

Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants



NCD Risk Factor Collaboration (NCD-RisC)*



Summary

Background Hypertension can be detected at the primary health-care level and low-cost treatments can effectively control hypertension. We aimed to measure the prevalence of hypertension and progress in its detection, treatment, and control from 1990 to 2019 for 200 countries and territories.

Methods We used data from 1990 to 2019 on people aged 30–79 years from population-representative studies with measurement of blood pressure and data on blood pressure treatment. We defined hypertension as having systolic blood pressure 140 mm Hg or greater, diastolic blood pressure 90 mm Hg or greater, or taking medication for hypertension. We applied a Bayesian hierarchical model to estimate the prevalence of hypertension and the proportion of people with hypertension who had a previous diagnosis (detection), who were taking medication for hypertension (treatment), and whose hypertension was controlled to below 140/90 mm Hg (control). The model allowed for trends over time to be non-linear and to vary by age.

Findings The number of people aged 30–79 years with hypertension doubled from 1990 to 2019, from 331 (95% credible interval 306–359) million women and 317 (292–344) million men in 1990 to 626 (584–668) million women and 652 (604–698) million men in 2019, despite stable global age-standardised prevalence. In 2019, age-standardised hypertension prevalence was lowest in Canada and Peru for both men and women; in Taiwan, South Korea, Japan, and some countries in western Europe including Switzerland, Spain, and the UK for women; and in several low-income and middle-income countries such as Eritrea, Bangladesh, Ethiopia, and Solomon Islands for men. Hypertension prevalence surpassed 50% for women in two countries and men in nine countries, in central and eastern Europe, central Asia, Oceania, and Latin America. Globally, 59% (55–62) of women and 49% (46–52) of men with hypertension reported a previous diagnosis of hypertension in 2019, and 47% (43–51) of women and 38% (35–41) of men were treated. Control rates among people with hypertension in 2019 were 23% (20–27) for women and 18% (16–21) for men. In 2019, treatment and control rates were highest in South Korea, Canada, and Iceland (treatment >70%; control >50%), followed by the USA, Costa Rica, Germany, Portugal, and Taiwan. Treatment rates were less than 25% for women and less than 20% for men in Nepal, Indonesia, and some countries in sub-Saharan Africa and Oceania. Control rates were below 10% for women and men in these countries and for men in some countries in north Africa, central and south Asia, and eastern Europe. Treatment and control rates have improved in most countries since 1990, but we found little change in most countries in sub-Saharan Africa and Oceania. Improvements were largest in high-income countries, central Europe, and some upper-middle-income and recently high-income countries including Costa Rica, Taiwan, Kazakhstan, South Africa, Brazil, Chile, Turkey, and Iran.

Interpretation Improvements in the detection, treatment, and control of hypertension have varied substantially across countries, with some middle-income countries now outperforming most high-income nations. The dual approach of reducing hypertension prevalence through primary prevention and enhancing its treatment and control is achievable not only in high-income countries but also in low-income and middle-income settings.

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Introduction

Hypertension, along with pre-hypertension and other hazardously high blood pressure, is responsible for

8.5 million deaths from stroke, ischaemic heart disease, other vascular diseases, and renal disease worldwide.^{1,2} Hypertension can be detected in the

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*NCD-RisC members listed at the end of the manuscript

Correspondence to:

Prof Majid Ezzati, School of Public Health, Imperial College London, London W2 1PG, UK

majid.ezzati@imperial.ac.uk

Research in context

Evidence before this study

We searched MEDLINE (via PubMed) for articles published from inception to Jan 15, 2021, using the search terms ((hypertension[Title] AND (((medication OR treatment) AND control) OR aware*)) AND "blood pressure") OR (cardiovascular[Title] AND risk factor*[Title] AND "blood pressure" AND (((medication OR treatment) AND control) OR aware*)) AND (trend* OR global OR worldwide) NOT patient*[Title]. No language restrictions were applied. We found a few multi-country studies that reported hypertension prevalence, treatment, and control. These studies used up to 135 data sources that had sampled from national or sub-national populations or data from small communities. Few multi-country studies reported trends over time. The largest of these analyses covered snapshots in 2000 and 2010 and grouped countries into high income versus low income and middle income. We also found several studies that analysed trends in individual countries. To our knowledge, there is no study on long-term trends in, nor the contemporary levels of, hypertension prevalence, detection, treatment, and control that covers the entire world.

Added value of this study

To our knowledge, this study is the first comprehensive global analysis of trends in hypertension prevalence, detection,

treatment, and control that covers all countries worldwide. The data used in the study were from 184 countries, together covering 99% of the global population, and were subject to rigorous inclusion and exclusion criteria. Data were analysed using a standardised protocol and were pooled using a statistical model designed to incorporate how hypertension and its care and control vary in relation to age, geography, and time.

Implications of all the available evidence

Hypertension care—including detection, treatment, and control—varies substantially worldwide and even within the same region of the world. Sub-Saharan Africa, Oceania, and south Asia have the lowest rates of detection, treatment, and control and many countries in these regions have seen little improvement in these outcomes over the past 30 years. The large improvements observed in some upper-middle-income and recently high-income countries show that the expansion of universal health coverage and primary care can be leveraged to enhance hypertension care and reduce the health burden of this condition.

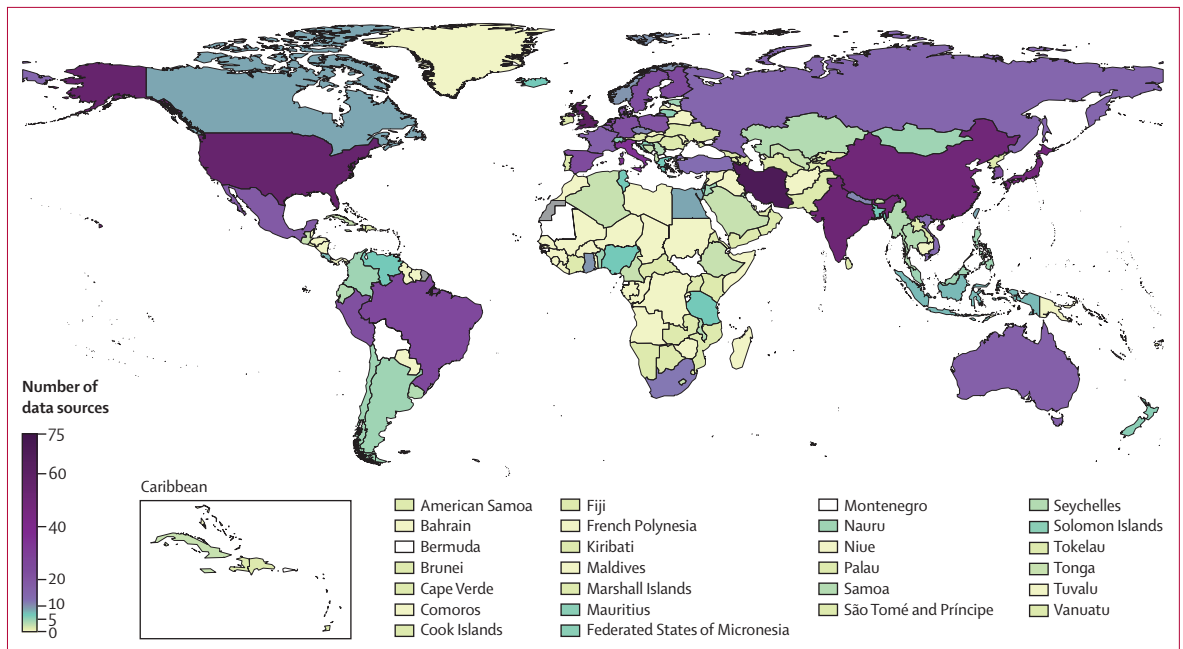
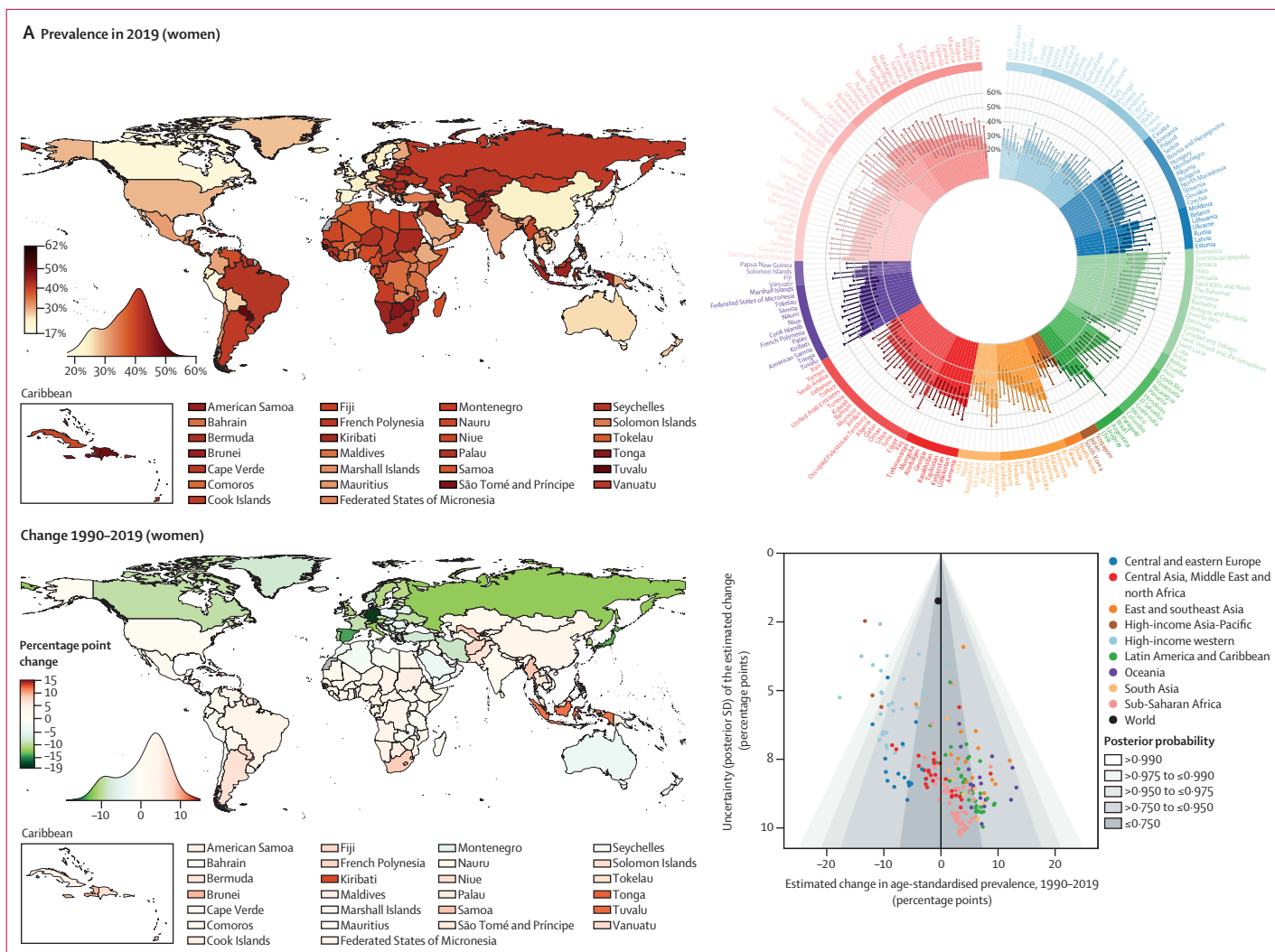


Figure 1: Number of data sources by country

community and primary care facilities, and several effective drugs are available at fairly low cost for treating patients with hypertension and reducing the risk of its sequelae.^{1,3-5} Improving the effective coverage of treatment for patients with hypertension is an objective

of many global, regional, and national initiatives, and programmes.

Comparable data on hypertension detection, treatment, and control are needed to learn from good practice to guide health system programmes. No



(Figure 2 continues on next page)

comparable global data exist to assess which countries have high versus low rates of detection, treatment, and control, and how these measures have changed over time. We present consistent national, regional, and global estimates of trends in hypertension prevalence, detection, treatment and control from 1990 to 2019 for 200 countries and territories (referred to as countries hereafter).

Methods

Data sources

We used data from 1990 to 2019, collated by the NCD Risk Factor Collaboration (NCD-RisC), as detailed previously⁶ and summarised in the appendix (pp 2–3). The inclusion criteria were that (1) data were collected using a probabilistic sampling method with a defined sampling frame; (2) data were from population samples at the national, sub-national (covering one or more sub-national regions), or community (one or a small number

of communities) level; (3) systolic blood pressure and diastolic blood pressure were measured; and (4) data on hypertension treatment were available.

Studies were excluded if they (1) included or excluded participants on the basis of health status; (2) were done only among minority ethnic groups or specific educational, occupational, or other socioeconomic groups; (3) recruited participants through health facilities, except studies whose sampling frame was health insurance schemes in countries where at least 80% of the population were insured, and studies based on primary care systems in high-income and central European countries with universal insurance; or (4) had not measured blood pressure. A list of data sources and their characteristics is provided in the appendix (pp 7–30).

We established whether a participant had been diagnosed with hypertension using questions worded as variations of “Have you ever been told by a doctor or other health professional that you had hypertension, also called high

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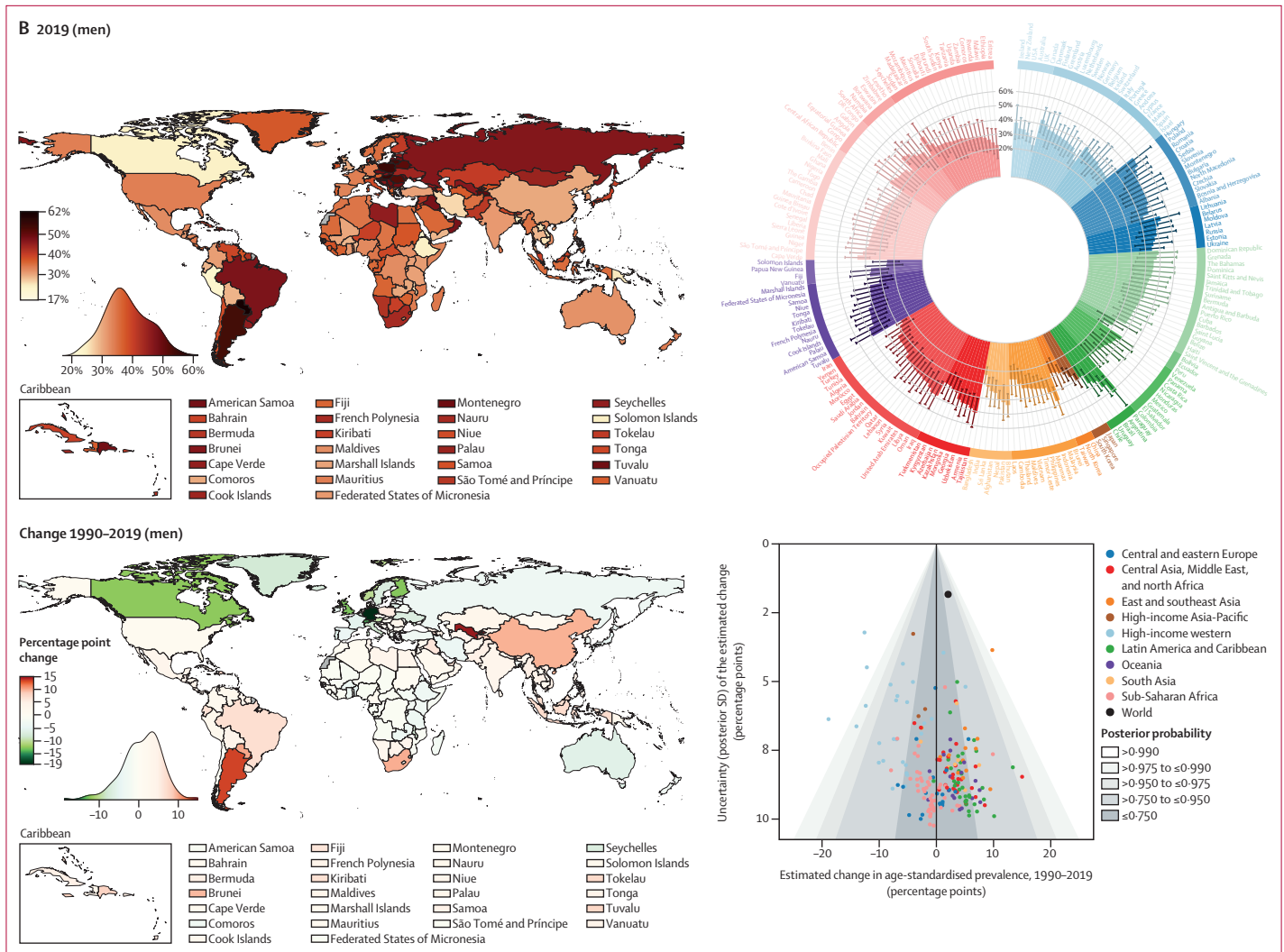


Figure 2: Prevalence of hypertension in 2019 and change from 1990 to 2019 in women and men
 Prevalence of hypertension in 2019 and change from 1990 to 2019 in women (A) and men (B). The density plot alongside each map shows the distribution of estimates across countries. The top right graph in each panel shows results ordered within regions and super-regions with 95% credible intervals. The bottom right graph in each panel shows the change from 1990 to 2019 in hypertension prevalence in relation to the uncertainty of the change measured by posterior SD. Shaded areas show the posterior probability of an estimated increase or decrease being a true increase or decrease. Each point shows one country. See the appendix (pp 33–46) for numerical results.

blood pressure?” We assessed whether a person was taking medication for hypertension using questions worded as variations of “Are you currently taking any medicines, tablets, or pills for high blood pressure?” or “In the past 2 weeks, have you taken any drugs (medication) for raised blood pressure prescribed by a doctor or other health worker?” In studies that gathered information on prescribed medicines, we used survey information to establish that the purpose of taking a blood pressure-lowering drug was specifically to treat hypertension.

Outcomes

Our primary outcomes were prevalence of hypertension, the proportion of people with hypertension who reported a previous hypertension diagnosis (detection), who were

taking medication for hypertension (treatment), and whose blood pressure was controlled (control).⁷ Hypertension was defined as having systolic blood pressure 140 mm Hg or greater, diastolic blood pressure 90 mm Hg or greater, or taking medication for hypertension. Control was defined as taking medication for hypertension and having systolic blood pressure less than 140 mm Hg and diastolic blood pressure less than 90 mm Hg. We also report the proportion of people with hypertension who were undiagnosed or untreated with systolic blood pressure 160 mm Hg or greater or diastolic blood pressure 100 mm Hg or greater. We restricted our analysis to men and women aged 30–79 years because hypertension prevalence is relatively low before age 30 years and because guidelines differ in thresholds and treatment targets in older ages.⁸

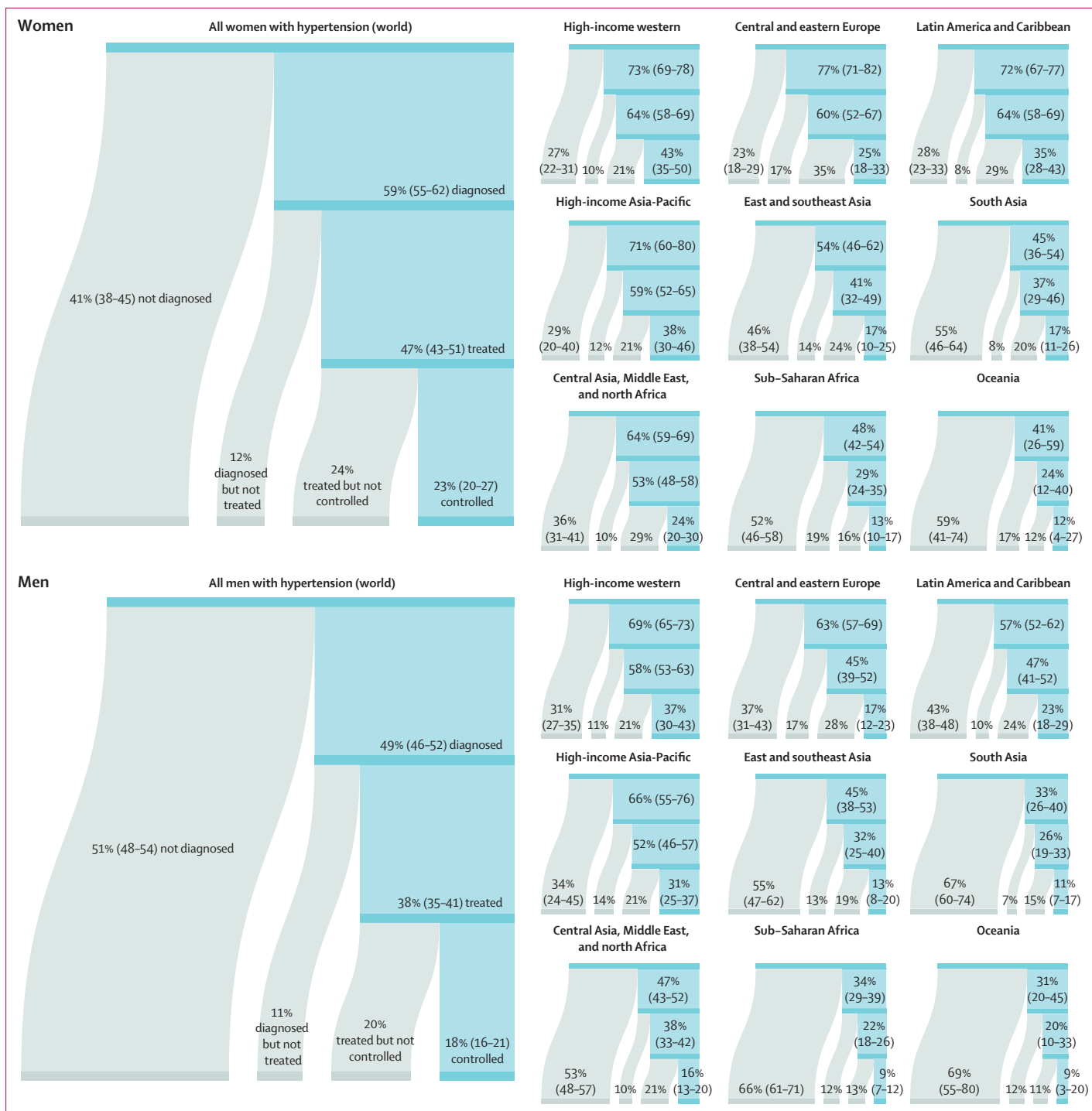


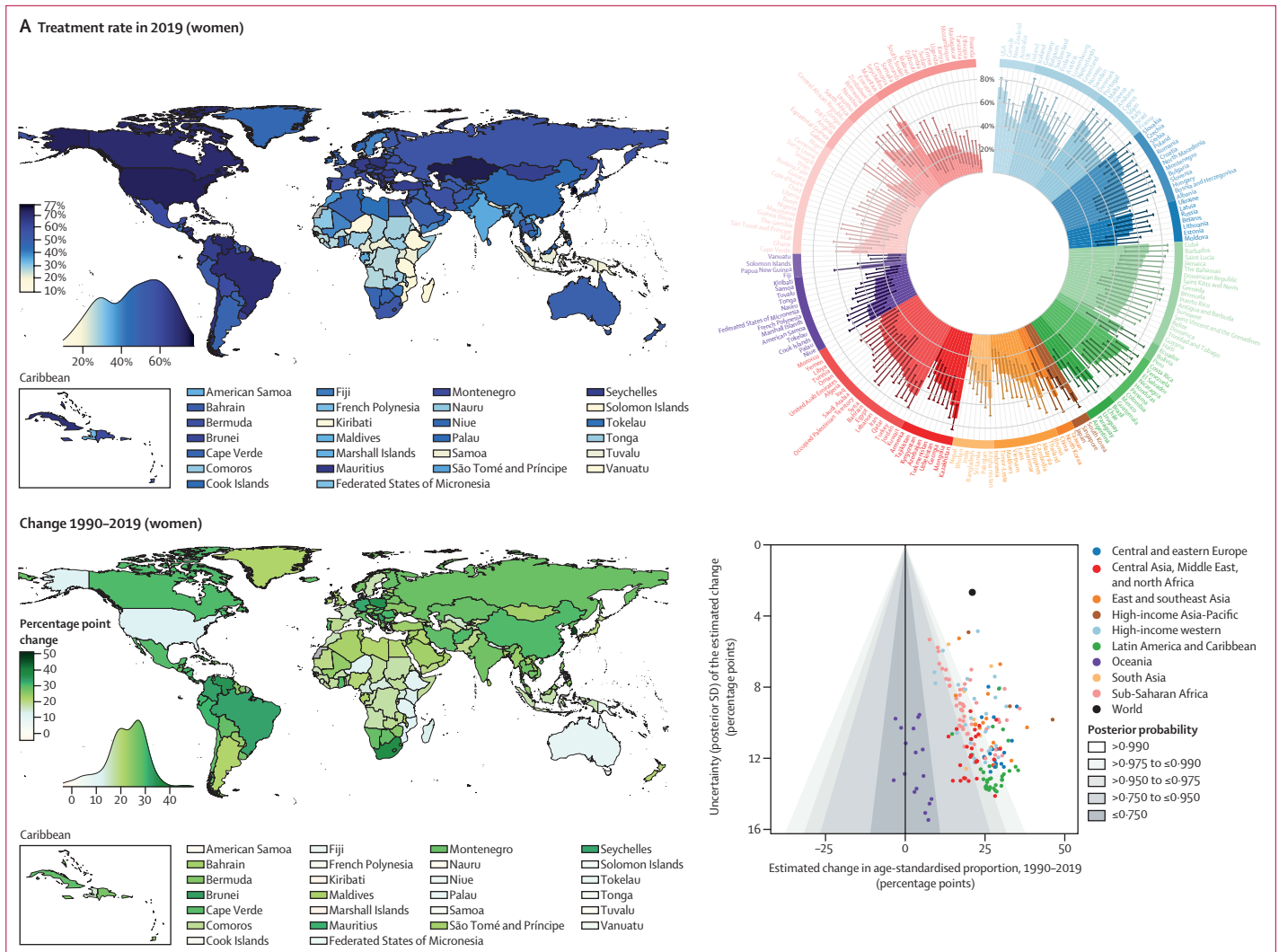
Figure 3: Hypertension treatment cascade in 2019, for women and men globally and by region
 Data are estimate (95% credible interval). Each stream shows the loss of people with hypertension throughout the treatment cascade and its associated percentage for women and men.

Statistical analysis

We calculated the prevalence, detection, treatment, and control of hypertension by sex and age group for each study. The denominators for detection, treatment, and control were the number of people with hypertension.

When applicable, we used survey sample weights and accounted for complex survey design.

We applied a Bayesian hierarchical model to these sex-specific and age-specific data to estimate the primary outcomes by country, year, and age. All analyses



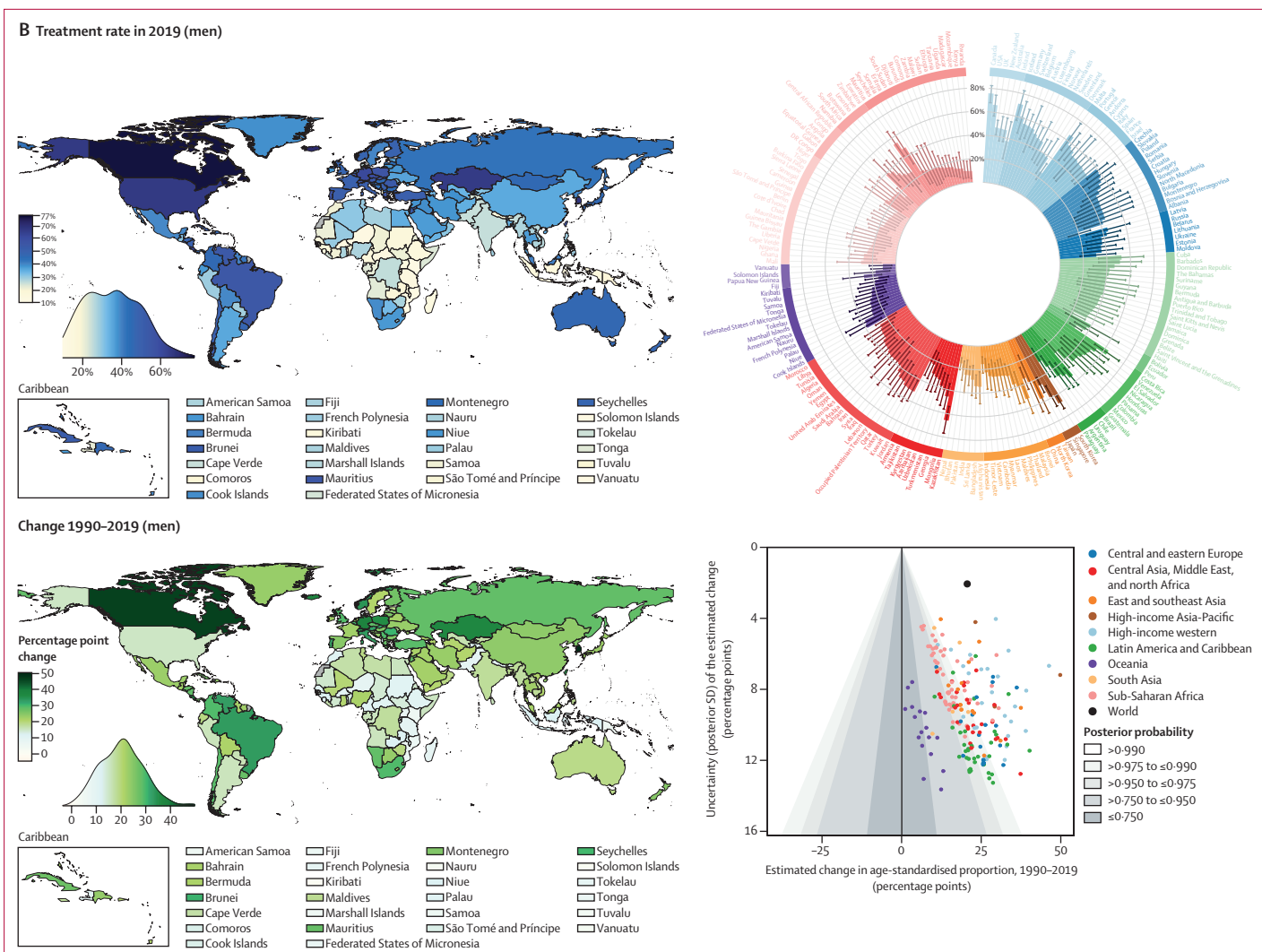
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were done separately by sex and for each primary outcome. The model is described in detail in a statistical paper⁹ and related substantive papers^{6,10} and summarised in the appendix (pp 4–6). Countries were grouped into 21 regions, which were further grouped into nine super-regions (appendix pp 31–32). In the hierarchical model, estimates for a country-year were informed by its own data if available, by data from other years in the same country, and from other countries, especially those from the same region and super-region. The extent to which estimates for each country-year were influenced by data from other years and countries depended on whether the country had data, sample size, whether data were national, and the within-country and within-region variability of the available data.

The model allowed for non-linear time trends and non-linear age patterns. For this analysis, we adapted the model

to allow time trends to vary by age (appendix pp 4–6) because how hypertension and its detection, treatment, and control have changed over time depends on age.^{11,12} The model also accounted for the possibility that hypertension prevalence, detection, treatment, and control in sub-national and community studies might systematically differ from those in nationally representative studies, or might have larger variation than in national studies, so that national data had a larger influence on the estimates than sub-national or community data did with similar sample sizes. Finally, the model accounted and adjusted for how much studies that were done in only rural or urban areas differed from national studies.

We fitted the model using the Markov chain Monte Carlo (MCMC) algorithm implemented in R (version 3.6.0), and obtained 50 000 post-burn-in samples from the posterior distribution of model parameters. We kept every 10th sample, and the resultant 5000 samples



(Figure 4 continues on next page)

were used to obtain the posterior distributions of the primary outcomes. The reported 95% credible intervals (CrIs) are the 2·5th to 97·5th percentiles of the posterior distributions. We calculated age-standardised hypertension prevalence, and the rates of detection, treatment, and control, by weighting age-specific estimates using the WHO standard population.¹³ When calculating age-standardised detection, treatment, and control rates, we also accounted for the age pattern of hypertension prevalence, which appears in the denominator, by using the combination of WHO standard population weights and age-specific hypertension prevalence in each country and year to weight age-specific estimates. Estimates for regions, super-regions, and the world were calculated by weighting the age-specific and sex-specific posterior samples for the constituent countries with the corresponding age-specific and sex-specific national populations; the population data were from World

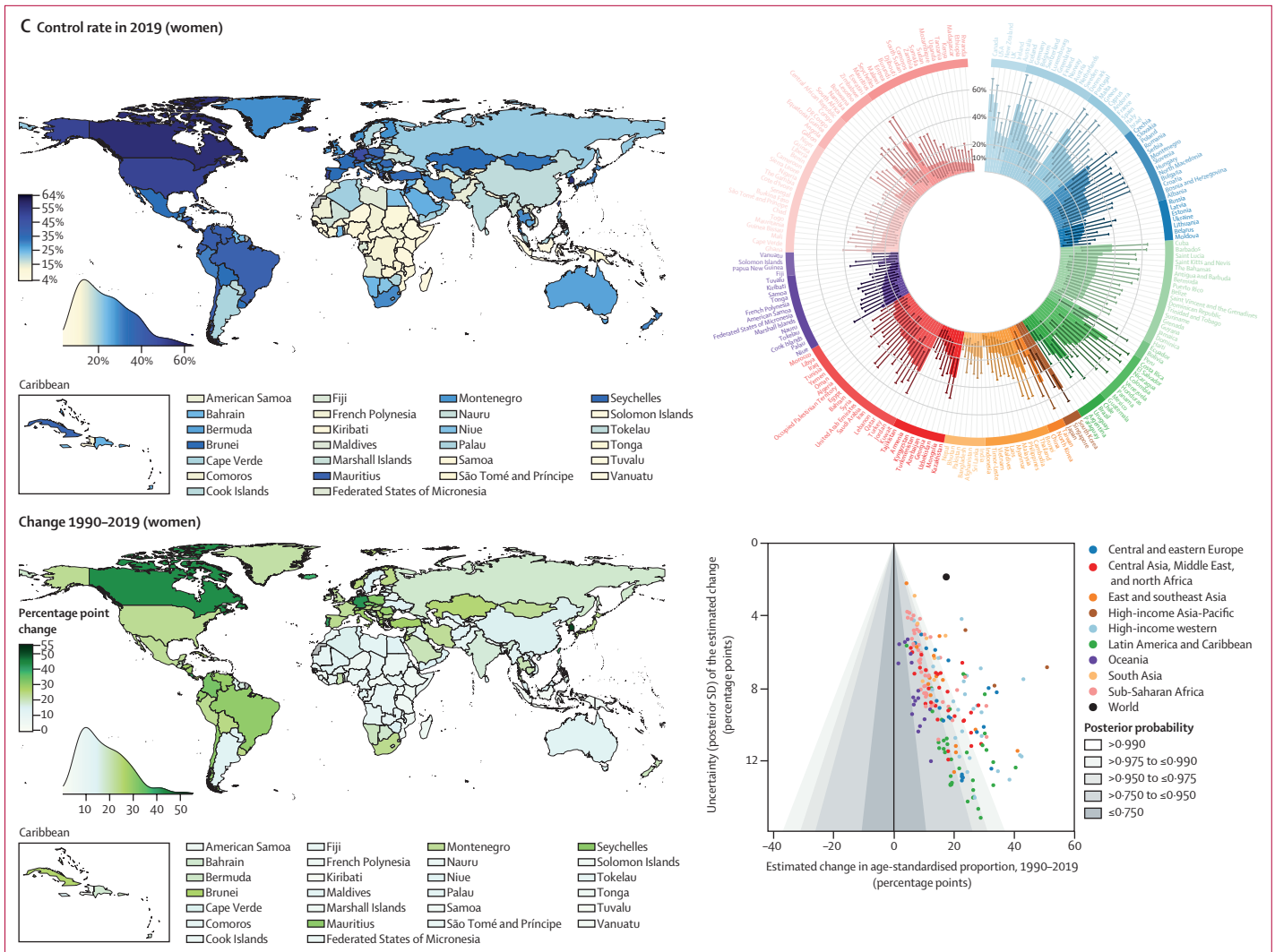
Population Prospects (2019 revision).¹⁴ The estimates in each country and region and in each year are for the corresponding national and regional population in that year. We used consistent analysis and presentation units over the entire 30-year period. For countries that were formed during these 30 years (eg, South Sudan and Montenegro), estimates apply to an equivalent territory for the years before their formation.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

We used 1201 studies carried out from 1990 to 2019 with data on 104 million participants aged 30–79 years. Of these, 986 (82·1%) studies also had information on



(Figure 4 continues on next page)

previous diagnosis. 184 countries, covering 99% of the global population, had at least one data source (figure 1), and 131 countries, covering 94% of the world's population, had two or more data sources. Regionally, data availability ranged from 2.2 data sources per country in sub-Saharan Africa to 26.0 data sources per country in the high-income Asia-Pacific region (figure 1).

In 2019, the global age-standardised prevalence of hypertension in adults aged 30–79 years was 32% (95% CrI 30–34) in women and 34% (32–37) in men, similar to 1990 levels of 32% (30–35) in women and 32% (30–35) in men (figure 2). The stable global prevalence was a net effect of a decrease in high-income countries, and for women also in central and eastern Europe, and an increase in some low-income and middle-income countries. The decline was greater than 12 percentage points in women in several high-income countries (posterior probability [PP] of the observed

decline being a true decline >0.98 for all country and sex combinations; figure 2). By contrast, age-standardised prevalence increased, or at best remained unchanged, in most low-income and middle-income countries (figure 2). The increase was 10–15 percentage points among men in three countries and among women in four countries (PP 0.85–0.99).

Nationally, prevalence of hypertension in 2019 was lowest in Canada and Peru for both men and women; in Taiwan, South Korea, Japan, and some countries in western Europe for women; and in some low-income and middle-income countries for men (figure 2). Age-standardised prevalence in all of these countries was less than 24% for women and less than 25% for men in 2019 (figure 2). Hypertension prevalence was highest throughout central and eastern Europe, central Asia, Oceania, southern Africa, and some countries in Latin America and the Caribbean (figure 2). For women

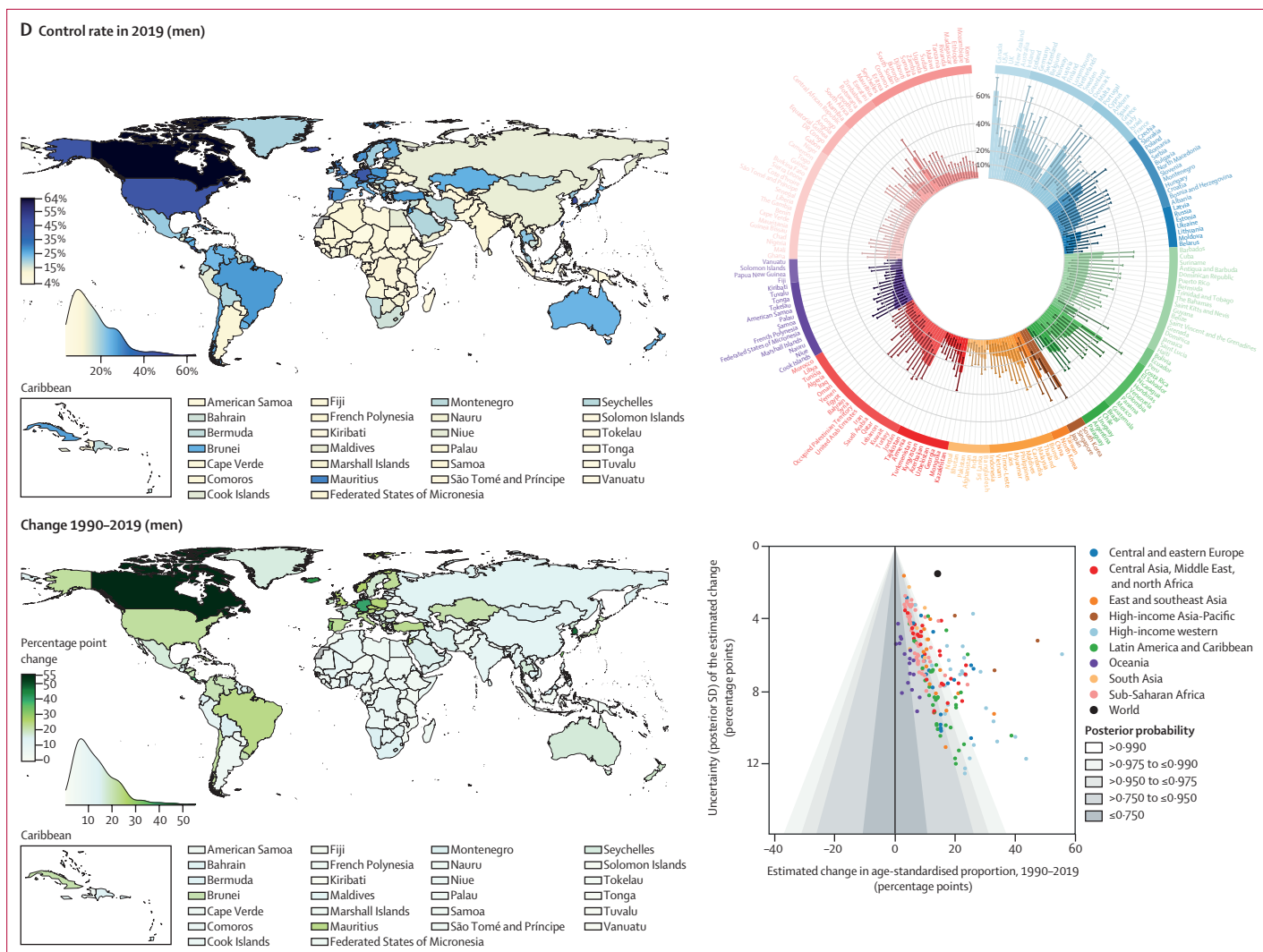


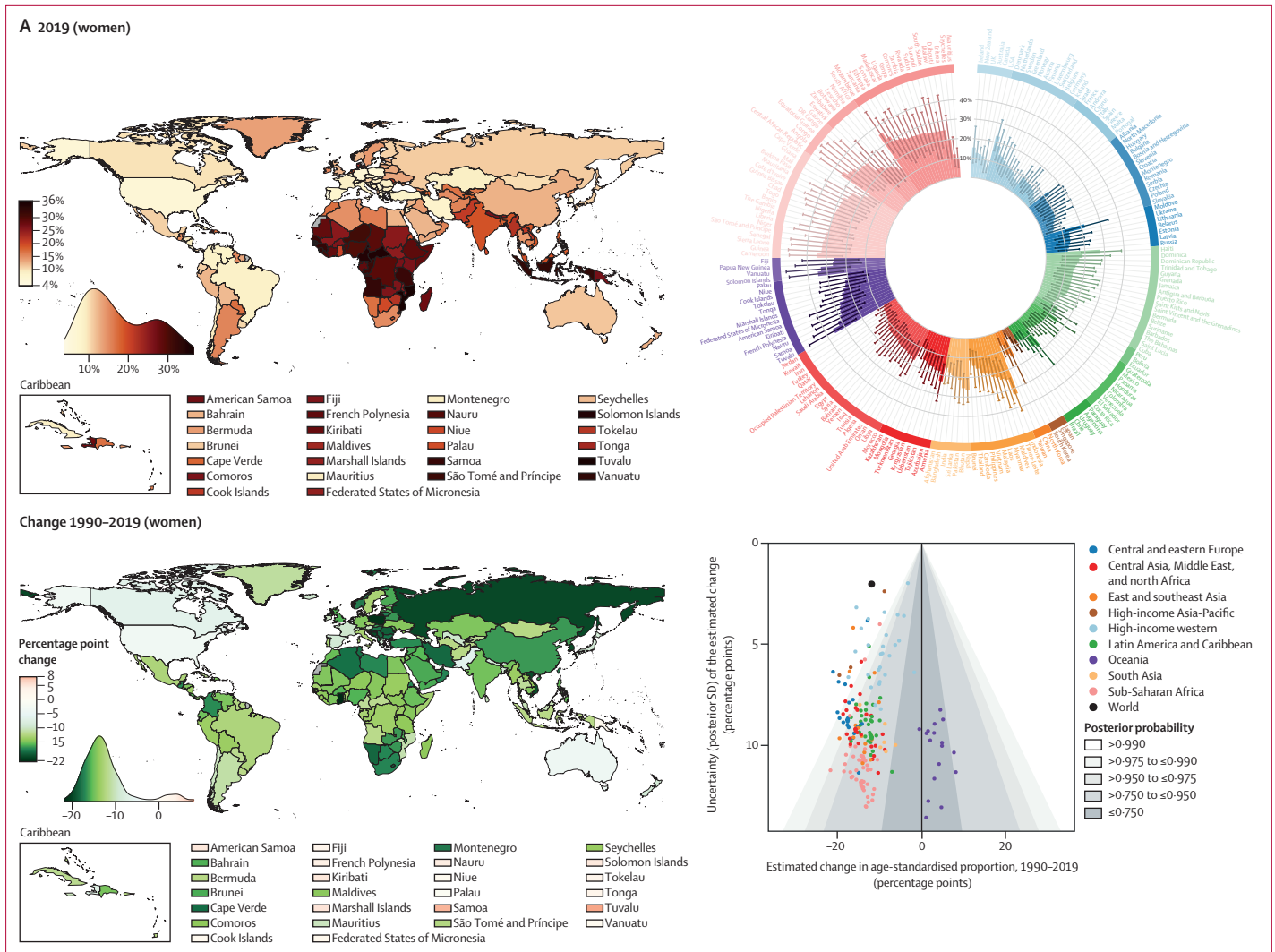
Figure 4: Proportion of women and men with hypertension who used treatment and whose blood pressure was controlled in 2019, and change from 1990 to 2019
 See the appendix (pp 52–53) for control rates among those on treatment and for a comparison of treatment and control rates (pp 54–55). The density plot alongside each map shows the distribution of estimates across countries. The top right graph in each panel shows the results ordered within regions and super-regions with their 95% credible intervals. The bottom right graph in each panel shows the change from 1990 to 2019 in hypertension treatment and control rates in relation to the uncertainty of the change measured by posterior SD. Shaded areas show the posterior probability of an estimated increase or decrease being a true increase or decrease. Each point shows one country. See the appendix (pp 33–46) for numerical results.

in two countries and men in nine countries, age-standardised prevalence surpassed 50% (figure 2).

Globally, 41% (95% CrI 38–45) of women and 51% (48–54) of men with hypertension did not report a previous diagnosis (figure 3). The treatment rate was 47% (43–51) in women and 38% (35–41) in men. Less than half of those treated had achieved hypertension control, leading to global control rates of 23% (20–27) for women and 18% (16–21) for men with hypertension (figure 3). 27–34% of women and men in the high-income western and Asia-Pacific regions with hypertension were not aware of their condition, an additional 10–14% were untreated, and 21% did not achieve control (figure 3). The detection gap, together with sequential low treatment coverage and effectiveness, led to control

rates ranging from 31% in men in the high-income Asia-Pacific to 43% in women in the high-income western region (figure 3). Control rates were below 13% in sub-Saharan Africa and Oceania, where 50–60% of women and nearly 70% of men with hypertension were not aware of their condition; detection, treatment and control rates in south Asia were only slightly higher (figure 3). In all regions the coverage of treatment increased with age, being highest in those aged 65 years and older (appendix pp 50–51).

Nationally, hypertension treatment and control were highest in South Korea, Canada, and Iceland, where more than 70% of women and men with hypertension were treated and over half had their hypertension controlled (figure 4). Treatment and control rates were also high in



(Figure 5 continues on next page)

the USA, Costa Rica, Germany, Portugal, and Taiwan. At the other extreme, treatment rates were less than 25% for women and less than 20% for men in Nepal, Indonesia, and several countries in sub-Saharan Africa and Oceania (figure 4). Control rates were less than 10% for women and men in these countries and for men in some countries in the Middle East and north Africa, central and south Asia, and eastern Europe (figure 4). The proportion of those treated who achieved control varied by more than four times across countries (appendix pp 54-55). In particular, many countries in eastern Europe, central and east Asia, and the Middle East and north Africa had somewhat high treatment rates but low control, contrasting with findings in high-income countries and some countries in Latin America and the Caribbean, where treatment and control tracked more closely (appendix pp 54-55).

Hypertension treatment and control improved in most countries since 1990, but we found little improvement in

many countries in sub-Saharan Africa and Oceania (figure 4). Improvements were largest in high-income countries and central Europe, with some countries expanding treatment and control by more than 30 percentage points (figure 4). Some upper-middle-income countries and recently high-income countries in other regions (eg, Costa Rica, Taiwan, Kazakhstan, South Africa, Brazil, Chile, Turkey, and Iran) also substantially enhanced treatment and control (figure 4). Hypertension treatment and control rates were lower in men than in women in most countries (appendix pp 56-57). The male disadvantage in treatment was smaller in high-income countries than elsewhere and, in a few countries, we found the reverse of this pattern (appendix pp 56-57).

In 2019, the proportion of people with systolic blood pressure 160 mm Hg or greater or diastolic blood pressure 100 mm Hg or greater but were not diagnosed or treated was below 10% in countries with high treatment coverage,

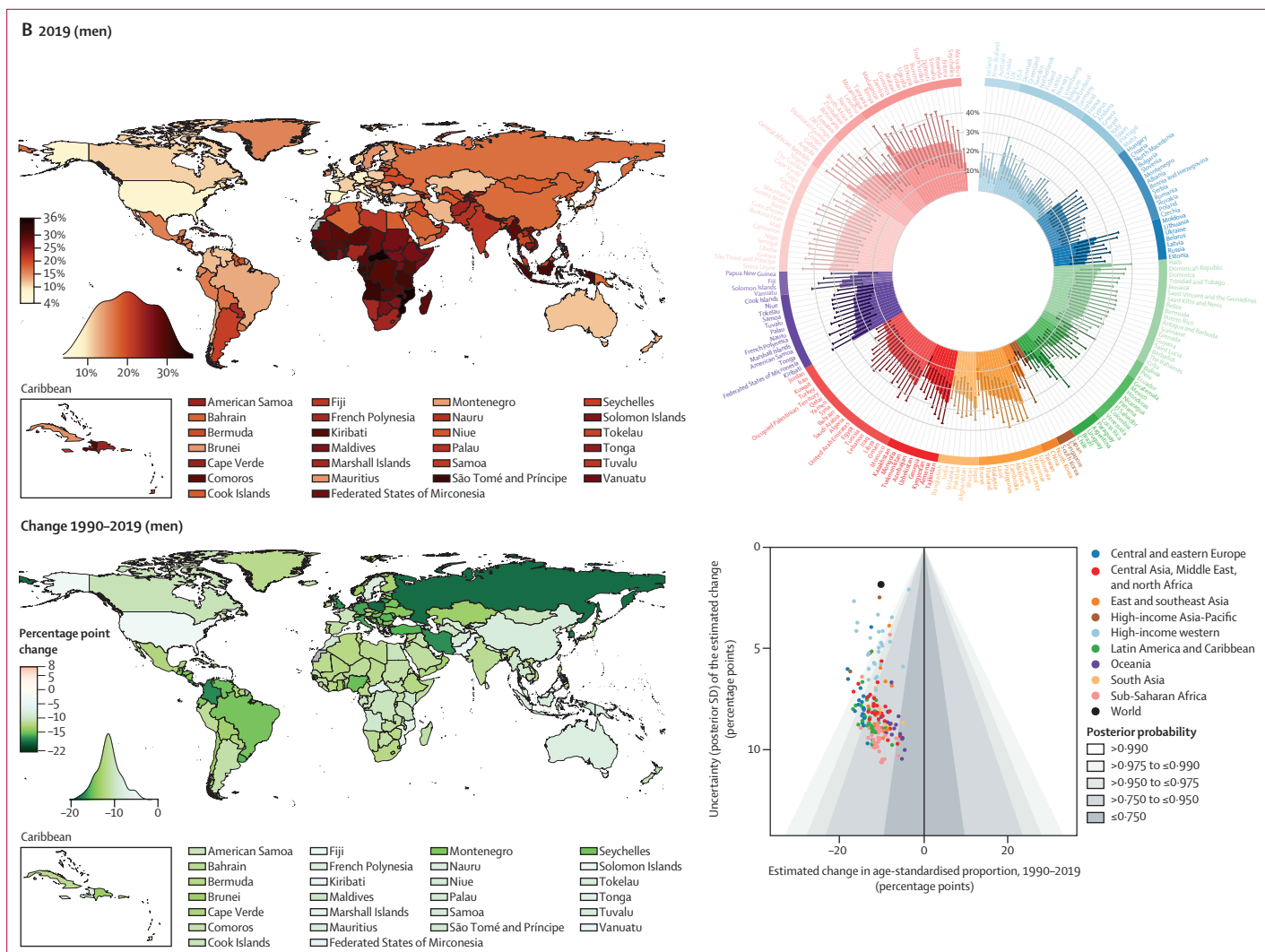


Figure 5: Proportion of women and men with hypertension who had systolic blood pressure 160 mm Hg or greater or diastolic blood pressure 100 mm Hg or greater but were not diagnosed or treated, in 2019, and change from 1990 to 2019

The density plot alongside each map shows the distribution of estimates across countries. The top right graph in each panel shows the results ordered within regions and super-regions with their 95% credible intervals. The bottom right graph in each panel shows the change from 1990 to 2019 in the proportion of people with hypertension who had systolic blood pressure 160 mm Hg or greater or diastolic blood pressure 100 mm Hg or greater but were not diagnosed or treated, in relation to the uncertainty of the change measured by posterior SD. Shaded areas show the posterior probability of an estimated increase or decrease being a true increase or decrease. Each point shows one country.

and as low as 4% among women in South Korea (figure 5). Between one in four to one in three women and men with hypertension in many sub-Saharan African and Oceanian countries and in some countries in central, south, and southeast Asia had systolic blood pressure 160 mm Hg or greater or diastolic blood pressure 100 mm Hg or greater but were not diagnosed or treated (figure 5).

Despite stable global prevalence, the absolute number of people aged 30–79 years with hypertension doubled from 331 (95% CrI 306–359) million women and 317 (292–344) million men in 1990 to 626 (584–668) million women and 652 (604–698) million men in 2019 due to population growth and ageing (figure 6). Similarly, despite improvement in detection, treatment, and control

rates, more people did not achieve effective control in 2019 than in 1990 because of the large increase in the number of people with hypertension (figure 6).

In high-income western and Asia-Pacific regions and in central and eastern Europe, the opposite effects of declining prevalence and population growth and ageing led to a small net increase in the number of people with hypertension (figure 6). The improvements in treatment and control from 1990 to 2019 shifted many of those with hypertension in these regions from being untreated to being treated and having their hypertension controlled (figure 6). These improvements lowered the absolute number of those who were not treated or whose hypertension was not effectively controlled (figure 6).

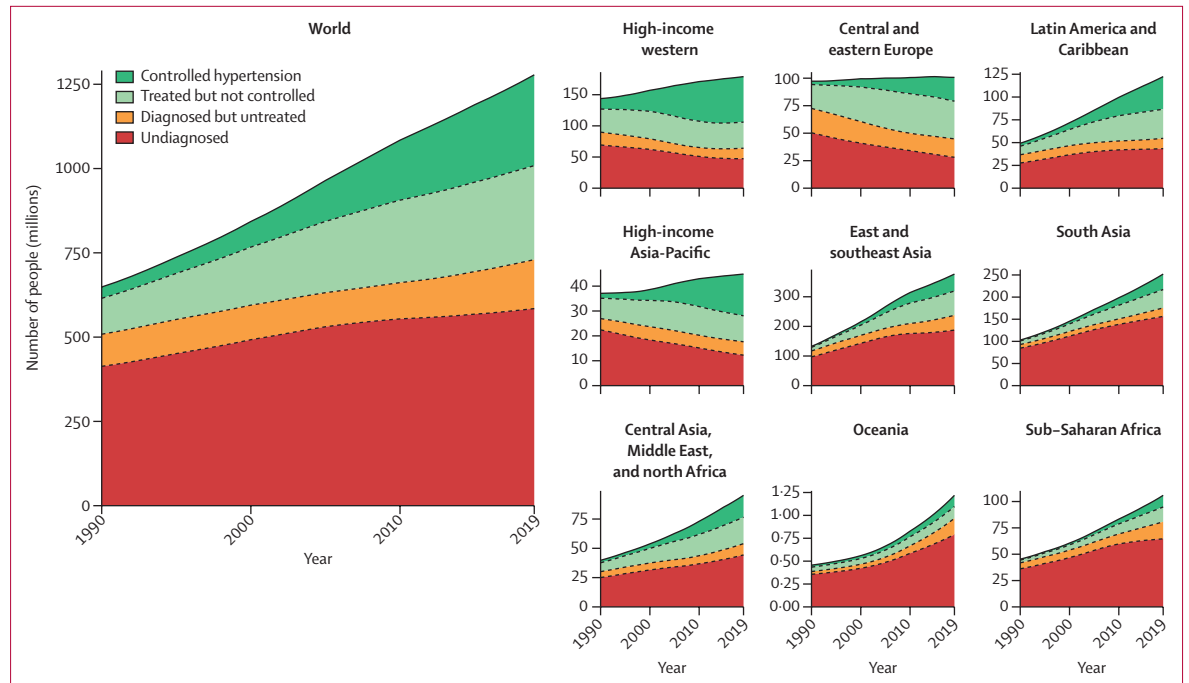


Figure 6: Trends in the number of people with hypertension who reported a diagnosis, who used treatment, and whose blood pressure was effectively controlled, globally and by region, 1990–2019

See the appendix (pp 58–60) for trends in the percentage of people with hypertension who reported a diagnosis, who had treatment, and whose blood pressure was effectively controlled, globally and by region.

In 2019, over 1 billion people with hypertension (82% of all people with hypertension in the world) lived in low-income and middle-income regions (figure 6). This number was much larger than the number in 1990 because prevalence remained unchanged or increased and the population grew and became older. In sub-Saharan Africa, Oceania, and south Asia, most of the increase was in those without a previous diagnosis, whereas in east and southeast Asia and Latin America and the Caribbean the number of people in this category increased slightly until the mid-2000s before flattening. Since then, many more of those with hypertension have been detected, treated, and controlled (figure 6).

Discussion

Our novel comprehensive analysis of hypertension prevalence and care has shown that since 1990 the number of people with hypertension worldwide has doubled, with most of the increase occurring in low-income and middle-income regions. In high-income countries, prevalence has declined while health systems have achieved treatment rates of up to 80% and control rates of up to 60%. Middle-income countries in Latin America; east and southeast Asia; and central Asia, the Middle East, and north Africa have also enhanced the detection and treatment of hypertension. Some of these countries, such as Costa Rica, now outperform most high-income nations in hypertension treatment and control. Low detection and treatment rates persist in the

world's poorest nations, especially in sub-Saharan Africa, Oceania, and south Asia. Together with the increasing number of people who have hypertension, these low detection and treatment rates will shift an increasing share of the burden of vascular and renal conditions to these regions.

To our knowledge, no previous study of trends in hypertension prevalence, detection, treatment, and control covers all countries in the world. Our results are consistent with a multi-country study that reported for 2000 and 2010,¹⁵ in terms of higher treatment and control in high-income countries than in low-income and middle-income countries, but our national results show that substantial variability exists at any level of economic development, with some upper-middle-income countries having treatment and control rates as good as, or better than, those in some high-income countries. The findings of a study¹⁶ on 44 low-income and middle-income countries were consistent with ours in terms of hypertension treatment rates being highest in Latin America and lowest in sub-Saharan Africa; although, this study did not have data on trends or from high-income countries. Our finding on variable improvement in rates of hypertension treatment in high-income countries is consistent with a previous multi-country study.¹²

The strengths of our study include its scope of presenting consistent and comparable global estimates of hypertension prevalence, treatment, and control; the

scale and quality of data that were harmonised in a rigorous process; and the statistical methods that were designed for analysing trends in the hypertension treatment cascade. We used data from more than 1200 studies in 184 countries, covering 99% of the world's population, which is eight times as many studies as were in the previous largest analysis.¹⁵ We used only data from studies that had measured blood pressure to avoid bias in self-reported data. We re-analysed data according to a standardised protocol and the characteristics and quality of data were rigorously verified through repeated checks by NCD-RisC members. We used a statistical model that accounted for heterogeneous trends by age in hypertension prevalence, detection, treatment, and control, and we used all available data, while giving more weight to national data than to non-national sources.

Similar to all global analyses, our study has some limitations. Despite our extensive efforts to identify and access data, some countries, especially those in Oceania and sub-Saharan Africa, had less data than in other regions. Most health surveys collect data on previous diagnosis and treatment of hypertension using a questionnaire, which may lead to measurement error. Validation studies show that recall of hypertension diagnosis and medication has good agreement with actual medical history (eg, with Cohen's κ ranging between 0.55 and 0.91).^{17–20} Mercury sphygmomanometers were more common in earlier studies, whereas studies done after 2000 often used digital oscillometric devices. Similarly, studies differed on whether they used multiple cuff sizes or one cuff size or whether they measured blood pressure more than once. The effect of measurement device and protocol on population prevalence depends on the circumstances of each study. For example, an automated digital device with a standard cuff, although not the traditional gold standard in a clinical setting, avoids observer bias and increases compliance and possibly even response rate, compared with a mercury sphygmomanometer with multiple cuffs.²¹ Nonetheless, measurements from different devices are not fully comparable. Most health surveys are based on one visit to each participant, during which blood pressure is measured multiple times, usually after a resting period when interviews are done. Hypertension prevalence based on data collected in multiple visits might be lower than that based on one visit.²² We had insufficient comparable data on treatment details such as the type of drugs because these data are not consistently collected in population-representative surveys. Complementing survey data with data from health facilities or prescriptions could provide such clinically relevant details.

Our country results show that preventing hypertension and enhancing its detection, treatment, and control is feasible not only in high-income countries, but also in low-income and middle-income nations. Although the

nutritional, behavioural, and environmental causes of increased blood pressure are well established, little is known on which actions and interventions that can be widely replicated are responsible for the observed reductions in hypertension prevalence.²³ Similarly, although randomised trials have shown the efficacy of hypertension treatment and studies in some countries or communities have shown that strategies such as simple evidence-based guidelines, the use of non-physician health workers, and patient follow-ups using text messages can improve hypertension care,^{1,2,24–30} little transferable guidance exists on how to achieve high rates of detection, treatment, and control for entire populations. Implementation research on the role of risk factors and health system determinants of hypertension care and management requires detailed country-level data. Information for seven countries with high rates of treatment is summarised in the appendix (pp 47–49).

Over the period of our analysis, hypertension prevalence decreased while obesity, which is a risk factor for hypertension, increased,⁶ which implies that hypertension's dietary and environmental determinants must have improved. Reducing salt intake to prevent hypertension might be possible through a combination of fiscal, regulatory, and possibly behavioural interventions,^{31,32} although few examples exist of successful national programmes so far. Increased availability and consumption of fruits and vegetables³³ might partly account for the observed declines in hypertension, which indicates that making these foods affordable (eg, through targeted subsidies for poorer families) and accessible (eg, through more efficient supply and storage) might be effective for hypertension prevention.

Expanding hypertension detection has been helped by both more widespread and regular contact with health services and more frequent measurement of blood pressure.^{34,35} Increased health-care use requires universal health insurance^{36–39} and expansion of primary care. In some countries, training non-physician health workers in the management of non-communicable diseases (NCDs) might be needed.^{24–28} Guidelines, availability of blood pressure monitors, and regular health checks and screening programmes^{40–44} facilitate more frequent measurement. The expansion of universal health coverage and primary care in places with low rates of diagnosis, especially sub-Saharan Africa and south Asia, provides an opportunity for improving hypertension care,^{45,46} but needs to be accompanied with guidelines,⁴⁷ training, and blood pressure monitors in health facilities. Improvements in treatment have been helped by some of the same factors as those for diagnosis, as well as guidelines that recommend progressively lower thresholds to initiate treatment and wider availability and lower cost of antihypertensive medicines, many of which are no longer under a patent.⁴⁸ Despite this improvement, insufficient access to medicines contributes to the low treatment rates in some low-income countries.^{46,49–51}

We also found large variation in hypertension control among those who were treated. Understanding the reasons for the large variation in real-world effectiveness of treatment needs data on both the health-system features that enable high-quality care and the type of pharmacological approach used—eg, renin-angiotensin-system inhibitors, calcium-channel blockers, or diuretics;⁵² whether single-pill combination therapy is used;⁵³ how much the prescribing physician titrates or intensifies treatment when needed; and patient adherence to treatment. New technologies such as telemonitoring, home blood pressure monitoring, and text message reminders might improve adherence,^{29,54–56} but these measures can be effective only if patients have uninterrupted access to effective medicines.

Hypertension prevention and control can make a substantial contribution to achieving the Sustainable Development Goals target 3.4 on NCDs.^{57,58} Some countries, such as Canada, Costa Rica, South Korea, and Taiwan, have achieved low hypertension prevalence or high control through both improved prevention and improving every stage of the treatment cascade.^{30,59} Universal health insurance has been instrumental in achieving high effective coverage but should be complemented with primary care strengthening, evidence-based hypertension guidelines that are up to date and are adapted to the country contexts,^{8,47} health workforce training, and a robust system of drug procurement and distribution.³⁰ Programmes should also be regularly assessed, both at the population level, as our work has done, and in health facilities to ensure accountability and stimulate improvement.⁶⁰

Contributors

BZ, GD, LMR, GAS, EWG, and ME designed the study. Members of the Country and Regional Data Group collected and re-analysed data and checked pooled data for accuracy of information about their study and other studies in their country. BZ and RMCL led the data collection with help from BS, RKS, MKS, MLCI, VPFL, MJC, and SS. BZ led the statistical analysis with input from GD, CJP, JEB, and ME and prepared results. Members of the Pooled Analysis and Writing Group contributed to study design, collated data, and checked all data sources in consultation with the Country and Regional Data Group. Country and Regional Data Group members, BZ, RMCL, BS, RKS, and VPFL had access to the data used in the study. BZ and ME wrote the first draft of the report with input from other members of the Pooled Analysis and Writing Group. Members of the Country and Regional Data Group commented on the draft report. ME oversaw research. The authors alone are responsible for the views expressed in this Article and they do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated. The corresponding author had the final responsibility for the decision to submit for publication.

NCD Risk Factor Collaboration (NCD-RisC)

Pooled analysis and writing—Bin Zhou (PhD; Imperial College London, UK); Rodrigo M Carrillo-Larco (MD; Imperial College London, UK); Goodarz Danaei (ScD; Harvard T H Chan School of Public Health, USA); Leanne M Riley (MSc; WHO, Switzerland); Prof Christopher J Paciorek (PhD; University of California, Berkeley, USA); Gretchen A Stevens (ScD; USA; Imperial College London, UK); Prof Edward W Gregg (PhD; Imperial College London, UK); James E Bennett (PhD; Imperial College London, UK); Bethlehem Solomon (MPH; Imperial College London, UK);

Rosie K Singleton (MSc; Imperial College London, UK); Marisa K Sophiea (MSc; Imperial College London, UK); Maria LC Iurilli (MRes; Imperial College London, UK); Victor PF Lhoste (MSc; Imperial College London, UK); Melanie J Cowan (MPH; WHO, Switzerland); Stefan Savin (MPH; WHO, Switzerland); Prof Mark Woodward (PhD; University of New South Wales, Australia; Imperial College London, UK); Yulia Balanova (PhD; National Medical Research Centre for Therapy and Preventive Medicine, Russia); Prof Renata Cifkova (MD; Charles University, Czech Republic; Thomayer Hospital, Czech Republic); Prof Albertino Damasceno (PhD; Eduardo Mondlane University, Mozambique); Prof Paul Elliott (FMedSci; Imperial College London, UK); Prof Farshad Farzadfar (MD; Non-Communicable Diseases Research Center, Iran); Prof Jiang He (MD; Tulane University, USA); Nayu Ikeda (PhD; National Institutes of Biomedical Innovation, Health and Nutrition, Japan); Prof Andre P Kengne (PhD; South African Medical Research Council, South Africa); Prof Young-Ho Khang (MD; Seoul National University College of Medicine, South Korea); Prof Hyeon Chang Kim (MD; Yonsei University College of Medicine, South Korea); Prof Avula Laxmaiah (PhD; ICMR - National Institute of Nutrition, India); Prof Hsien-Ho Lin (MD; National Taiwan University, Taiwan); Paula Margozzini Maira (MD; Pontificia Universidad Católica de Chile, Chile); Prof J Jaime Miranda (PhD; Universidad Peruana Cayetano Heredia, Peru); Hannelore Neuhauser (PhD; Robert Koch Institute, Germany); Prof Johan Sundström (PhD; Uppsala University, Sweden); Cherian Varghese (MD; WHO, Switzerland); Indah S Widyahening (PhD; Universitas Indonesia, Indonesia); Prof Tomasz Zdrojewski (MD; Medical University of Gdansk, Poland); Prof Majid Ezzati (FMedSci; Imperial College London, UK; University of Ghana, Ghana). *Country and regional data* (*equal contribution; listed alphabetically)—Leandra Abarca-Gómez (Caja Costarricense de Seguro Social, Costa Rica)*; Ziad A Abdeen (Al-Quds University, Palestine)*; Hanan F Abdul Rahim (Qatar University, Qatar)*; Niveen M Abu-Rmeileh (Birzeit University, Palestine)*; Benjamin Acosta-Cazares (Instituto Mexicano del Seguro Social, Mexico)*; Robert J Adams (Flinders University, Australia)*; Wichai Aekplakorn (Mahidol University, Thailand)*; Kaosar Afsana (BRAC University, Bangladesh)*; Shoaib Afzal (University of Copenhagen, Denmark; Copenhagen University Hospital, Denmark)*; Imelda A Agdeppa (Food and Nutrition Research Institute, Philippines)*; Javad Aghazadeh-Attari (Urmia University of Medical Sciences, Iran)*; Carlos A Aguilar-Salinas (Instituto Nacional de Ciencias Médicas y Nutrición, Mexico)*; Charles Agyemang (University of Amsterdam, Netherlands)*; Noor Ani Ahmad (Ministry of Health, Malaysia)*; Ali Ahmadi (Modeling in Health Research Center, Iran)*; Naser Ahmadi (Non-Communicable Diseases Research Center, Iran)*; Nastaran Ahmadi (Shahid Sadoughi University of Medical Sciences, Iran)*; Fariba Ahmadizar (Erasmus Medical Center Rotterdam, Netherlands)*; Soheir H Ahmed (University of Oslo, Norway)*; Wolfgang Ahrens (Leibniz Institute for Prevention Research and Epidemiology—BIPS, Germany)*; Kamel Ajlouni (National Center for Diabetes, Endocrinology and Genetics, Jordan)*; Rajaa Al-Raddadi (King Abdulaziz University, Saudi Arabia)*; Monira Alarouj (Dasman Diabetes Institute, Kuwait)*; Fadia AlBuhairan (Aldara Hospital and Medical Center, Saudi Arabia)*; Shahla AlDhukair (King Abdullah International Medical Research Center, Saudi Arabia)*; Mohamed M Ali (WHO, Switzerland)*; Abdullah Alkandari (Dasman Diabetes Institute, Kuwait)*; Ala'a Alkerwi (Luxembourg Institute of Health, Luxembourg)*; Kristine Allin (Bispebjerg and Frederiksberg Hospital, Denmark)*; Eman Aly (WHO Regional Office for the Eastern Mediterranean, Egypt)*; Deepak N Amarapurkar (Bombay Hospital and Medical Research Centre, India)*; Norbert Amougou (UMR CNRS-MNHN 7206, France)*; Philippe Amouyel (University of Lille, France; Lille University Hospital, France)*; Lars Bo Andersen (Western Norway University of Applied Sciences, Norway)*; Sigmund A Anderssen (Norwegian School of Sport Sciences, Norway)*; Ranjit Mohan Anjana (Madras Diabetes Research Foundation, India)*; Alireza Ansari-Moghaddam (Zahedan University of Medical Sciences, Iran)*; Daniel Ansong (Kwame Nkrumah University of Science and Technology, Ghana)*; Hajer Aounallah-Skhiri (National Institute of Public Health, Tunisia)*; Joana Araújo (Institute of Public Health of the

University of Porto, Portugal)*; Inger Ariansen (Norwegian Institute of Public Health, Norway)*; Tahir Aris (Ministry of Health, Malaysia)*; Raphael E Arku (University of Massachusetts Amherst, USA)*; Nimmathota Arlappa (ICMR - National Institute of Nutrition, India)*; Krishna K Aryal (Abt Associates, Nepal)*; Thor Aspelund (University of Iceland, Iceland)*; Felix K Assah (University of Yaoundé I, Cameroon)*; Maria Cecília F Assunção (Federal University of Pelotas, Brazil)*; Juha Auvinen (University of Oulu, Finland; Oulu University Hospital, Finland)*; Mária Avdičová (Banska Bystrica Regional Authority of Public Health, Slovakia)*; Ana Azevedo (University of Porto Medical School, Portugal)*; Mohsen Azimi-Nezhad (Neyshabur University of Medical Sciences, Iran)*; Fereidoun Azizi (Research Institute for Endocrine Sciences, Iran)*; Mehrdad Azmin (Non-Communicable Diseases Research Center, Iran)*; Bontha V Babu (Indian Council of Medical Research, India)*; Suhad Bahijri (King Abdulaziz University, Saudi Arabia)*; Nagalla Balakrishna (ICMR - National Institute of Nutrition, India)*; Yulia Balanova (National Medical Research Centre for Therapy and Preventive Medicine, Russia)*; Mohamed Bamoshmoosh (University of Science and Technology, Yemen)*; Maciej Banach (Medical University of Lodz, Poland)*; Maja Banadinović (University of Zagreb School of Medicine, Croatia)*; Piotr Bandosz (Medical University of Gdansk, Poland)*; José R Banegas (Universidad Autónoma de Madrid CIBERESP, Spain)*; Joanna Baran (University of Rzeszów, Poland)*; Carlo M Barbagallo (University of Palermo, Italy)*; Alberto Barceló (Pan American Health Organization, USA)*; Amina Barkat (Mohammed V University of Rabat, Morocco)*; Marta Barreto (National Institute of Health Doutor Ricardo Jorge, Portugal; NOVA University Lisbon, Portugal)*; Aluisio JD Barros (Federal University of Pelotas, Brazil)*; Mauro Virgílio Gomes Barros (University of Pernambuco, Brazil)*; Anna Bartosiewicz (University of Rzeszów, Poland)*; Abdul Basit (Baqai Institute of Diabetology and Endocrinology, Pakistan)*; Joao Luiz D Bastos (Federal University of Santa Catarina, Brazil)*; Iqbal Bata (Dalhousie University, Canada)*; Anwar M Batieha (Jordan University of Science and Technology, Jordan)*; Assembekov Batyrbek (Al-Farabi Kazakh National University, Kazakhstan)*; Louise A Baur (University of Sydney, Australia)*; Robert Beaglehole (University of Auckland, New Zealand)*; Antonisamy Belavendra (Christian Medical College Vellore, India)*; Habiba Ben Romdhane (University Tunis El Manar, Tunisia)*; Mikhail Benet (Cafam University Foundation, Colombia)*; James E Bennett (Imperial College London, UK)*; Lowell S Benson (University of Utah School of Medicine, USA)*; Salim Berkinbayev (Kazakh National Medical University, Kazakhstan)*; Antonio Bernabe-Ortiz (Universidad Peruana Cayetano Heredia, Peru)*; Gailute Bernotiene (Lithuanian University of Health Sciences, Lithuania)*; Heloisa Bettiol (University of São Paulo, Brazil)*; Jorge Bezerra (University of Pernambuco, Brazil)*; Aroor Bhargyalaxmi (B J Medical College, India)*; Santosh K Bhargava (Sunder Lal Jain Hospital, India)*; Daniel Bia (Universidad de la República, Uruguay)*; Katia Biasch (University of Strasbourg, France)*; Elysée Claude Bika Lele (Institute of Medical Research and Medicinal Plant Studies, Cameroon)*; Mukharram M Bikbov (Ufa Eye Research Institute, Russia)*; Bihungum Bista (Nepal Health Research Council, Nepal)*; Peter Bjerregaard (University of Southern Denmark, Denmark)*; Espen Bjertness (University of Oslo, Norway)*; Marius B Bjertness (University of Oslo, Norway)*; Cecilia Björkelund (University of Gothenburg, Sweden)*; Katia V Bloch (Universidade Federal do Rio de Janeiro, Brazil)*; Anneke Blokstra (National Institute for Public Health and the Environment, Netherlands)*; Simona Bo (University of Turin, Italy)*; Martin Bobak (University College London, UK)*; Heiner Boeing (German Institute of Human Nutrition, Germany)*; Jose G Boggia (Universidad de la República, Uruguay)*; Carlos P Boissonnet (Centro de Educación Médica e Investigaciones Clínicas, Argentina)*; Stig E Bojesen (Copenhagen University Hospital, Denmark; University of Copenhagen, Denmark)*; Vanina Bongard (Toulouse University School of Medicine, France)*; Alice Bonilla-Vargas (Caja Costarricense de Seguro Social, Costa Rica)*; Matthias Bopp (University of Zurich, Switzerland)*; Herman Borghs (University Hospital KU Leuven, Belgium)*; Pascal Bovet (Ministry of Health, Seychelles; Unisanté, Switzerland)*; Christopher B Boyer (Harvard T H Chan School of Public Health, USA)*; Lutgart Braeckman (Ghent University, Belgium)*; Imperia Brajkovich (Universidad Central de Venezuela, Venezuela)*; Francesco Branca (WHO, Switzerland)*; Juergen Breckenkamp (Bielefeld University, Germany)*; Hermann Brenner (German Cancer Research Center, Germany)*; Lizzy M Brewster (University of Amsterdam, Netherlands)*; Yajaira Briceño (University of the Andres, Venezuela)*; Miguel Brito (Instituto Politécnico de Lisboa, Portugal)*; Graziella Bruno (University of Turin, Italy)*; H Bas Bueno-de-Mesquita (National Institute for Public Health and the Environment, Netherlands)*; Gloria Bueno (University of Zaragoza, Spain)*; Anna Bugge (University College Copenhagen, Denmark)*; Con Burns (Munster Technological University, Ireland)*; Michael Bursztyn (Hadassah University Medical Center, Israel)*; Antonio Cabrera de León (Universidad de La Laguna, Spain)*; Joseph Cacciottolo (University of Malta, Malta)*; Christine Cameron (Canadian Fitness and Lifestyle Research Institute, Canada)*; Günay Can (Istanbul University - Cerrahpasa, Turkey)*; Ana Paula C Cândido (Universidade Federal de Juiz de Fora, Brazil)*; Mario V Capanzana (Food and Nutrition Research Institute, Philippines)*; Naděžda Čapková (National Institute of Public Health, Czech Republic)*; Eduardo Capuano (Gaetano Fucito Hospital, Italy)*; Vincenzo Capuano (Gaetano Fucito Hospital, Italy)*; Viviane C Cardoso (University of São Paulo, Brazil)*; Axel C Carlsson (Karolinska Institutet, Sweden)*; Joana Carvalho (University of Porto, Portugal)*; Felipe F Casanueva (Santiago de Compostela University, Spain)*; Laura Censi (Council for Agricultural Research and Economics, Italy)*; Marvin Cervantes-Loaiza (Caja Costarricense de Seguro Social, Costa Rica)*; Charalambos A Chadjigeorgiou (Research and Education Institute of Child Health, Cyprus)*; Snehalatha Chamukuttan (India Diabetes Research Foundation, India)*; Angélique W Chan (Duke-NUS Medical School, Singapore)*; Queenie Chan (Imperial College London, UK)*; Himanshu K Chaturvedi (ICMR - National Institute of Medical Statistics, India)*; Nish Chaturvedi (University College London, UK)*; Miao Li Chee (Singapore Eye Research Institute, Singapore)*; Chien-Jen Chen (Academia Sinica, Taiwan)*; Fangfang Chen (Capital Institute of Pediatrics, China)*; Huashuai Chen (Duke University, USA)*; Shuohua Chen (Kailuan General Hospital, China)*; Zhengming Chen (University of Oxford, UK)*; Ching-Yu Cheng (Duke-NUS Medical School, Singapore; Singapore Eye Research Institute, Singapore)*; Bahman Cheraghian (Ahvaz Jundishapur University of Medical Sciences, Iran)*; Imane Cherkaoui Dekkaki (Mohammed V University de Rabat, Morocco)*; Angela Chetrit (The Gertner Institute for Epidemiology and Health Policy Research, Israel)*; Kuo-Liong Chien (National Taiwan University, Taiwan)*; Arnaud Chiolerio (University of Bern, Switzerland)*; Shu-Ti Chiou (Ministry of Health and Welfare, Taiwan)*; Adela Chirita-Emandi (Victor Babes University of Medicine and Pharmacy Timisoara, Romania)*; Maria-Dolores Chirlaque (CIBER Epidemiologia y Salud Pública, Spain)*; Belong Cho (Seoul National University, South Korea)*; Kaare Christensen (University of Southern Denmark, Denmark)*; Diego G Christofaro (Universidade Estadual Paulista, Brazil)*; Jerzy Chudek (Medical University of Silesia, Poland)*; Renata Cifkova (Charles University, Czech Republic; Thomayer Hospital, Czech Republic)*; Eliza Cinteza (Carol Davila University of Medicine and Pharmacy, Romania)*; Frank Claessens (Katholieke Universiteit Leuven, Belgium)*; Janine Clarke (Statistics Canada, Canada)*; Els Clays (Ghent University, Belgium)*; Emmanuel Cohen (UMR CNRS-MNHN 7206, France)*; Hans Concin (Agency for Preventive and Social Medicine, Austria)*; Cyrus Cooper (University of Southampton, UK)*; Tara C Coppinger (Munster Technological University, Ireland)*; Simona Costanzo (IRCCS NeuroMed, Italy)*; Dominique Cottel (Institut Pasteur de Lille, France)*; Chris Cowell (University of Sydney, Australia)*; Cora L Craig (Canadian Fitness and Lifestyle Research Institute, Canada)*; Amelia C Crampin (Malawi Epidemiology and Intervention Research Unit, Malawi)*; Ana B Crujeiras (CIBEROBN, Spain)*; Juan J Cruz (Universidad Autónoma de Madrid CIBERESP, Spain)*; Semánová Csilla (University of Debrecen, Hungary)*; Liufu Cui (Kailuan General Hospital, China)*; Felipe V Cureau (Universidade Federal do Rio Grande do Sul, Brazil)*; Sarah Cuschieri (University of Malta, Malta)*; Graziella D'Arrigo (National Research Council, Italy)*; Eleonora d'Orsi (Federal University of Santa Catarina, Brazil)*; Jean Dallongeville (Institut Pasteur de Lille, France)*;

- Albertino Damasceno (Eduardo Mondlane University, Mozambique)*; Goodarz Danaei (Harvard T H Chan School of Public Health, USA)*; Rachel Dankner (The Gertner Institute for Epidemiology and Health Policy Research, Israel)*; Thomas M Dantoft (Bispebjerg and Frederiksberg Hospital, Denmark)*; Luc Dauchet (University of Lille, France); Lille University Hospital, France)*; Kairat Davletov (Al-Farabi Kazakh National University, Kazakhstan)*; Guy De Backer (Ghent University, Belgium)*; Dirk De Bacquer (Ghent University, Belgium)*; Amalia De Curtis (IRCCS Neuromed, Italy)*; Giovanni de Gaetano (IRCCS Neuromed, Italy)*; Stefaan De Henauw (Ghent University, Belgium)*; Paula Duarte de Oliveira (Federal University of Pelotas, Brazil)*; David De Ridder (Geneva University Hospitals, Switzerland)*; Delphine De Smedt (Ghent University, Belgium)*; Mohan Deepa (Madras Diabetes Research Foundation, India)*; Alexander D Deev (National Medical Research Centre for Therapy and Preventive Medicine, Russia)*; Vincent Jr DeGennaro (Innovating Health International, Haiti)*; H el ene Delisle (University of Montreal, Canada)*; Stefaan Demarest (Sciensano, Belgium)*; Elaine Dennison (University of Southampton, UK)*; Val erie Deschamps (French Public Health Agency, France)*; Meghnath Dhimal (Nepal Health Research Council, Nepal)*; Augusto F Di Castelnuovo (Mediterranea Cardiocentro, Italy)*; Juvenal Soares Dias-da-Costa (Universidade do Vale do Rio dos Sinos, Brazil)*; Alejandro Diaz (National Council of Scientific and Technical Research, Argentina)*; Ty T Dickerson (University of Utah School of Medicine, USA)*; Zivka Dika (University of Zagreb, Croatia)*; Shirin Djalalinia (Ministry of Health and Medical Education, Iran)*; Ha TP Do (National Institute of Nutrition, Vietnam)*; Annette J Dobson (University of Queensland, Australia)*; Chiara Donfrancesco (Istituto Superiore di Sanit , Italy)*; Silvana P Donoso (Universidad de Cuenca, Ecuador)*; Angela D oring (Helmholtz Zentrum M unchen, Germany)*; Maria Dorobantu (Carol Davila University of Medicine and Pharmacy, Romania)*; Marcus D orr (University Medicine Greifswald, Germany)*; Kouamelan Doua (Minist re de la Sant  et de l'Hygi ne Publique, C te d'Ivoire)*; Nico Dragano (University Hospital D usseldorf, Germany)*; Wojciech Drygas (National Institute of Cardiology, Warsaw, Poland; Medical University of Lodz, Poland)*; Charmaine A Duante (Food and Nutrition Research Institute, Philippines)*; Priscilla Duboz (IRL 3189 ESS, France)*; Rosemary B Duda (Beth Israel Deaconess Medical Center, USA; Harvard Medical School, USA)*; Virginija Dulskiene (Lithuanian University of Health Sciences, Lithuania)*; Anar Dushpanova (Scuola Superiore Sant'Anna, Italy); Al-Farabi Kazakh National University, Kazakhstan)*; Aleksandar Dzakula (University of Zagreb School of Medicine, Croatia)*; Vilnis Dzerve (University of Latvia, Latvia)*; Elzbieta Dzionkowska-Zaborszczyk (Medical University of Lodz, Poland)*; Ricky Eddie (Ministry of Health and Medical Services, Solomon Islands)*; Ebrahim Eftekhari (Hormozgan University of Medical Sciences, Iran)*; Robert Eggertsen (University of Gothenburg, Sweden)*; Sareh Eghtesad (Tehran University of Medical Sciences, Iran)*; Gabriele Eiben (University of Sk vde, Sweden)*; Ulf Ekelund (Norwegian School of Sport Sciences, Norway)*; Mohammad El-Khateeb (National Center for Diabetes, Endocrinology and Genetics, Jordan)*; Jalila El Ati (National Institute of Nutrition and Food Technology, Tunisia)*; Denise Eldemire-Shearer (The University of the West Indies, Jamaica)*; Marie Eliassen (Bispebjerg and Frederiksberg Hospital, Denmark)*; Paul Elliott (Imperial College London, UK)*; Roberto Elosua (Institut Hospital del Mar d'Investigacions M diques, Spain; CIBERCV, Spain)*; Rajiv T Erasmus (University of Stellenbosch, South Africa)*; Raimund Erbel (University of Duisburg-Essen, Germany)*; Cihangir Erem (Karadeniz Technical University, Turkey)*; Louise Eriksen (University of Southern Denmark, Denmark)*; Johan G Eriksson (University of Helsinki, Finland)*; Jorge Escobedo-de la Pe a (Instituto Mexicano del Seguro Social, Mexico)*; Saeid Eslami (Mashhad University of Medical Sciences, Iran)*; Ali Esmaeili (Rafsanjan University of Medical Sciences, Iran)*; Alun Evans (Queen's University of Belfast, UK)*; David Faeh (University of Zurich, Switzerland)*; Albina A Fakhretdinova (Ufa Eye Research Institute, Russia)*; Caroline H Fall (University of Southampton, UK)*; Elnaz Faramarzi (Tabriz University of Medical Sciences, Iran)*; Mojtaba Farjam (Fasa University of Medical Sciences, Iran)*; Farshad Farzadfar (Non-Communicable Diseases Research Center, Iran)*; Mohammad Reza Fattahi (Shiraz University of Medical Sciences, Iran)*; Asher Fawwad (Baqai Medical University, Pakistan)*; Francisco J Felix-Redondo (Centro de Salud Villanueva Norte, Spain)*; Stephan B Felix (University Medicine Greifswald, Germany)*; Trevor S Ferguson (The University of the West Indies, Jamaica)*; Romulo A Fernandes (Universidade Estadual Paulista, Brazil)*; Daniel Fern andez-Berg es (Hospital Don Benito-Villanueva de la Serena, Spain)*; Daniel Ferrante (Ministry of Health, Argentina)*; Thomas Ferrao (Statistics Canada, Canada)*; Marika Ferrari (Council for Agricultural Research and Economics, Italy)*; Marco M Ferrario (University of Insubria, Italy)*; Caterina Ferreccio (Pontificia Universidad Cat lica de Chile, Chile)*; Haroldo S Ferreira (Federal University of Alagoas, Brazil)*; Eldridge Ferrer (Food and Nutrition Research Institute, Philippines)*; Jean Ferrieres (Toulouse University School of Medicine, France)*; Thamara Hubler Figueir  (Federal University of Santa Catarina, Brazil)*; G nther Fink (Swiss Tropical and Public Health Institute, Switzerland; University of Basel, Switzerland)*; Krista Fischer (University of Tartu, Estonia)*; Leng Huat Foo (Universiti Sains Malaysia, Malaysia)*; Maria Forsner (Ume  University, Sweden)*; Heba M Fouad (WHO Regional Office for the Eastern Mediterranean, Egypt)*; Damian K Francis (The University of the West Indies, Jamaica)*; Maria do Carmo Franco (Federal University of S o Paulo, Brazil)*; Ruth Frikke-Schmidt (Copenhagen University Hospital, Denmark; University of Copenhagen, Denmark)*; Guillermo Frontera (Hospital Universitario Son Espases, Spain)*; Flavio D Fuchs (Hospital de Cl nicas de Porto Alegre, Brazil)*; Sandra C Fuchs (Universidade Federal do Rio Grande do Sul, Brazil)*; Yuki Fujita (Kindai University, Japan)*; Matsuda Fumihiko (Kyoto University, Japan)*; Viktoriya Furdela (I. Horbachevsky Ternopil National Medical University, Ukraine)*; Ariel Furer (Tel-Aviv University, Israel; Hebrew University of Jerusalem, Israel)*; Takuro Furusawa (Kyoto University, Japan)*; Zbigniew Gacjonek (Medical University of Warsaw, Poland)*; Andrzej Galbarczyk (Jagiellonian University Medical College, Poland)*; Henrike Galenkamp (University of Amsterdam, Netherlands)*; Fabio Galvano (University of Catania, Italy)*; Jingli Gao (Kailuan General Hospital, China)*; Pei Gao (Peking University, China)*; Manoli Garcia-de-la-Hera (CIBER en Epidemiolog a y Salud P blica, Spain)*; Pablo Garcia (Wuqi Kawoq, Guatemala)*; Dickman Garetta (Africa Health Research Institute, South Africa)*; Sarah P Garnett (University of Sydney, Australia)*; Jean-Michel Gaspoz (Geneva University Medical School, Switzerland)*; Magda Gasull (CIBER en Epidemiolog a y Salud P blica, Spain)*; Andrea Gazzinelli (Universidade Federal de Minas Gerais, Brazil)*; Ulrike Gehring (Utrecht University, Netherlands)*; Johanna M Geleijnse (Wageningen University, Netherlands)*; Ronnie George (Medical Research Foundation, India)*; Ali Ghanbari (Non-Communicable Diseases Research Center, Iran)*; Erfan Ghasemi (Non-Communicable Diseases Research Center, Iran)*; Oana-Florentina Gheorghe-Fronea (Carol Davila University of Medicine and Pharmacy, Romania)*; Anup Ghimire (B P Koirala Institute of Health Sciences, Nepal)*; Alessandro Gialluisi (IRCCS Neuromed, Italy)*; Simona Giampaoli (Istituto Superiore di Sanit , Italy)*; Christian Gieger (Helmholtz Zentrum M unchen, Germany)*; Tiffany K Gill (University of Adelaide, Australia)*; Jonathan Giovannelli (University of Lille, France; Lille University Hospital, France)*; Glen Gironella (Food and Nutrition Research Institute, Philippines)*; Aleksander Giwercman (Lund University, Sweden)*; Konstantinos Gkiouras (Aristotle University of Thessaloniki, Greece)*; Marcel Goldberg (Institut National de la Sant  et de la Recherche M dicale, France; Paris University, France)*; Rebecca A Goldsmith (Ministry of Health, Israel)*; Luis F Gomez (Pontificia Universidad Javeriana, Colombia)*; Aleksandra Gomula (PASs Hirsfeld Institute of Immunology and Experimental Therapy, Poland)*; Bruna Gonalves Cordeiro da Silva (Federal University of Pelotas, Brazil)*; Helen Gonalves (Federal University of Pelotas, Brazil)*; Mauer Gonalves (University Agostinho Neto, Angola)*; David A Gonzalez-Chica (University of Adelaide, Australia)*; Marcela Gonzalez-Gross (Universidad Polit cnica de Madrid, Spain)*; Juan P Gonz lez-Rivas (International Clinical Research Center, Czech Republic)*; Clicerio Gonz lez-Villalpando (National Institute of Public Health, Mexico)*; Mar a-Elena Gonz lez-Villalpando (Centro de Estudios en Diabetes AC, Mexico)*; Angel R Gonz lez (Universidad Aut noma de Santo Domingo, Dominican Republic)*;

Mariano Bonet Gorbea (National Institute of Hygiene, Epidemiology and Microbiology, Cuba)*; Frederic Gottrand (University of Lille, France)*; Sidsel Graff-Iversen (Norwegian Institute of Public Health, Norway)*; Dušan Grafnetter (Institute for Clinical and Experimental Medicine, Czech Republic)*; Aneta Grajda (Children's Memorial Health Institute, Poland)*; Maria G Grammatikopoulou (International Hellenic University, Greece)*; Ronald D Gregor (Dalhousie University, Canada)*; Tomasz Grodzicki (Jagiellonian University Medical College, Poland)*; Giuseppe Grosso (University of Catania, Italy)*; Gabriella Gruden (University of Turin, Italy)*; Dongfeng Gu (National Center of Cardiovascular Diseases, China)*; Ong Peng Guan (Singapore Eye Research Institute, Singapore)*; Elias F Gudmundsson (Icelandic Heart Association, Iceland)*; Vilmundur Gudnason (University of Iceland, Iceland)*; Ramiro Guerrero (Universidad Icesi, Colombia)*; Idris Guessou (Geneva University Hospitals, Switzerland)*; Andre L Guimaraes (State University of Montes Claros, Brazil)*; Martin C Gulliford (King's College London, UK)*; Johanna Gunnlaugsdottir (Icelandic Heart Association, Iceland)*; Marc J Gunter (International Agency for Research on Cancer, France)*; Prakash C Gupta (Healis-Sekhsaria Institute for Public Health, India)*; Rajeev Gupta (Eternal Heart Care Centre and Research Institute, India)*; Oye Gureje (University of Ibadan, Nigeria)*; Beata Gurzkowska (Children's Memorial Health Institute, Poland)*; Laura Gutierrez (Institute for Clinical Effectiveness and Health Policy, Argentina)*; Felix Gutzwiller (University of Zurich, Switzerland)*; Seongjun Ha (National Health Insurance Service, South Korea)*; Farzad Hadaegh (Prevention of Metabolic Disorders Research Center, Iran)*; Rosa Haghshenas (Non-Communicable Diseases Research Center, Iran)*; Hamid Hakimi (Rafsanjan University of Medical Sciences, Iran)*; Jytte Halkjær (Danish Cancer Society Research Center, Denmark)*; Ian R Hambleton (The University of the West Indies, Barbados)*; Behrooz Hamzeh (Kermanshah University of Medical Sciences, Iran)*; Dominique Hange (University of Gothenburg, Sweden)*; Abu AM Hanif (BRAC James P Grant School of Public Health, Bangladesh)*; Sari Hantunen (University of Eastern Finland, Finland)*; Jie Hao (Beijing Institute of Ophthalmology, China)*; Carla Meneses Hardman (Federal University of Pernambuco, Brazil)*; Rachakulla Hari Kumar (ICMR - National Institute of Nutrition, India)*; Seyed Mohammad Hashemi-Shahri (Zahedan University of Medical Sciences, Iran)*; Jun Hata (Kyushu University, Japan)*; Teresa Haugsgjerd (University of Bergen, Norway)*; Alison J Hayes (University of Sydney, Australia)*; Jiang He (Tulane University, USA)*; Yuna He (Chinese Center for Disease Control and Prevention, China)*; Margit Heier (Helmholtz Zentrum München, Germany)*; Marleen Elisabeth Hendriks (Joep Lange Institute, Netherlands)*; Rafael dos Santos Henrique (Federal University of Pernambuco, Brazil)*; Ana Henriques (Institute of Public Health of the University of Porto, Portugal)*; Leticia Hernandez Cadena (National Institute of Public Health, Mexico)*; Herqutanto (Universitas Indonesia, Indonesia)*; Sauli Herrala (Oulu University Hospital, Finland)*; Ramin Heshmat (Chronic Diseases Research Center, Iran)*; Allan G Hill (University of Southampton, UK)*; Sai Yin Ho (University of Hong Kong, China)*; Suzanne C Ho (The Chinese University of Hong Kong, China)*; Michael Hobbs (University of Western Australia, Australia)*; Michelle Holdsworth (French National Research Institute for Sustainable Development, France)*; Reza Homayounfar (Fasa University of Medical Sciences, Iran)*; Gonul Horasan Dinc (Celal Bayar University, Turkey)*; Andrea RVR Horimoto (University of São Paulo, Brazil)*; Claudia M Hormiga (Fundación Oftalmológica de Santander, Colombia)*; Bernardo L Horta (Federal University of Pelotas, Brazil)*; Leila Houti (University Oran 1, Algeria)*; Christina Howitt (The University of the West Indies, Barbados)*; Thein Thein Htay (Independent Public Health Specialist, Myanmar)*; Aung Soe Htet (Ministry of Health and Sports, Myanmar)*; Maung Maung Than Htike (Ministry of Health and Sports, Myanmar)*; Yonghua Hu (Peking University, China)*; José María Huerta (CIBER en Epidemiología y Salud Pública, Spain)*; Ilpo Tapani Huhtaniemi (Imperial College London, UK)*; Laetitia Huiart (Santé publique France, Luxembourg)*; Martijn Huisman (VU University Medical Center, Netherlands)*; Abdullatif S Hussein (Birzeit University, Palestine)*; Inge Huybrechts (International Agency for Research on Cancer, France)*; Nahla Hwalla (American University of Beirut, Lebanon)*; Licia Iacoviello (IRCCS Neuromed, Italy; University of Insubria, Italy)*; Anna G Iannone (Gaetano Fucito Hospital, Italy)*; Mohsen M Ibrahim (Cairo University, Egypt)*; Norazizah Ibrahim Wong (Ministry of Health, Malaysia)*; Nayu Ikeda (National Institutes of Biomedical Innovation, Health and Nutrition, Japan)*; M Arfan Ikram (Erasmus Medical Center Rotterdam, Netherlands)*; Violeta Iotova (Medical University Varna, Bulgaria)*; Vilma E Irazola (Institute for Clinical Effectiveness and Health Policy, Argentina)*; Takafumi Ishida (The University of Tokyo, Japan)*; Godsent C Isiguzo (Alex Ekwueme Federal University Teaching Hospital, Nigeria)*; Muhammad Islam (The Hospital for Sick Children, Canada)*; Sheikh Mohammed Shariful Islam (Deakin University, Australia)*; Masanori Iwasaki (Tokyo Metropolitan Institute of Gerontology, Japan)*; Rod T Jackson (University of Auckland, New Zealand)*; Jeremy M Jacobs (Hadassah University Medical Center, Israel)*; Hashem Y Jaddou (Jordan University of Science and Technology, Jordan)*; Tazeen Jafar (Duke-NUS Medical School, Singapore)*; Kenneth James (The University of the West Indies, Jamaica)*; Konrad Jamrozik (University of Adelaide, Australia; deceased)*; Imre Janszky (Norwegian University of Science and Technology, Norway)*; Edward Janus (University of Melbourne, Australia)*; Marjo-Riitta Jarvelin (Imperial College London, UK; University of Oulu, Finland)*; Grazyna Jasienska (Jagiellonian University Medical College, Poland)*; Ana Jelaković (University Hospital Center Zagreb, Croatia)*; Bojan Jelaković (University of Zagreb School of Medicine, Croatia)*; Garry Jennings (Heart Foundation, Australia)*; Anjani Kumar Jha (Nepal Health Research Council, Nepal)*; Chao Qiang Jiang (Guangzhou 12th Hospital, China)*; Ramon O Jimenez (Universidad Eugenio Maria de Hostos, Dominican Republic)*; Karl-Heinz Jöckel (University of Duisburg-Essen, Germany)*; Michel Joffres (Simon Fraser University, Canada)*; Mattias Johansson (International Agency for Research on Cancer, France)*; Jari J Jokelainen (Oulu University Hospital, Finland)*; Jost B Jonas (Institute of Molecular and Clinical Ophthalmology Basel, Switzerland)*; Torben Jørgensen (Bispebjerg and Frederiksberg Hospital, Denmark)*; Pradeep Joshi (WHO Country Office, India)*; Farahnaz Joukar (Guilan University of Medical Sciences, Iran)*; Jacek Józwiak (University of Opole, Poland)*; Anne Juolevi (Finnish Institute for Health and Welfare, Finland)*; Gregor Jurak (University of Ljubljana, Slovenia)*; Vesna Jureša (University of Zagreb, Croatia)*; Rudolf Kaaks (German Cancer Research Center, Germany)*; Anthony Kafatos (University of Crete, Greece)*; Eero O Kajantie (Finnish Institute for Health and Welfare, Finland)*; Zhanna Kalmatayeva (Al Farabi Kazakh National University, Kazakhstan)*; Natasa Kalpourtzi (National and Kapodistrian University of Athens, Greece)*; Ofra Kalter-Leibovici (The Gertner Institute for Epidemiology and Health Policy Research, Israel)*; Freja B Kampmann (Bispebjerg and Frederiksberg Hospital, Denmark)*; Srinivasan Kannan (Sree Chitra Tirunal Institute for Medical Sciences and Technology, India)*; Eva Karaglani (Harokopio University, Greece)*; Line L Kärhus (Bispebjerg and Frederiksberg Hospital, Denmark)*; Khem B Karki (Maharajgunj Medical Campus, Nepal)*; Marzieh Katibeh (Aarhus University, Denmark)*; Joanne Katz (Johns Hopkins Bloomberg School of Public Health, USA)*; Jussi Kauhanen (University of Eastern Finland, Finland)*; Prabhdeep Kaur (National Institute of Epidemiology, India)*; Maryam Kavousi (Erasmus Medical Center Rotterdam, Netherlands)*; Gylli M Kazakbaeva (Ufa Eye Research Institute, Russia)*; Ulrich Keil (University of Münster, Germany)*; Lital Keinan Boker (Israel Center for Disease Control, Israel)*; Sirkka Keinänen-Kiukkaanniemi (Oulu University Hospital, Finland)*; Roya Kelishadi (Research Institute for Primordial Prevention of Non-communicable Disease, Iran)*; Han CG Kemper (Amsterdam UMC Public Health Research Institute, Netherlands)*; Andre P Kengne (South African Medical Research Council, South Africa)*; Maryam Keramati (Mashhad University of Medical Sciences, Iran)*; Alina Kerimkulova (Kyrgyz State Medical Academy, Kyrgyzstan)*; Mathilde Kersting (Research Institute of Child Nutrition, Germany)*; Timothy Key (University of Oxford, UK)*; Yousef Saleh Khader (Jordan University of Science and Technology, Jordan)*; Davood Khalili (Shahid Beheshti University of Medical Sciences, Iran)*; Young-Ho Khang (Seoul National University College of Medicine, South Korea)*; Kay-Tee Khaw (University of Cambridge,

- UK)*; Bahareh Kheiri (Shahid Beheshti University of Medical Sciences, Iran)*; Motahareh Kheradmand (Mazandaran University of Medical Sciences, Iran)*; Alireza Khosravi (Hypertension Research Center, Iran)*; Ursula Kiechl-Kohlendorfer (Medical University of Innsbruck, Austria)*; Stefan Kiechl (Medical University of Innsbruck, Austria; VASCage, Austria)*; Japhet Killewo (Muhimbili University of Health and Allied Sciences, Tanzania)*; Dong Wook Kim (National Health Insurance Service, South Korea)*; Hyeon Chang Kim (Yonsei University College of Medicine, South Korea)*; Jeongseon Kim (National Cancer Center, South Korea)*; Heidi Klakk (University College South Denmark, Denmark)*; Magdalena Klimek (Jagiellonian University Medical College, Poland)*; Jurate Klumbiene (Lithuanian University of Health Sciences, Lithuania)*; Michael Knoflach (Medical University of Innsbruck, Austria)*; Elin Kolle (Norwegian School of Sport Sciences, Norway)*; Patrick Kolsteren (Ghent University, Belgium)*; Jukka P Kontto (Finnish Institute for Health and Welfare, Finland)*; Raija Korpelainen (University of Oulu, Finland; Oulu Deaconess Institute Foundation, Finland)*; Paul Korrovits (Tartu University Clinics, Estonia)*; Jelena Kos (University Hospital Center Zagreb, Croatia)*; Seppo Koskinen (Finnish Institute for Health and Welfare, Finland)*; Katsuyasu Kouda (Kansai Medical University, Japan)*; Sudhir Kowlessur (Ministry of Health and Wellness, Mauritius)*; Sławomir Koziel (PASs Hirsfeld Institute of Immunology and Experimental Therapy, Poland)*; Jana Kratenova (National Institute of Public Health, Czech Republic)*; Vilma Kriaucioniene (Lithuanian University of Health Sciences, Lithuania)*; Peter Lund Kristensen (University of Southern Denmark, Denmark)*; Steiner Krokstad (Norwegian University of Science and Technology, Norway)*; Daan Kromhout (University of Groningen, Netherlands)*; Herculina S Kruger (North-West University, South Africa; South African Medical Research Council, South Africa)*; Ruzena Kubinova (National Institute of Public Health, Czech Republic)*; Renata Kuciene (Lithuanian University of Health Sciences, Lithuania)*; Urho M Kujala (University of Jyväskylä, Finland)*; Zbigniew Kulaga (Children's Memorial Health Institute, Poland)*; R Krishna Kumar (Amrita Institute of Medical Sciences, India)*; Pawel Kurjata (National Institute of Cardiology, Poland)*; Yadlapalli S Kusuma (All India Institute of Medical Sciences, India)*; Vladimir Kutsenko (National Medical Research Centre for Therapy and Preventive Medicine, Russia)*; Kari Kuulasmaa (Finnish Institute for Health and Welfare, Finland)*; Catherine Kyobutungi (African Population and Health Research Center, Kenya)*; Tiina Laatikainen (Finnish Institute for Health and Welfare, Finland)*; Carl Lachat (Ghent University, Belgium)*; Youcef Laid (Ministry of Health, Algeria)*; Tai Hing Lam (University of Hong Kong, China)*; Orlando Landrove (Ministerio de Salud Pública, Cuba)*; Vera Lanska (Institute for Clinical and Experimental Medicine, Czech Republic)*; Georg Lappas (Sahlgrenska Academy, Sweden)*; Bagher Larijani (Endocrinology and Metabolism Research Center, Iran)*; Tint Swe Latt (University of Public Health, Myanmar)*; Avula Laxmaiah (ICMR - National Institute of Nutrition, India)*; Gwenaëlle Le Coller (Luxembourg Institute of Health, Luxembourg)*; Khanh Le Nguyen Bao (National Institute of Nutrition, Vietnam)*; Tuyen D Le (National Institute of Nutrition, Vietnam)*; Jeannette Lee (National University of Singapore, Singapore)*; Jeonghee Lee (National Cancer Center, South Korea)*; Nils Lehmann (University of Duisburg-Essen, Germany)*; Terho Lehtimäki (Tampere University Hospital, Finland; Tampere University, Finland)*; Daniel Lemogoum (University of Douala, Cameroon)*; Naomi S Levitt (University of Cape Town, South Africa)*; Yanping Li (Harvard T H Chan School of Public Health, USA)*; Christa L Lilly (West Virginia University, USA)*; Wei-Yen Lim (National University of Singapore, Singapore)*; M Fernanda Lima-Costa (Oswaldo Cruz Foundation Rene Rachou Research Institute, Brazil)*; Hsien-Ho Lin (National Taiwan University, Taiwan)*; Xu Lin (Shanghai Institute of Nutrition and Health, China)*; Yi-Ting Lin (Uppsala University, Sweden)*; Lars Lind (Uppsala University, Sweden)*; Vijaya Lingam (Medical Research Foundation, India)*; Allan Linneberg (Bispebjerg and Frederiksberg Hospital, Denmark)*; Lauren Lissner (University of Gothenburg, Sweden)*; Mieczyslaw Litwin (Children's Memorial Health Institute, Poland)*; Wei-Cheng Lo (Taipei Medical University, Taiwan)*; Helle-Mai Loit (National Institute for Health Development, Estonia)*; Esther Lopez-Garcia (Universidad Autónoma de Madrid CIBERESP, Spain)*; Tania Lopez (Universidad San Martín de Porres, Peru)*; Paulo A Lotufo (University of São Paulo, Brazil)*; José Eugenio Lozano (Consejería de Sanidad Junta de Castilla y León, Spain)*; Iva Lukačević Lovrenčić (University of Zagreb School of Medicine, Croatia)*; Janice L Lukrafka (Universidade Federal de Ciências da Saúde de Porto Alegre, Brazil)*; Dalia Luksiene (Lithuanian University of Health Sciences, Lithuania)*; Annamari Lundqvist (Finnish Institute for Health and Welfare, Finland)*; Robert Lundqvist (Norrbotten County Council, Sweden)*; Nuno Lunet (University of Porto, Portugal)*; Michala Lustigová (Charles University, Czech Republic; National Institute of Public Health, Czech Republic)*; Edyta Luszczyki (University of Rzeszów, Poland)*; Guansheng Ma (Peking University, China)*; Jun Ma (Peking University, China)*; George LL Machado-Coelho (Universidade Federal de Ouro Preto, Brazil)*; Aristides M Machado-Rodrigues (University of Coimbra, Portugal)*; Enguerran Macia (IRL 3189 ESS, France)*; Luisa M Macieira (Coimbra University Hospital Center, Portugal)*; Ahmed A Madar (University of Oslo, Norway)*; Stefania Maggi (Institute of Neuroscience of the National Research Council, Italy)*; Dianna J Magliano (Baker Heart and Diabetes Institute, Australia)*; Emmanuella Magriplis (Agricultural University of Athens, Greece)*; Gowri Mahasampath (Christian Medical College Vellore, India)*; Bernard Maire (French National Research Institute for Sustainable Development, France)*; Marjeta Majer (University of Zagreb, Croatia)*; Marcia Makdisse (Hospital Israelita Albert Einstein, Brazil)*; Fatemeh Malekzadeh (Tehran University of Medical Sciences, Iran)*; Reza Malekzadeh (Shiraz University of Medical Sciences, Iran; Tehran University of Medical Sciences, Iran)*; Rahul Malhotra (Duke-NUS Medical School, Singapore)*; Kodavanti Mallikharjuna Rao (ICMR - National Institute of Nutrition, India)*; Sofia K Maluytina (SB RAS Federal Research Center Institute of Cytology and Genetics, Russia)*; Lynell V Maniego (Food and Nutrition Research Institute, Philippines)*; Yannis Manios (Harokopio University, Greece)*; Jim I Mann (University of Otago, New Zealand)*; Fariborz Mansour-Ghanaei (Guilan University of Medical Sciences, Iran)*; Enzo Manzato (University of Padua, Italy)*; Anie Marcil (Statistics Canada, Canada)*; Paula Margozzini (Pontificia Universidad Católica de Chile, Chile)*; Staffan B Märild (Göteborg University, Sweden)*; Mihalea Marinović Glavić (University of Rijeka, Croatia)*; Pedro Marques-Vidal (Lausanne University Hospital, Switzerland; University of Lausanne, Switzerland)*; Larissa Pruner Marques (Escola Nacional de Saúde Pública Sergio Arouca, Brazil)*; Jaime Marrugat (CIBERCV, Spain; Institut Hospital del Mar d'Investigacions Mèdiques, Spain)*; Reynaldo Martorell (Emory University, USA)*; Luis P Mascarenhas (Universidade Estadual do Centro-Oeste, Brazil)*; Marija Matasin (University Hospital Center Zagreb, Croatia)*; Ellisiv B Mathiesen (UiT The Arctic University of Norway, Norway)*; Prashant Mathur (ICMR - National Centre for Disease Informatics and Research, India)*; Alicia Matijasevich (University of São Paulo, Brazil)*; Piotr Matlosz (University of Rzeszów, Poland)*; Tandí E Matsha (Cape Peninsula University of Technology, South Africa)*; Christina Mavroggianni (Harokopio University, Greece)*; Jean Claude N Mbanya (University of Yaoundé 1, Cameroon)*; Anselmo J Mc Donald Posso (Instituto Conmemorativo Gorgas de Estudios de la Salud, Panama)*; Shelly R McFarlane (The University of the West Indies, Jamaica)*; Stephen T McCarvey (Brown University, USA)*; Stela McLachlan (University of Edinburgh, UK)*; Rachael M McLean (University of Otago, New Zealand)*; Scott B McLean (Statistics Canada, Canada)*; Breige A McNulty (University College Dublin, Ireland)*; Sounnia Mediene Benchechor (University Oran 1, Algeria)*; Jurate Medzioniene (Lithuanian University of Health Sciences, Lithuania)*; Parinaz Mehdipour (Non-Communicable Diseases Research Center, Iran)*; Kirsten Mehlig (University of Gothenburg, Sweden)*; Amir Houshang Mehrparvar (Shahid Sadoughi University of Medical Sciences, Iran)*; Aline Meirhaeghe (Institut National de la Santé et de la Recherche Médicale, France)*; Christa Meisinger (Helmholtz Zentrum München, Germany)*; Carlos Mendoza Montano (Instituto de Nutrición de Centroamérica y Panamá, Guatemala)*; Ana Maria B Menezes (Federal University of Pelotas, Brazil)*; Geetha R Menon (ICMR - National Institute of Medical Statistics, India)*; Alibek Mereke (Al-Farabi Kazakh National University, Kazakhstan)*; Indrapal I Meshram (ICMR - National Institute of Nutrition, India)*; Andres Metspalu

(University of Tartu, Estonia)*; Haakon E Meyer (University of Oslo, Norway)*; Jie Mi (Capital Institute of Pediatrics, China)*; Nathalie Michels (Ghent University, Belgium)*; Kairit Mikkel (University of Tartu, Estonia)*; Karolina Milkowska (Jagiellonian University Medical College, Poland)*; Jody C Miller (University of Otago, New Zealand)*; Cláudia S Minderico (Universidade de Lisboa, Portugal)*; GK Mini (Women's Social and Health Studies Foundation, India)*; J Jaime Miranda (Universidad Peruana Cayetano Heredia, Peru)*; Mohammad Reza Mirjalili (Shahid Sadoughi University of Medical Sciences, Iran)*; Erkin Mirrakhimov (Kyrgyz State Medical Academy, Kyrgyzstan)*; Marjeta Mišigoj-Duraković (University of Zagreb, Croatia)*; Pietro A Modesti (Università degli Studi di Firenze, Italy)*; Sahar Saeedi Moghaddam (Non-Communicable Diseases Research Center, Iran)*; Bahram Mohajer (Non-Communicable Diseases Research Center, Iran)*; Mostafa K Mohamed (Ain Shams University, Egypt)*; Shukri F Mohamed (African Population and Health Research Center, Kenya)*; Kazem Mohammad (Tehran University of Medical Sciences, Iran)*; Mohammad Reza Mohammadi (Psychiatry and Psychology Research Center, Iran)*; Zahra Mohammadi (Tehran University of Medical Sciences, Iran)*; Noushin Mohammadifard (Isfahan Cardiovascular Research Center, Iran)*; Reza Mohammadpourhodki (Mashhad University of Medical Sciences, Iran)*; Viswanathan Mohan (Madras Diabetes Research Foundation, India)*; Salim Mohanna (Universidad Peruana Cayetano Heredia, Peru)*; Muhammad Fadhli Mohd Yusoff (Ministry of Health, Malaysia)*; Iraj Mohebbi (Urmia University of Medical Sciences, Iran)*; Farnam Mohebi (University of California, Berkeley, USA)*; Marie Moitry (University of Strasbourg, France; Strasbourg University Hospital, France)*; Line T Møllehave (Bispebjerg and Frederiksberg Hospital, Denmark)*; Dénes Molnár (University of Pécs, Hungary)*; Amirabbas Momenan (Shahid Beheshti University of Medical Sciences, Iran)*; Charles K Mondo (Mulago Hospital, Uganda)*; Eric Monterrubio-Flores (National Institute of Public Health, Mexico)*; Kotsedi Daniel K Monyeke (University of Limpopo, South Africa)*; Jin Soo Moon (Seoul National University, South Korea)*; Mahmood Moosazadeh (Mazandaran University of Medical Sciences, Iran)*; Leila B Moreira (Universidade Federal do Rio Grande do Sul, Brazil)*; Alain Morejon (University of Medical Sciences of Cienfuegos, Cuba)*; Luis A Moreno (University of Zaragoza, Spain; CIBEROBN, Spain)*; Karen Morgan (Royal College of Surgeons in Ireland, Ireland)*; George Moschonis (La Trobe University, Australia)*; Malgorzata Mossakowska (International Institute of Molecular and Cell Biology, Poland)*; Aya Mostafa (Ain Shams University, Egypt)*; Seyed-Ali Mostafavi (Tehran University of Medical Sciences, Iran)*; Jorge Mota (University of Porto, Portugal)*; Mohammad Esmael Motlagh (Ahvaz Jundishapur University of Medical Sciences, Iran)*; Jorge Motta (Instituto Conmemorativo Gorgas de Estudios de la Salud, Panama)*; Marcos André Moura-dos-Santos (University of Pernambuco, Brazil)*; Malay K Mridha (BRAC James P Grant School of Public Health, Bangladesh)*; Kelias P Msyamboza (WHO Country Office, Malawi)*; Thet Thet Mu (Department of Public Health, Myanmar)*; Alfa J Muhihi (Muhimbili University of Health and Allied Sciences, Tanzania)*; Maria L Muienes (University of Brescia, Italy)*; Martina Müller-Nurasyid (Ludwig-Maximilians-Universität München, Germany)*; Neil Murphy (International Agency for Research on Cancer, France)*; Jaakko Mursu (University of Eastern Finland, Finland)*; Kamarul Imran Musa (Universiti Sains Malaysia, Malaysia)*; Sanja Musić Milanović (Croatian Institute of Public Health, Croatia; University of Zagreb, Croatia)*; Vera Musil (University of Zagreb, Croatia)*; Norlaila Mustafa (Universiti Kebangsaan Malaysia, Malaysia)*; Iraj Nabipour (Bushehr University of Medical Sciences, Iran)*; Shohreh Naderimaghham (Non-Communicable Diseases Research Center, Iran)*; Gabriele Nagel (Ulm University, Germany)*; Balkish M Naidu (Department of Statistics, Malaysia)*; Farid Najafi (Kermanshah University of Medical Sciences, Iran)*; Harunobu Nakamura (Kobe University, Japan)*; Jana Námešná (Banská Bystrica Regional Authority of Public Health, Slovakia)*; Ei Ei K Nang (National University of Singapore, Singapore)*; Vinay B Nangia (Suraj Eye Institute, India)*; Sameer Narake (Healis-Sekhsaria Institute for Public Health, India)*; Ndeye Coumba Ndiaye (Institut National de la Santé et de la Recherche Médicale, France)*; William A Neal (West Virginia University, USA)*; Azim Nejatizadeh (Hormozgan University of Medical Sciences, Iran)*; Ilona Nenko (Jagiellonian University Medical College, Poland)*; Martin Neovius (Karolinska Institutet, Sweden)*; Hannelore K Neuhauser (Robert Koch Institute, Germany)*; Chung T Nguyen (National Institute of Hygiene and Epidemiology, Vietnam)*; Nguyen D Nguyen (University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam)*; Quang V Nguyen (National Hospital of Endocrinology, Vietnam)*; Quang Ngoc Nguyen (Hanoi Medical University, Vietnam)*; Ramfis E Nieto-Martínez (LifeDoc Health, USA)*; Teemu J Niiranen (Finnish Institute for Health and Welfare, Finland; University of Turku, Finland)*; Yuri P Nikitin (SB RAS Federal Research Center Institute of Cytology and Genetics, Russia)*; Toshiharu Ninomiya (Kyushu University, Japan)*; Sania Nishtar (Heartfile, Pakistan)*; Marina A Njelekela (Muhimbili University of Health and Allied Science, Tanzania)*; Marianna Noale (Institute of Neuroscience of the National Research Council, Italy)*; Oscar A Noboa (Universidad de la República, Uruguay)*; Ahmad Ali Noorbala (Tehran University of Medical Sciences, Iran)*; Teresa Norat (Imperial College London, UK)*; Maria Nordendahl (Umeå University, Sweden)*; Børge G Nordestgaard (Copenhagen University Hospital, Denmark; University of Copenhagen, Denmark)*; Davide Note (University of Palermo, Italy)*; Natalia Nowak-Szczepanska (PASS Hirsfeld Institute of Immunology and Experimental Therapy, Poland)*; Mohammad Al Nsour (Eastern Mediterranean Public Health Network, Jordan)*; Baltazar Nunes (National Institute of Health Doutor Ricardo Jorge, Portugal; NOVA University Lisbon, Portugal)*; Terence W O'Neill (University of Manchester, UK)*; Dermot O'Reilly (Queen's University of Belfast, UK)*; Caleb Ochimana (Harvard T H Chan School of Public Health, USA)*; Eiji Oda (Tachikawa General Hospital, Japan)*; Augustine N Odili (University of Abuja College of Health Sciences, Nigeria)*; Kyungwon Oh (Korea Centers for Disease Control and Prevention, South Korea)*; Kumiko Ohara (Kindai University, Japan)*; Ryutaro Ohtsuka (Japan Wildlife Research Center, Japan)*; Valérie Olié (French Public Health Agency, France)*; Maria Teresa A Olinto (Universidade do Vale do Rio dos Sinos, Brazil)*; Isabel O Oliveira (Federal University of Pelotas, Brazil)*; Mohd Azahadi Omar (Ministry of Health, Malaysia)*; Altan Onat (Istanbul University, Turkey; deceased)*; Sok King Ong (Ministry of Health, Brunei)*; Lariane M Ono (Universidade Federal do Paraná, Brazil)*; Pedro Ordunez (Pan American Health Organization, USA)*; Rui Ornelas (University of Madeira, Portugal)*; Pedro J Ortiz (Universidad Peruana Cayetano Heredia, Peru)*; Clive Osmond (University of Southampton, UK)*; Sergej M Ostojic (University of Novi Sad, Serbia)*; Afshin Ostovar (Osteoporosis Research Center, Iran)*; Johanna A Otero (Fundación Oftalmológica de Santander, Colombia)*; Kim Overvad (Aarhus University, Denmark)*; Ellis Owusu-Dabo (Kwame Nkrumah University of Science and Technology, Ghana)*; Fred Michel Paccaud (UniSanté, Switzerland)*; Cristina Padez (University of Coimbra, Portugal)*; Elena Pahomova (University of Latvia, Latvia)*; Karina Mary de Paiva (Federal University of Santa Catarina, Brazil)*; Andrzej Pająk (Jagiellonian University Medical College, Poland)*; Domenico Palli (Institute for Cancer Research, Prevention and Clinical Network, Italy)*; Luigi Palmieri (Istituto Superiore di Sanità, Italy)*; Wen-Harn Pan (Academia Sinica, Taiwan)*; Songhomitra Panda-Jonas (Institute of Clinical and Scientific Ophthalmology and Acupuncture Jonas & Panda, Germany)*; Francesco Panza (IRCCS Ente Ospedaliero Specializzato in Gastroenterologia S. de Bellis, Italy)*; Mariela Paoli (University of the Andes, Venezuela)*; Dimitrios Papatheou (Zayed University, United Arab Emirates)*; Soon-Woo Park (Catholic University of Daegu, South Korea)*; Suyeon Park (Korea Centers for Disease Control and Prevention, South Korea)*; Winsome R Parnell (University of Otago, New Zealand)*; Mahboubeh Parsaeian (Tehran University of Medical Sciences, Iran)*; Patrick Pasquet (UMR CNRS-MNHN 7206, France)*; Nikhil D Patel (Jivandeep Hospital, India)*; Halyna Pavlyshyn (I Horbachevsky Ternopil National Medical University, Ukraine)*; Ivan Pećin (University Hospital Center Zagreb, Croatia)*; Mangesh S Pednekar (Healis-Sekhsaria Institute for Public Health, India)*; João M Pedro (Centro de Investigação em Saúde de Angola, Angola)*; Nasheeta Peer (South African Medical Research Council, South Africa)*; Sergio Viana Peixoto (Oswaldo Cruz Foundation Rene Rachou Research Institute, Brazil)*; Markku Peltonen (Finnish Institute

for Health and Welfare, Finland)*; Alexandre C Pereira (University of São Paulo, Brazil)*; Karen GDA Peres (Griffith University, Australia)*; Marco A Peres (National Dental Care Centre Singapore, Singapore)*; Annette Peters (Helmholtz Zentrum München, Germany)*; Janina Petkeviciene (Lithuanian University of Health Sciences, Lithuania)*; Niloofar Peykari (Ministry of Health and Medical Education, Iran)*; Son Thai Pham (Vietnam National Heart Institute, Vietnam)*; Rafael N Pichardo (Clínica de Medicina Avanzada Dr. Abel González, Dominican Republic)*; Iris Pigeot (Leibniz Institute for Prevention Research and Epidemiology—BIPS, Germany)*; Hynek Pikhart (University College London, UK)*; Aida Pilav (University of Sarajevo, Bosnia and Herzegovina)*; Lorenza Pilotto (Cardiovascular Prevention Centre Udine, Italy)*; Freda Pitakaka (Ministry of Health and Medical Services, Solomon Islands)*; Aleksandra Piwonska (National Institute of Cardiology, Poland)*; Andrea n Pizarro (University of Porto, Portugal)*; Pedro Plans-Rubió (Public Health Agency of Catalonia, Spain)*; Ozren Polašek (University of Split, Croatia)*; Miquel Porta (Institut Hospital del Mar d'Investigacions Mèdiques, Spain)*; Anil Poudyal (Nepal Health Research Council, Nepal)*; Farhad Pourfarzi (Ardabil University of Medical Sciences, Iran)*; Akram Pourshams (Tehran University of Medical Sciences, Iran)*; Hossein Poustchi (Tehran University of Medical Sciences, Iran)*; Rajendra Pradeepa (Madras Diabetes Research Foundation, India)*; Alison J Price (London School of Hygiene & Tropical Medicine, UK)*; Jacqueline F Price (University of Edinburgh, UK)*; Rui Providencia (University College London, UK)*; Soile E Puhakka (University of Oulu, Finland; Oulu Deaconess Institute Foundation, Finland)*; Maria Puiu (Victor Babes University of Medicine and Pharmacy Timisoara, Romania)*; Margus Punab (Tartu University Clinics, Estonia)*; Radwan F Qasrawi (Al-Quds University, Palestine)*; Mostafa Qorbani (Alborz University of Medical Sciences, Iran)*; Daniel Queiroz (Federal University of Pernambuco, Brazil)*; Tran Quoc Bao (Ministry of Health, Vietnam)*; Ivana Radić (University of Novi Sad, Serbia)*; Ricardas Radisauskas (Lithuanian University of Health Sciences, Lithuania)*; Salar Rahimikazerooni (Shiraz University of Medical Sciences, Iran)*; Mahfuzar Rahman (Pure Earth, Bangladesh)*; Olli Raitakari (University of Turku, Finland)*; Manu Raj (Amrita Institute of Medical Sciences, India)*; Ellina M Rakhimova (Ufa Eye Research Institute, Russia)*; Sudha Ramachandra Rao (National Institute of Epidemiology, India)*; Ambady Ramachandran (India Diabetes Research Foundation, India)*; Elisabete Ramos (University of Porto Medical School, Portugal)*; Lekhraj Rampal (Universiti Putra Malaysia, Malaysia)*; Sanjay Rampal (University of Malaya, Malaysia)*; Daniel A Rangel Reina (Instituto Conmemorativo Gorgas de Estudios de la Salud, Panama)*; Vayia Rarra (Sotiria Hospital, Greece)*; Cassiano Ricardo Rech (Federal University of Santa Catarina, Brazil)*; Josep Redon (University of Valencia, Spain)*; Paul Ferdinand M Reganit (University of the Philippines, Philippines)*; Valéria Regecová (Slovak Academy of Sciences, Slovakia)*; Luis Revilla (Universidad San Martín de Porres, Peru)*; Abbas Rezaianzadeh (Shiraz University of Medical Sciences, Iran)*; Robespierre Ribeiro (Minas Gerais State Secretariat for Health, Brazil; deceased)*; Elio Riboli (Imperial College London, UK)*; Adrian Richter (University Medicine Greifswald, Germany)*; Fernando Rigo (CS S. 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Maria Ruiz-Castell (Luxembourg Institute of Health, Luxembourg)*; Iuliia A Rusakova (Ufa Eye Research Institute, Russia)*; Paola Russo (National Research Council, Italy)*; Marcin Rutkowski (Medical University of Gdansk, Poland)*; Charumathi Sabanayagam (Singapore Eye Research Institute, Singapore)*; Hamideh Sabbaghi (Shahid Beheshti University of Medical Sciences, Iran)*; Harshpal S Sachdev (Sitaram Bhartia Institute of Science and Research, India)*; Alireza Sadjadi (Tehran University of Medical Sciences, Iran)*; Ali Reza Safarpour (Shiraz University of Medical Sciences, Iran)*; Sare Safi (Shahid Beheshti University of Medical Sciences, Iran)*; Saeid Safiri (Tabriz University of Medical Sciences, Iran)*; Olfa Saidi (University Tunis El Manar, Tunisia)*; Sibel Sakarya (Koç University, Turkey)*; Nader Saki (Ahvaz Jundishapur University of Medical Sciences, Iran)*; Benoit Salanave (French Public Health Agency, France)*; Eduardo Salazar Martinez (National Institute of Public Health, Mexico)*; Diego Salmerón (CIBER en Epidemiología y Salud Pública, Spain)*; Veikko Salomaa (Finnish Institute for Health and Welfare, Finland)*; Jukka T Salonen (University of Helsinki, Finland)*; Massimo Salvetti (University of Brescia, Italy)*; Jose Sánchez-Abanto (National Institute of Health, Peru)*; Susana Sans (Catalan Department of Health, Spain)*; Diana A Santos (Universidade de Lisboa, Portugal)*; Ina S Santos (Federal University of Pelotas, Brazil)*; Lélita C Santos (Coimbra University Hospital Center, Portugal)*; Maria Paula Santos (University of Porto, Portugal)*; Rute Santos (University of Porto, Portugal)*; Jouko L Saramies (South Karelia Social and Health Care District, Finland)*; Luis B Sardinha (Universidade de Lisboa, Portugal)*; Giselle Sarganas (German Centre for Cardiovascular Research, Germany; Robert Koch Institute, Germany)*; Nizal Sarrafzadegan (Isfahan Cardiovascular Research Center, Iran)*; Thirunavukkarasu Sathish (McMaster University, Canada)*; Kai-Uwe Saum (German Cancer Research Center, Germany)*; Savvas Savva (Research and Education Institute of Child Health, Cyprus)*; Norie Sawada (National Cancer Center, Japan)*; Mariana Sbaraini (Universidade Federal do Rio Grande do Sul, Brazil)*; Marcia Scazufca (University of São Paulo Clinics Hospital, Brazil)*; Beatriz D Schaan (Universidade Federal do Rio Grande do Sul, Brazil)*; Herman Schargrodsky (Hospital Italiano de Buenos Aires, Argentina)*; Sabine Schipf (University Medicine Greifswald, Germany)*; Carsten O Schmidt (University Medicine Greifswald, Germany)*; Peter Schnohr (Copenhagen University Hospital, Denmark)*; Ben Schöttker (German Cancer Research Center, Germany)*; Sara Schramm (University of Duisburg-Essen, Germany)*; Constance Schultsz (Academic Medical Center of University of Amsterdam, Netherlands)*; Aletta E Schutte (University of New South Wales, Australia; The George Institute for Global Health, Australia)*; Sylvain Sebert (University of Oulu, Finland)*; Aye Aye Sein (Ministry of Health and Sports, Myanmar)*; Abhijit Sen (Center for Oral Health Services and Research Mid-Norway, Norway)*; Idowu O Senbanjo (Lagos State University College of Medicine, Nigeria)*; Sadaf G Sepanlou (Tehran University of Medical Sciences, Iran)*; Jennifer Servais (Statistics Canada, Canada)*; Svetlana A Shalnova (National Medical Research Centre for Therapy and Preventive Medicine, Russia)*; Teresa Shamah-Levy (National Institute of Public Health, Mexico)*; Morteza Shamshirgaran (Neyshabur University of Medical Sciences, Iran)*; Coimbatore Subramaniam Shanthirani (Madras Diabetes Research Foundation, India)*; Maryam Sharafkhan (Tehran University of Medical Sciences, Iran)*; Sanjib K Sharma (B P Koirala Institute of Health Sciences, Nepal)*; Jonathan E Shaw (Baker Heart and Diabetes Institute, Australia)*; Amaneh Shayanrad (Tehran University of Medical Sciences, Iran)*; Ali Akbar Shayesteh (Ahvaz Jundishapur University of Medical Sciences, Iran)*; Zumin Shi (Qatar University, Qatar)*; Kenji Shibuya (King's College London, UK)*; Hana Shimizu-Furusawa (Nippon Medical School, Japan)*; Dong Wook Shin (Sungkyunkwan University, South Korea)*; Majid Shirani (Shahrekord University of Medical Sciences, Iran)*; Rahman Shiri (Finnish Institute of Occupational Health, Finland)*; Namuna Shrestha (Public Health Promotion and Development Organization, Nepal)*; Khairil Si-Ramlee (Ministry of Health, Brunei)*; Alfonso Siani (National Research Council, Italy)*; Rosalynn Siantar (Singapore Eye Research Institute, Singapore)*; Abl M Sibai (American University of Beirut, Lebanon)*; Caroline Ramos de Moura Silva (University of Pernambuco, Brazil)*; Diego Augusto Santos Silva (Federal University of Santa Catarina, Brazil)*; Mary Simon (India Diabetes Research Foundation, India)*; Judith Simons (St Vincent's Hospital, Australia)*; Leon A Simons

(University of New South Wales, Australia)*; Michael Sjöström (Karolinska Institutet, Sweden; deceased)*; Jolanta Slowikowska-Hilczek (Medical University of Lodz, Poland)*; Przemyslaw Slusarczyk (International Institute of Molecular and Cell Biology, Poland)*; Liam Smeeth (London School of Hygiene & Tropical Medicine, UK)*; Hung-Kwan So (University of Hong Kong, China)*; Fernanda Cunha Soares (University of Pernambuco, Brazil)*; Eugène Sobngwi (University of Yaoundé 1, Cameroon)*; Stefan Söderberg (Umeå University, Sweden)*; Agustinus Soemantri (Diponegoro University, Indonesia; deceased)*; Reecha Sofat (University College London, UK)*; Vincenzo Solfrizzi (University of Bari, Italy)*; Mohammad Hossein Somi (Tabriz University of Medical Sciences, Iran)*; Emily Sonstedt (Lund University, Sweden)*; Yi Song (Peking University, China)*; Thorkild IA Sørensen (University of Copenhagen, Denmark)*; Elin P Sørgerd (Norwegian University of Science and Technology, Norway)*; Maroje Sorić (University of Zagreb, Croatia)*; 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Maria Wany Strufaldi (Federal University of São Paulo, Brazil)*; Machi Suka (The Jikei University School of Medicine, Japan)*; Chien-An Sun (Fu Jen Catholic University, Taiwan)*; Johan Sundström (Uppsala University, Sweden)*; Yn-Tz Sung (The Chinese University of Hong Kong, China)*; Paibul Suriyawongpaisal (Mahidol University, Thailand)*; Rody G Sy (University of the Philippines, Philippines)*; Holly E Syddall (University of Southampton, UK)*; René Charles Sylva (National Statistical Office, Cape Verde)*; Moyses Szklo (Johns Hopkins Bloomberg School of Public Health, USA)*; E Shyong Tai (National University of Singapore, Singapore)*; Mari-Liis Tammeo (University of Tartu, Estonia)*; Abdonas Tamosiunas (Lithuanian University of Health Sciences, Lithuania)*; Eng Joo Tan (Deakin University, Australia)*; Xun Tang (Peking University, China)*; Frank Tanser (University of Lincoln, UK)*; Yong Tao (Peking University, China)*; Mohammed Rasoul Tarawneh (Ministry of Health, Jordan)*; Carolina B Tarqui-Mamani (National Institute of Health, Peru)*; Anne Taylor (University of Adelaide, Australia)*; Julie Taylor (University College London, UK)*; William R Tebar (Universidade Estadual Paulista, Brazil)*; Grethe S Tell (University of Bergen, Norway)*; Tania Tello (Universidad Peruana Cayetano Heredia, Peru)*; Yih Chung Tham (Singapore Eye Research Institute, Singapore)*; K R Thankappan (Central University of Kerala, India)*; Holger Theobald (Karolinska Institutet, Sweden)*; Xenophon Theodoridis (Aristotle University of Thessaloniki, Greece)*; Lutgarde Thijs (University of Leuven, Belgium)*; Mikael Thinggaard (University of Southern Denmark, Denmark)*; Nihal Thomas (Christian Medical College Vellore, India)*; Barbara Thorand (Helmholtz Zentrum München, Germany)*; Betina H Thuesen (Bispebjerg and Frederiksberg Hospital, Denmark)*; Erik J Timmermans (Amsterdam Public Health Research Institute, Netherlands)*; Dwi H Tjandrarini (National Institute of Health Research and Development, Indonesia)*; Anne Tjønneland (Danish Cancer Society Research Center, Denmark)*; Ulla Toft (Bispebjerg and Frederiksberg Hospital, Denmark)*; Hanna K Tolonen (Finnish Institute for Health and Welfare, Finland)*; Janne S Tolstrup (University of Southern Denmark, Denmark)*; Murat Topbas (Karadeniz Technical University, Turkey)*; Roman Topór-Madry (Jagiellonian University Medical College, Poland)*; María José Tormo (Health Service of Murcia, Spain)*; Michael J Tornaritis (Research and Education Institute of Child Health, Cyprus)*; Maties Torrent (Institut d'Investigació Sanitària Illes Balears, Spain)*; Laura Torres-Collado (CIBER en Epidemiología y Salud Pública, Spain)*; Giota Touloumi (National and Kapodistrian University of Athens, Greece)*; Pierre Traissac (French National Research Institute for Sustainable Development, France)*; Areti Triantafyllou (Aristotle University of Thessaloniki, Greece)*; Dimitrios Trichopoulos (Harvard T H Chan School of Public Health, USA; deceased)*; Antonia Trichopoulou (Hellenic Health Foundation, Greece)*; Oanh TH Trinh (University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam)*; Atul Trivedi (Government Medical College, India)*; Lechaba Tshepo (Sefako Makgatho Health Science University, South Africa)*; Shoichiro Tsugane (National Cancer Center, Japan)*; Azaliya M Tuliakova (Ufa Eye Research Institute, Russia)*; Marshall K Tulloch-Reid (The University of the West Indies, Jamaica)*; Fikru Tullu (Addis Ababa University, Ethiopia)*; Tomi-Pekka Tuomainen (University of Eastern Finland, Finland)*; Jaakko Tuomilehto (Finnish Institute for Health and Welfare, Finland)*; Maria L Turley (Ministry of Health, New Zealand)*; Gilad Twig (Tel-Aviv University, Israel; Israel Defense Forces Medical Corps, Israel)*; Per Tynelius (Karolinska Institutet, Sweden)*; Christophe Tzourio (University of Bordeaux, France)*; Peter Ueda (Karolinska Institutet, Sweden)*; Eunice Ugel (Universidad Centro-Occidental Lisandro Alvarado, Venezuela)*; Hanno Ulmer (Medical University of Innsbruck, Austria)*; Hannu MT Uusitalo (University of Tampere Tays Eye Center, Finland)*; Gonzalo Valdivia (Pontificia Universidad Católica de Chile, Chile)*; Damaskini Valvi (Icahn School of Medicine at Mount Sinai, USA)*; Rob M van den Born (National University of Singapore, Singapore)*; Bert-Jan van den Born (University of Amsterdam, Netherlands)*; Johan Van der Heyden (Sciensano, Belgium)*; Yvonne T van der Schouw (Utrecht University, Netherlands)*; Koen Van Herck (Ghent University, Belgium)*; Hoang Van Minh (Hanoi University of Public Health, Vietnam)*; Natasja M Van Schoor (VU University Medical Center, Netherlands)*; Irene GM van Valkengoed (University of Amsterdam, Netherlands)*; Elisabeth M van Zutphen (VU University Medical Center, Netherlands)*; Dirk Vanderschueren (Katholieke Universiteit Leuven, Belgium)*; Diego Vanuzzo (Cardiovascular Prevention Centre Udine, Italy)*; Anette Varbo (Copenhagen University Hospital, Denmark; University of Copenhagen, Denmark)*; Senthil K Vasan (University of Southampton, UK)*; Tomas Vega (Consejería de Sanidad Junta de Castilla y León, Spain)*; Toomas Veidebaum (National Institute for Health Development, Estonia)*; Gustavo Velasquez-Melendez (Universidade Federal de Minas Gerais, Brazil)*; Giovanni Veronesi (University of Insubria, Italy)*; WM Monique Verschuren (National Institute for Public Health and the Environment, Netherlands)*; Roosmarijn Verstraeten (Institute of Tropical Medicine, Belgium)*; Cesar G Victora (Federal University of Pelotas, Brazil)*; Lucie Viet (National Institute for Public Health and the Environment, Netherlands)*; Salvador Villalpando (National Institute of Public Health, Mexico)*; Paolo Vineis (Imperial College London, UK)*; Jesus Vioque (University Miguel Hernandez, Spain)*; Jyrki K Virtanen (University of Eastern Finland, Finland)*; Sophie Visvikis-Siest (Université de Lorraine, France)*; Bharathi Viswanathan (Ministry of Health, Seychelles)*; Tiina Vlasoff (North Karelia Center for Public Health, Finland)*; Peter Vollenweider (Lausanne University Hospital, Switzerland; University of Lausanne, Switzerland)*; Ari Voutilainen (University of Eastern Finland, Finland)*; Alisha N Wade (University of the Witwatersrand, South Africa)*; Janette Walton (Munster Technological University, Ireland)*; Elvis OA Wambiya (African Population and Health Research Center, Kenya)*; Wan Mohamad Wan Bekar (Universiti Sains Malaysia, Malaysia)*; Wan Nazaimoon Wan Mohamad (Institute for Medical Research, Malaysia)*; Rildo de Souza Wanderley Junior (University of Pernambuco, Brazil)*; Ming-Dong Wang (Public Health Agency of Canada, Canada)*; Ningli Wang (Capital Medical University Beijing Tongren Hospital, China)*; Qian Wang (Xinjiang Medical University, China)*; Xiangjun Wang (Shanghai Educational Development Co Ltd, China)*; Ya Xing Wang (Capital Medical University, China)*; Ying-Wei Wang (Ministry of Health and Welfare, Taiwan)*; S Goya Wannamethee (University College London, UK)*; Nicholas Wareham (University of Cambridge, UK)*; Wenbin Wei (Capital Medical University, China)*; Aneta Weres (University of Rzeszów, Poland)*; Bo Werner (Örebro University, Sweden)*; Peter H Whincup (St George's, University of London, UK)*;

Kurt Widhalm (Medical University of Vienna, Austria)*; Indah S Widyahening (Universitas Indonesia, Indonesia)*; Andrzej Wiecek (Medical University of Silesia, Poland)*; Rainford J Wilks (The University of the West Indies, Jamaica)*; Johann Willeit (Medical University of Innsbruck, Austria)*; Peter Willeit (Medical University of Innsbruck, Austria)*; Emmanuel A Williams (Komfo Anokye Teaching Hospital, Ghana)*; Tom Wilsgaard (UiT The Arctic University of Norway, Norway)*; Bogdan Wojtyniak (National Institute of Public Health - National Institute of Hygiene, Poland)*; Roy A Wong-McClure (Caja Costarricense de Seguro Social, Costa Rica)*; Andrew Wong (University College London, UK)*; Tien Yin Wong (Duke-NUS Medical School, Singapore)*; Jean Woo (The Chinese University of Hong Kong, China)*; Mark Woodward (University of New South Wales, Australia; Imperial College London, UK)*; Frederick C Wu (University of Manchester, UK)*; Shouling Wu (Kailuan General Hospital, China)*; Justyna Wyszynska (University of Rzeszów, Poland)*; Haiquan Xu (Institute of Food and Nutrition Development of Ministry of Agriculture and Rural Affairs, China)*; Liang Xu (Beijing Institute of Ophthalmology, China)*; Nor Azwany Yaacob (Universiti Sains Malaysia, Malaysia)*; Weili Yan (Children's Hospital of Fudan University, China)*; Ling Yang (University of Oxford, UK)*; Xiaoguang Yang (Chinese Center for Disease Control and Prevention, China)*; Yang Yang (Shanghai Educational Development, China)*; Tabara Yasuharu (Kyoto University, Japan)*; Xingwang Ye (Shanghai Institute of Nutrition and Health, China)*; Panayiotis K Yiallourou (University of Cyprus, Cyprus)*; Moein Yoosefi (Non-Communicable Diseases Research Center, Iran)*; Akihiro Yoshihara (Niigata University, Japan)*; San-Lin You (Fu Jen Catholic University, Taiwan)*; Novie O Younger-Coleman (The University of the West Indies, Jamaica)*; Ahmad Faudzi Yusoff (Ministry of Health, Malaysia)*; Ahmad A Zainuddin (Ministry of Health, Malaysia)*; Seyed Rasoul Zakavi (Mashhad University of Medical Sciences, Iran)*; Farhad Zamani (Iran University of Medical Sciences, Iran)*; Sabina Zambon (University of Padua, Italy)*; Antonis Zampelas (Agricultural University of Athens, Greece)*; Maria Elisa Zapata (Centro de Estudios sobre Nutrición Infantil, Argentina)*; Ko Ko Zaw (University of Public Health, Myanmar)*; Tomasz Zdrojewski (Medical University of Gdansk, Poland)*; Kristyna Zejglicova (National Institute of Public Health, Czech Republic)*; Tajana Zeljkovic Vrkic (University Hospital Center Zagreb, Croatia)*; Yi Zeng (Peking University, China; Duke University, USA)*; Luxia Zhang (Peking University First Hospital, China)*; Zhen-Yu Zhang (University of Leuven, Belgium)*; Dong Zhao (Capital Medical University Beijing An Zhen Hospital, China)*; Ming-Hui Zhao (Peking University First Hospital, China)*; Shiqi Zhen (Jiangsu Provincial Center for Disease Control and Prevention, China)*; Yingfeng Zheng (Sun Yat-sen University, China)*; Bekbolat Zholdin (West Kazakhstan Medical University, Kazakhstan)*; Dan Zhu (Inner Mongolia Medical University, China)*; Marie Zins (Institut National de la Santé et de la Recherche Médicale, France; Paris University, France)*; Emanuel Zitt (Agency for Preventive and Social Medicine, Austria)*; Yanina Zocalo (Universidad de la República, Uruguay)*; Nada Zoghalmi (National Institute of Public Health, Tunisia)*; Julio Zuñiga Cisneros (Instituto Conmemorativo Gorgas de Estudios de la Salud, Panama)*.

Declaration of interests

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Data sharing

Computer code and age-standardised and crude results of this study can be downloaded from <https://www.ncdrisc.org> and age-specific results can

be requested via the same website. The input data are available at <https://www.ncdrisc.org> when permitted by data governance and sharing arrangements; contact information is provided for other data sources.

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