age and sex, along with a measure of years of schooling or educational attainment. The majority of these surveys also include information about location of residence (rural/urban, 46 surveys), marital status (68 surveys), working status (72 surveys), pregnancy status (70 surveys) and a measure of household wealth (62 surveys). The construction of variables capturing economic status within each survey depends on the available household economic indicators. Surveys using an assets, or wealth, index for economic status assessment have surveyed household ownership of a range of assets, dwelling characteristics and other country-specific wealth indicators. Based on the standard DHS approach, we use principal component analysis to derive an asset index, from which we create household wealth quintiles.[15] Countries using a household income-based measurement mainly followed the WHO STEPS template questionnaire. In these cases, respondents were asked

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Table 2 Key details about the Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC) data resource

Inclusion criteria	I. Includes adults aged 15 years and older
	II. Nationally representative surveys
	III. Individual microdata available
	IV. Contains at least one of the following three biological measures: blood pressure, blood glucose/HbA1c, and lipids
	V. Response rate ≥50%
	VI. Conducted in or after 2005
	VII. Conducted in a LMIC (according to World Bank) in the year of the survey
Sample size	1 269 542 individuals from 76 LMICs covering 73% of the LMIC population
	Regional composition
	Africa: 26 countries
	Americas: 10 countries
	Eastern Mediterranean: 7 countries
	Europe: 11 countries
	South East Asia: 8 countries
	Western Pacific: 14 countries
Survey type and years	Date range: 2005–2020
	STEPS Surveys (57)
	Non-STEPS surveys (20)
Thematic domains	Demographic assessment: age, sex, education, marital status, rural/urban residence, household wealth quintile, working status
	Biological measures: anthropometry, blood pressure, blood glucose/HbA1c, lipids
	Measures of healthcare utilization: health care, cascade measures (ever screened, diagnosed, treated), lifestyle counselling regarding diet, exercise, smoking cessation, salt reduction
	Behavioural risk factors: fruit and vegetable intake, salt intake, physical activity, tobacco use,alcohol use
	Current data frontiers: HIV, oral health, suicide, mental health, injury and violence
Research themes	Prevalence of CVD risk factors
	Unmet need for healthcare services for CVD risk factors
	Socio-economic and demographic patterns of CVD risk factors
	Quantifying associations between CVD risk factors
	Modelling costs and effects of hypothetical intervention scenarios

CVD, cardiovascular disease; HbA1c, glycated haemoglobin; LMIC, low- and middle-income country; STEPS, WHO STEPwise approach to Surveillance.

about the household earnings over the past year: weekly or monthly average, or year total. In cases in which this question was left unanswered, respondents were asked to place their household in one of the given income brackets. These brackets were usually defined according to a country's national household income quintile thresholds. Both continuous income and income brackets are used in the creation of the wealth quintiles.

We assume that household incomes within a country follow a log-normal distribution and we are therefore able to combine income quintiles and categories.[16] In 11 surveys, we dismissed pre-coded income brackets as they displayed very large discrepancies with respect to the continuous income range or could otherwise not be correctly identified. However, as the pre-coded estimates were typically only asked of respondents that had not indicated a continuous income, this has resulted in only minor information losses.

Anthropometric and biological measures of disease status

The dataset includes height and weight measurements in all surveys and 69 surveys include waist and/or hip circumference. In terms of the three CVD risk factors of interest, 54 surveys measured blood pressure and diabetes and lipid biomarkers, and 9 surveys measured blood pressure and diabetes biomarkers only (Table 1). Blood pressure measurement was standardized, though the number of measurements that were taken and subsequently averaged per survey ranged from one to three. The most meaningful differences exist in the assessment of diabetes biomarkers as a variety of different measures were used. Fifty-six surveys measured fasting blood glucose only, four measured glycated haemoglobin (HbA1c) only, and five surveys measured both. We have collected extensive documentation of measurement details relating to each survey's approach to measurement of the biomarkers. For blood pressure measurements, we note the number of measurements, details of the procedure, and devices and cuff-

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

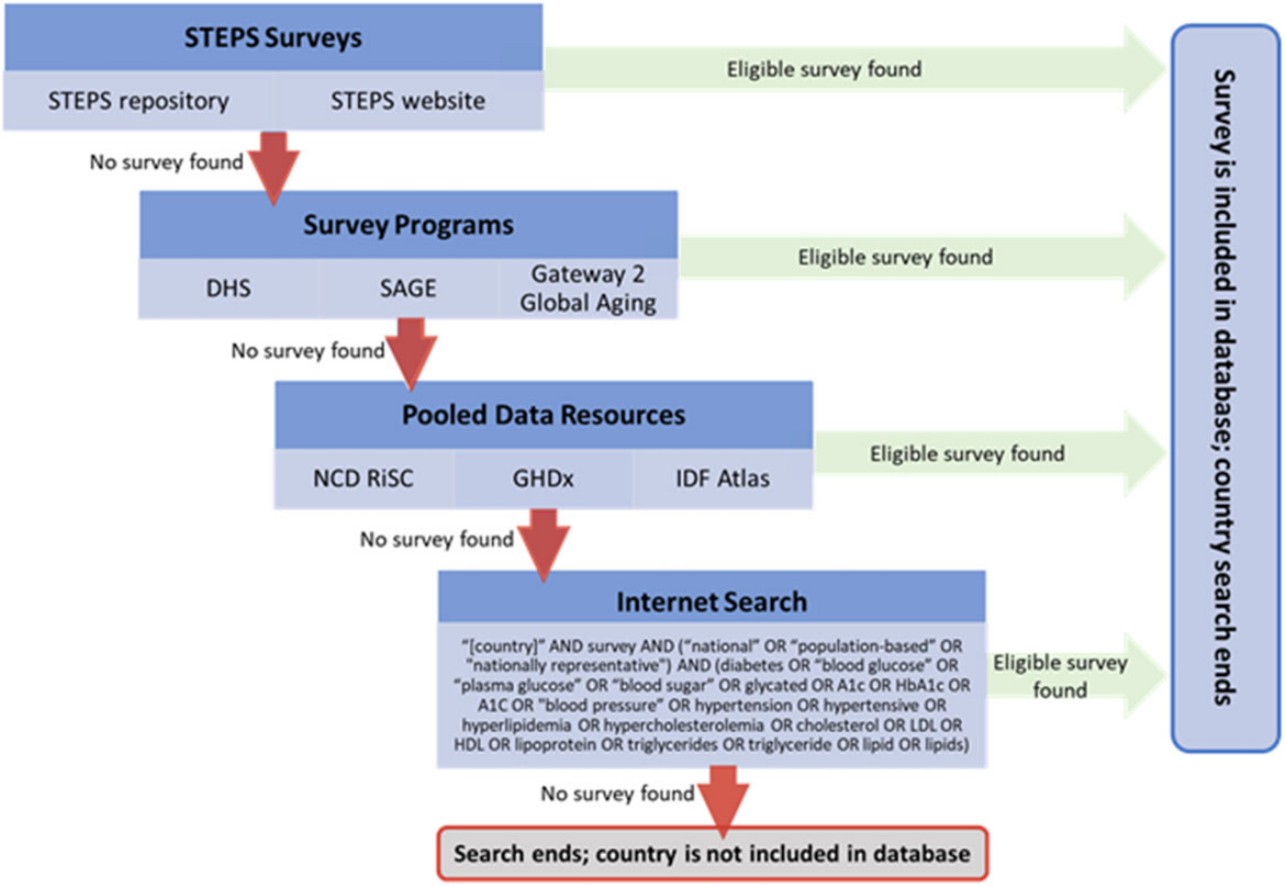

Figure 2 Global Health and Population Project on Access to Care for Cardiometabolic Diseases (HPACC) search strategy. DHS, Demographic and Health Survey; GHDx, Global Health Data Exchange; IDF, International Diabetes Federation; NCD RisC, NCD Risk-Factor Collaboration; SAGE, Study on global AGEing and Adult Health; STEPS, STEPwise Approach to Non-Communicable Disease Risk-Factor Surveillance. See the Supplementary Material (available as Supplementary data at *IJE* online) for a list of countries that were classified as low-income or middle-income for at least 1 year from 2005 to 2021.

sizes used. Documentation on the diabetes biomarker includes information on type of glucometer or measurement device, whether samples were capillary or venous, whether plasma conversions are required, and the fasting status of respondents.

The lipid measurements were also subject to modest variation in measurement, with countries choosing either a point-of-care approach or a lab-based measurement. In case of the former, the CardioCheck PA device was most frequently utilized. Of the surveys with lipid measurements, all measured total cholesterol and many additionally collected high-density lipoprotein, triglycerides and low-density lipoprotein cholesterol. Details of these measurement approaches are available in Supplementary Tables S1, S2 and S3 (available as Supplementary data at *IJE* online).

Measures of healthcare service utilization

A unique feature of the HPACC data set is that underlying surveys collected information on measures of healthcare service utilization for hypertension, diabetes and/or hyperlipidemia. For the vast majority of surveys, this includes a question about (1) whether a person had ever received a screening test for the respective condition, (2) whether they have been diagnosed with this condition, and (3) whether they are treated (have received advice or currently take medication) for the condition. Sixty surveys include information on ever having visited a traditional healer and 65 on whether they currently use traditional medicine for the respective condition. Forty-four of the included surveys asked respondents about prior history of CVD including heart attack or stroke. In addition, in the case of diabetes, of the 70 surveys with information on diabetes medication, 66 contained questions about use of oral medications and insulin separately. Sixty-eight surveys also included a suite of questions about whether a participant had received lifestyle counselling from a healthcare provider with respect to losing weight, physical activity, reducing salt intake, increasing fruit and vegetable intake and/or smoking cessation.

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

Behavioural measures

The majority of surveys include self-reported information on health behaviours relevant to CVD. This includes information about dietary patterns of fruit and vegetable consumption and salt intake (61 surveys). In addition, 63 include a physical activity inventory mainly using the Global Physical Activity Questionnaire (GPAQ). The GPAQ measures moderate and vigorous activity at work and during leisure time and travel to and from places. This enables the calculation of a standardized estimate of activity in Metabolic Equivalents of Tasks, which is in turn a ratio of the person's working metabolic rate relative to their resting rate. Furthermore, 60 surveys capture sedentary behaviour. The GPAQ has been validated for use in several LMICs previously and is a recognized tool for assessing physical activity level in resource-limited settings.[17–19] Surveys included in the HPACC data set also ask questions about alcohol (67 surveys) and tobacco use (76 surveys), including the history of use, frequency and intensity.

Novel research frontiers

The STEPS surveys and several of the other surveys included in the HPACC data set also feature modules on other chronic conditions that are of particular interest globally. These include sections about mental health, cervical cancer, and oral health . Furthermore, recent STEPS surveys include information on injury and violence. The DHSs include additional modules about health behaviours (e.g. sugar-sweetened beverage intake or fast/fried food consumption), HIV, and expanded nutritional biomarkers (e.g. micronutrient status).

Harmonization process

To harmonize surveys, we performed a detailed review of the survey documentation with respect to the design and questionnaires from which the data were obtained. The harmonization process is based on and guided by the STEPS survey instrument. We defined the core group of variables that were preserved across instruments and established common definitions for variables for which response items were heterogeneous. We perform detailed data quality assessments prior to harmonization and collation.

Brief overview of the study population

The current HPACC dataset contains data from 1 269 542 individuals aged ≥15 years who were eligible for at least one of the three measurements: blood pressure, blood glucose/HbA1c or lipids. The unweighted mean age of all individuals in the data set is 35.1 years (SD: 13.9) and 73.9% are female. The distribution of educational attainment of the individuals in the data set is 21.9% with no formal schooling, 20.2% with at least some primary school education or primary school completed and 56.6% with at least some secondary education or greater. Of all individuals in the dataset, 29.4% (95% CI 28.8–30.0) had hypertension, 8.6% (95% CI 7.9–9.4) had diabetes, and 6.7% (95% CI 6.2–7.2) had hyperlipedemia. (These prevalence estimates are derived from the respective biological or physical measurement and self-reported use of medication; the prevalence estimates are weighted for population size.)

Data resource use

The HPACC dataset has already provided several important and novel insights about the epidemiological relationships and health system performance for CVD risk factors in LMICs. To date, >15 research articles using the HPACC dataset have been published in peer-reviewed journals. These analyses cover a range of topics such as an evaluation of health system performance for the management of hypertension (in 44 LMICs),[20] the variation in eligibility for hypertension treatment depending on clinical guideline (in 50 LMICs),[21] targeting of hypertension screening through easily identifiable individual characteristics[22] and the relationship between estimated CVD risk and hypertension undertreatment/overtreatment (in 45 LMICs).[23] Health system performance for the management of diabetes has been analysed in three separate studies using the HPACC data, which included 12, 28 and 55 LMICs, respectively.[24–26] Furthermore, analyses of the association between diabetes and socio-economic status,[27] as well as anthropometric measures, including body mass index (BMI)[28] and adult height,[29] have been conducted. In addition to analyses focused on diabetes and hypertension, the HPACC data have been used to describe the cascade of care for hypercholesterolemia and estimate statin coverage in LMICs.[30,31] Health systems investigation in this data set has also included a comprehensive consideration of country preparedness indicators for management of CVD risk factors.[32]

Furthermore, the HPACC data have been used to explore important behavioural risk factors for CVD and diabetes, including the patterns of fruit and vegetable consumption,[33] as well as sex differences in dietary behaviours.[34] Another study estimated the lifetime prevalence of cervical cancer screening.[35] Finally, the HPACC data set is used in modelling studies such as the impact of increased diagnosis, treatment and control of diabetes.[36]

Participating countries institutions and researchers

The harmonization of survey data for the HPACC dataset is only possible thanks to the large number of HPACC

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

collaborators from the teams that conduct the individual surveys included in HPACC. These researchers play an active and crucial role in all studies that have been published so far and those that are planned. We have ongoing efforts to identify, contact and foster collaboration with the survey teams of publicly available data sets. Furthermore, the involvement of young researchers from LMICs is one of HPACC's priorities and efforts to do so are being intensified.

Strengths and weaknesses

Strengths

The HPACC dataset has several important strengths. First, uniquely, the data are at the individual level and population-based, and are harmonized to allow granular examination of key epidemiological and health systems relationships, including variation across demographic and socio-economic groups within countries. Moreover, the data set includes nationally representative survey data from 76 countries whose combined population is ~79% (4.4 billion people) of the adult population living in LMICs. The extensive geographic coverage has enabled analyses at the global and regional levels, along with cross-country comparisons. Second, all HPACC surveys contain biomarkers and biological measurements, including blood pressure, fasting blood glucose/HbA1c and/or lipids, as well as anthropometry. Given that CVD risk factors of interest are defined based on these measurements, the HPACC data set represents a substantial advance as few population-based surveys collected blood-based measurements prior to 2005. Third, most of these surveys include at least one measure of household income or asset ownership, which have been harmonized into mesaures of relative economic status. The availability of this measure has allowed a unique exploration of important relationships between prevalence and care for CVD risk factors and an individual's socio-economic status.

Weaknesses

The limitations of the HPACC dataset centre primarily on the challenge of harmonizing heterogeneous measures across many surveys from diverse geographic and cultural contexts. This includes the measures of economic status, which varies across surveys. In addition, there is substantial heterogeneity in the measurement of biomarkers of diabetes and hyperlipidemia. To ensure transparency, we have documented these variations, including the survey-specific approach to eliciting fasting status, biomarker measurement (point-of-care vs laboratory-based) and nuances about the specific measurement instruments that can impact the interpretation of results, such as plasma-equivalent blood glucose measures. We would like to note that surveys recording self-reported information are standardized within survey types (STEPS, DHS) and largely comparable. A second limitation is that the measures of access to care for all CVD risk factors are self-reported by survey participants and thus subject to reporting bias. Moreover, self-report of access may be affected by education or health literacy, which may lead to underestimates in the prevalence of health behaviours and barriers to healthcare. Other potential biases are those of the interviewer and social desirability. Third, the included surveys were conducted in or after 2005. The older surveys may not accurately describe the current situation in the respective countries. However, the data set is updated on a regular basis and thus includes the newest available data. Fourth, due to the cross-sectional nature of the data, it is currently not possible to describe time trends. It is planned to harmonize and include older and future waves conducted in LMICs, which will allow us to look at changes over time.

Data resource access

Many surveys contained in the HPACC dataset are publicly available. The two most common data sources are the WHO data repository and the DHS website.[7,8,37] Several additional surveys have been obtained through formal requests of survey teams whose data are not already made public. The pooled, harmonized, de-identified participant-level HPACC dataset and accompanying data dictionary have been created through a partnership between Harvard University, University of Göttingen and Heidelberg University, in collaboration with all country-level survey teams. Access can be requested through the corresponding author. More information about HPACC including additional contact information for the collaboration can be found at www.hpaccproject.org or by e-mailing Jennifer Manne-Goehler at jmanne@post.harvard.edu.

Ethics approval

The included population-based surveys sought ethical approval from the respective country's ethics review committee prior to data collection. All surveys followed standardized ethics procedures, such as asking for participants' informed consent to participate in the respective survey. The final collated HPACC dataset is de-identified and no investigator can contact or re-identify patients. The Federal Policy for the Protection of Human Subjects (45 CFR Part 46) states that studies are excluded from an Institutional Review Board (IRB) review if 'information, which may include information about biospecimens, is recorded by the investigator in such a manner that the

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects'. The HPACC data set was thus designated as Non-Human Subjects Research by the Harvard T.H. Chan School of Public Health in 2018 under protocol #IRB16-1915.

Data availability

See Data Resource Access, above.

Supplementary data

Supplementary data are available at *IJE* online.

Author contributions

J.M.G. and M.T. wrote the original draft. D.F. and M.E.M. validated the results. J.M.G., M.T., D.F., M.E.M., L.M.J., R.A., J.I.D., P.G., S.V. and T.W.B. co-conceived the HPACC project and this paper. All authors participated in the data curation and critically reviewed the article draft. J.M.G. and M.T. are the guarantors of the work.

Funding

Each STEPS survey is co-funded by the country's government and the WHO. DHS are co-funded by the United States Agency for International Development (USAID) and the respective country's government. The funding of the other surveys are mostly co-funded by a country's government, universities and international organizations, and sometimes supported by local sponsors. The creation of the final collated data set has been funded by the Harvard McLennan Family Fund and the Alexander von Humboldt Foundation as well as institutional funds from the Universities of Heidelberg and Göttingen.

Acknowledgements

We would like to thank each of the country-level survey teams and study participants who made the compilation of this data set possible. We also gratefully acknowledge the high-performance computing bwHPC and data storage service SDS@hd supported by the Ministry of Science, Research and the Arts Baden-Württemberg (MWK) and the German Research Foundation (DFG) through grants INST 35/1134–1 FUGG, INST 35/1314–1 FUGG and INST 35/1503–1 FUGG.

Conflict of interest

None declared.

References

1. Vos T, Lim SS, Abbafati C *et al.* Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020;**396**:1204–22.
2. Tucker KL, Buranapin S. Nutrition and aging in developing countries. *J Nutr* 2001;**131**:2417S–23S.
3. Sudharsanan N, Geldsetzer P. Impact of coming demographic changes on the number of adults in need of care for hypertension in Brazil, China, India, Indonesia, Mexico, and South Africa. *Hypertension* 2019;**73**:770–76.
4. United Nations DoEaSA, Population Division. World Population Prospects2019, Volume II: Demographic Profiles (ST/ESA/SER.A/427) 2019. https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf (2 June 2022, date last accessed).
5. Roth GA, Mensah GA, Johnson CO, *et al.*; GBD-NHLBI-JACC Global Burden of Cardiovascular Diseases Writing Group. Global burden of cardiovascular diseases and risk factors, 1990-2019: update from the GBD 2019 study. *J Am Coll Cardiol* 2020;**76**:2982–3021.
6. 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.
7. World Health Organization. NCD Microdata Repository 2020. https://extranet.who.int/ncdsmicrodata/index.php/catalog (2 June 2022, date last accessed).
8. ICF. The DHS Program: Demographic and Health Surveys 2021. https://dhsprogram.com/ (2 June 2022, date last accessed).
9. WHO. WHO Study on global AGEing and adult health (SAGE) 2021. https://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/sage (2 June 2022, date last accessed).
10. Program on Global Aging, Health, and Policy, Center for Economic and Social Research (CESR). Gateway to Global Aging Data 2021. https://g2aging.org/ (2 June 2022, date last accessed).
11. (NCD-RisC) NRFC. Data Downloads 2021. https://ncdrisc.org/data-downloads.html (2 June 2022, date last accessed).
12. Institute for Health Metrics and Evaluation. Global Health Data Exchange 2021. http://ghdx.healthdata.org/gbd-results-tool (2 June 2022, date last accessed).
13. International Diabetes Federation. IDF Diabetes Atlas, 9th edn. International Diabetes Federation, 2019.
14. ICF. Demographic and Health Survey: the DHS Website. USAID, 2021. https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm (2 June 2022, date last accessed).
15. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data–or tears: an application to educational enrollments in states of India. *Demography* 2001;**38**:115–32.
16. Harttgen K, Vollmer S. Using an asset index to simulate household income. *Econ Lett* 2013;**121**:257–62.
17. Bull FC, Maslin TS, Armstrong T. Global Physical Activity Questionnaire (GPAQ): nine country reliability and validity study. *J Phys Act Health* 2009;**6**:790–804.
18. Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the Global Physical Activity Questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. *BMC Public Health* 2014;**14**:1255.
19. Chu AH, Ng SH, Koh D, Muller-Riemenschneider F. Reliability and validity of the self- and interviewer-administered versions of the Global Physical Activity Questionnaire (GPAQ). *PLoS One* 2015;**10**:e0136944.

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024

20. Geldsetzer P, Manne-Goehler J, Marcus ME *et al.* The state of hypertension care in 44 low-income and middle-income countries: a cross-sectional study of nationally representative individual-level data from 1.1 million adults. *Lancet* 2019;**394**:652–62.
21. Sudharsanan N, Theilmann M, Kirschbaum TK *et al.* Variation in the proportion of adults in need of blood pressure-lowering medications by hypertension care guideline in low- and middle-income countries: a cross-sectional study of 1 037 215 individuals from 50 nationally representative surveys. *Circulation* 2021; **143**:991–1001.
22. Kirschbaum TK, Theilmann M, Sudharsanan N *et al.* Targeting hypertension screening in low- and middle-income countries: a cross-sectional analysis of 1.2 million adults in 56 countries. *J Am Heart Assoc* 2021;**10**:e021063.
23. Peiris D, Ghosh A, Manne-Goehler J *et al.* Cardiovascular disease risk profile and management practices in 45 low-income and middle-income countries: a cross-sectional study of nationally representative individual-level survey data. *PLoS Med* 2021; **18**:e1003485.
24. 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.
25. 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**:903–12.
26. 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**: E340–51.
27. Seiglie JA, Marcus ME, Ebert C *et al.* Diabetes prevalence and its relationship with education, wealth, and BMI in 29 low- and middle-income countries. *Diabetes Care* 2020;**43**:767–75.
28. Teufel F, Seiglie JA, Geldsetzer P *et al.* Body-mass index and diabetes risk in 57 low-income and middle-income countries: a cross-sectional study of nationally representative, individual-level data in 685 616 adults. *Lancet* 2021;**398**:238–48.
29. Teufel F, Geldsetzer P, Manne-Goehler J *et al.* Analysis of attained height and diabetes among 554,122 adults across 25 low- and middle-income countries. *Diabetes Care* 2020;**43**: 2403–10.
30. Marcus MM-G, Theilmann M, Farzadfar F *et al.* Use of statins for the prevention of cardiovascular disease in 41 low-income and middle-income countries: a cross-sectional study of nationally representative, individual-level data. *Lancet Glob Health* 2022;**10**:e369–79.
31. Marcus ME, Ebert C, Geldsetzer P *et al.* Unmet need for hypercholesterolemia care in 35 low- and middle-income countries: a cross-sectional study of nationally representative surveys. *PLoS Med* 2021;**18**:e1003841.
32. Davies JI, Reddiar SK, Hirschhorn LR *et al.* Association between country preparedness indicators and quality clinical care for cardiovascular disease risk factors in 44 lower- and middle-income countries: a multicountry analysis of survey data. *PLoS Med* 2020;**17**:e1003268.
33. Frank SM, Webster J, McKenzie B *et al.* Consumption of fruits and vegetables among individuals 15 years and older in 28 low- and middle-income countries. *J Nutr* 2019;**149**:1252–59.
34. McKenzie BL, Santos JA, Geldsetzer P *et al.* Evaluation of sex differences in dietary behaviours and their relationship with cardiovascular risk factors: a cross-sectional study of nationally representative surveys in seven low- and middle-income countries. *Nutr J* 2020;**19**:3.
35. Lemp JM, De Neve JW, Bussmann H *et al.* Lifetime prevalence of cervical cancer screening in 55 low- and middle-income countries. *JAMA* 2020;**324**:1532–42.
36. 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**:e1539–52.
37. World Health Organization. STEPwise Approach to NCD Risk Factor Surveillance (STEPS) 2021. https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps (2 June 2022, date last accessed).

Downloaded from https://academic.oup.com/ije/article/51/6/e337/6619177 by guest on 02 April 2024