May Measurement Month 2018: results of blood pressure screening from 41 countries

Neil R. Poulter1*, Claudio Borghi2, Dylan Burger3, Rafael R. Castillo4, Albertino Damasceno5, Sadayoshi Ito6, Arun P. Jose7, Ruan Kruger8, Trefor Morgan9, Peter M. Nilsson10, Markus P. Schlaich11, Aletta E. Schutte8, George Stergiou12, Thomas Unger13, Richard D. Wainford14, and Thomas Beaney1,15*

1Imperial Clinical Trials Unit, Imperial College London, Stadium House, 68 Wood Lane, London W12 7RH, UK; 2Dipartimento Cardio-Toraco-Vascolare, Università di Bologna, S. Orsola-Malpighi University Hospital, Via Albertioni 15, Bologna 40138, Italy; 3Kidney Research Centre, Ottawa Hospital Research Institute, University of Ottawa, 2513-451 Smyth Rd., Ottawa, ON K1H 8M5, Canada; 4Section of Cardiology, Department of Internal Medicine, Manila Doctors’ Hospital, 667 United Nations Ave., Ermita, Manila 1000, Philippines; 5Department of Medicine, Faculty of Medicine, Eduardo Mondlane University, Av. Salvador Allende 702, Maputo, Mozambique; 6Department of Medicine, Katta General Hospital, 36 Shimoharaoki Kuramoto Fukuoka, Shiroishi, 989-0231, Japan; 7Centre for Chronic Conditions and Injuries, Public Health Foundation of India, Plot 47, Sector 44, Gurugram, Haryana 122002, India; 8Hypertension in Africa Research Team (HART), MRC Unit for Hypertension and Cardiovascular Disease, North-West University, Hoffman Street, Potchefstroom 2520, South Africa; 9Department of Physiology, University of Melbourne, Melbourne, VIC 3010, Australia; 10Department of Clinical Sciences, Lund University, Skane University Hospital, Malmö S-20502, Sweden; 11Dobney Hypertension Centre, School of Medicine - Royal Perth Hospital Unit, The University of Western Australia, Level 3m MRF Building, Rear 50 Murray St, Perth, WA 6000, Australia; 12Third Department of Medicine, Hypertension Center STRIDE-7, National and Kapodistrian University of Athens, School of Medicine, Sotiria Hospital, 152 Mesogion Avenue, Athens 11527, Greece; 13CARIM School for Cardiovascular Diseases, Maastricht University, Minderbroedersberg 4-6, 6211, LH Maastricht, Netherlands; 14Department of Pharmacology & Experimental Therapeutics and The Whitaker Cardiovascular Institute, Boston University School of Medicine, 72 East Concord St, Boston, MA 02118, USA; and 15Department of Primary Care and Public Health, Imperial College London, St Dunstan’s Road, London W6 8RP, UK

Background

In May 2017, the International Society of Hypertension (ISH) introduced the first in a series of annual blood pressure (BP) screening programmes with the simple aim of raising awareness of the importance of raised BP as the single biggest contributor to the global burden of disease and to global mortality.1 After the success of this initial May Measurement Month (MMM) campaign—which included over 1.2 million screenees from 80 countries,2 MMM expanded in 2018 and again in 2019. The global results of MMM17 and MMM18 have been
published elsewhere and the national data from 39 of 40 countries who screened at least 2500 adults in 2017 were collated as a European Heart Journal (EHJ) Supplement. Here, we present a second collation of data from 41 countries with the highest number of participants who took part in MMM18.

**MMM18 summary**

The methods and results of MMM18 were published in full elsewhere. As in 2017, the MMM18 campaign was a cross-sectional opportunistic survey of the BPs of adults (aged ≥18 years) who wished to take part. Three sitting BPs were measured on each screenee in any of a wide range of locations from places of worship to hospital premises. Limited data on social, demographic, and lifestyle variables were also recorded and for those whose BPs (using the mean of the second and third reading) were deemed potentially in the hypertensive range (systolic ≥140 mmHg and/or diastolic ≥90 mmHg) were given non-pharmaceutical advice to lower their BP and advised to seek further BP recordings on a time scale depending on the degree of BP elevation and the availability of local healthcare facilities.

Over 1.5 million adults were screened in 89 countries of whom 33.4% were considered hypertensive (BPs in the hypertensive range and/or on antihypertensive medication to lower BP). Among the hypertensive population, 55.3% were on antihypertensive medication and of those 60.0% had their BPs controlled to <140 mmHg systolic and <90 mmHg diastolic. Therefore, of 502,079 hypertensive adults identified overall, 33.2% had their BPs controlled and over one-third of a million adults were identified with either untreated or inadequately treated raised BP. MMM18 was the largest synchronized and standardized survey of any cardiovascular risk factor ever to take place (with MMM17 the next largest!). The vast majority of those screened in MMM18 were new to MMM, with only 7.0% having participated in MMM17. Furthermore, over half a million people (518,168) reported never having had a BP measurement taken before the campaign.

### Methodological issues

Usually for logistical reasons, the data on some variables in some countries were insufficient in quality or number for analyses to provide reasonably valid results and hence they were not carried out.

However, even when carried out, given 41 separate national analyses chance alone would predict two significantly inconsistent results when compared with the global analyses. Hence, comparisons across countries should only be made with extreme caution.

Importantly, three seated BP measurements could not always be taken and so multiple imputation based on the global data was used to generate the mean of the second and third BP readings in the analyses, for the 375,427 people (25.2%) for whom the mean readings were not available. Our previous analyses showed that this combination of readings gave the most conservative estimate of hypertension prevalence which is likely to be spuriously elevated when based on a single set of readings.

For these national-level analyses, we have used the same imputed data from the global analyses which may result in an ‘averaging’ of any country-specific effects, as for many countries, there were insufficient data to allow individual imputations. Two imputation models were run: a full model requiring complete information on participants age, sex, ethnicity, and use of antihypertensive medication, and where one or more of these were missing, a reduced model, requiring only individual BP readings. Imputations using the two models were combined, and sensitivity analyses showed only small differences between the results using each model.

The national data presented in this supplement tend to give focus to those measures of association which differ from the reported global findings despite the cautions outlined above. Meanwhile less focus is placed on those associations—particularly those between BP and age, sex, and body mass index—that are essentially consistent across countries and with the global results.

### Challenges for MMM18

Having carried out MMM17, the set up and running of MMM18 was less time-pressured and was easier to conduct at both local and central levels. Most national coordinators and volunteer staff in each country were already in place from MMM17 (and prepared to be involved again) but even so, ethical clearance remained a major hurdle in some countries. Similarly, the distribution of the BP machines, kindly donated by OMRON Healthcare, caused variably large difficulties associated with customs charges and delays in delivery.

Data collection and delivery for central analyses were greatly improved in terms of quality and quantity compared with MMM17. However, the use of the MMM App (available on Windows and Mac computers, Android, and Apple mobile devices, as well as a web-based browser) remained low at 12.4% and central data cleaning remained a large task, taking several months. Consequently, once again we were only able to lock the database and initiate
the full analyses in October 2018—nominally 5 months after MMM18 ended.

Limitations of MMM

Feedback from local investigators who participated in MMM17 included a request not to extend the amount of data collected from each participant due to the extra time needed during the screening. Consequently, data from MMM18 remain limited to BP and heart rate measurements and self-reported observations, while blood and urine sampling or more sophisticated measurements of obesity, for example, were beyond the capacity of the personnel and budget for the campaign.

For similar reasons and also by design, the samples screened were not randomly selected and therefore not necessarily representative of the general population from which they were drawn. While standardizing of results could partially account for differences in the age and sex distributions amongst those screened in each country, there is likely to be residual confounding, most notably a

| Country                  | Total participants 2017 | Total participants 2018 | Number with hypertension | Proportion with hypertension (%) | Proportion of hypertensives aware (%) | Proportion of hypertensives on medication (%) | Proportion of those on medication with uncontrolled BP (%) |
|--------------------------|-------------------------|-------------------------|--------------------------|----------------------------------|---------------------------------------|------------------------------------------------------|----------------------------------------------------------|
| India                    | 122 685                 | 345 234                 | 111 462                  | 32.3                             | 56.9                                  | 55.3                                                 | 25.3                                                     |
| China                    | 125 236                 | 288 342                 | 85 835                   | 29.8                             | 62.3                                  | 57.3                                                 | 37.4                                                     |
| Philippines              | 271 604                 | 177 176                 | 69 126                   | 39.0                             | 50.3                                  | 49.9                                                 | 42.0                                                     |
| Indonesia                | 69 307                  | 91 222                  | 27 331                   | 30.0                             | 47.6                                  | 47.4                                                 | 78.0                                                     |
| Argentina                | 32 346                  | 70 418                  | 30 851                   | 43.8                             | 77.7                                  | 69.1                                                 | 44.0                                                     |
| Kenya                    | 14 847                  | 49 548                  | 84 69                   | 17.1                             | 30.7                                  | 26.6                                                 | 51.0                                                     |
| Sudan                    | 44 413                  | 40 779                  | 11 497                   | 28.2                             | 20.7                                  | 18.2                                                 | 45.4                                                     |
| Colombia                 | 22 258                  | 35 548                  | 94 75                   | 26.7                             | 69.9                                  | 65.0                                                 | 33.7                                                     |
| United Arab Emirates     | 6193                    | 31 316                  | 6243                     | 19.9                             | 40.7                                  | 37.3                                                 | 39.4                                                     |
| Venezuela                | 21 645                  | 28 649                  | 13 861                   | 48.4                             | 87.7                                  | 82.6                                                 | 33.7                                                     |
| Pakistan                 | 5333                    | 25 076                  | 14 641                   | 58.4                             | 79.9                                  | 73.5                                                 | 51.4                                                     |
| Armenia                  | 9199                    | 21 112                  | 8179                     | 38.7                             | 76.7                                  | 67.4                                                 | 52.9                                                     |
| Democratic Republic of Congo | Not included            | 18 719                  | 4885                     | 26.1                             | 46.3                                  | 29.6                                                 | 57.0                                                     |

| Vietnam                  | 10 993                  | 17 332                  | 5260                     | 30.3                             | 66.4                                  | 62.8                                                 | 46.6                                                     |
| Nepal                    | 5972                    | 15 561                  | 4321                     | 27.8                             | 49.9                                  | 39.1                                                 | 47.4                                                     |
| Taiwan                   | 52 514                  | 15 365                  | 7393                     | 48.1                             | 83.7                                  | 81.3                                                 | 32.3                                                     |
| Angola                   | 17 481                  | 14 433                  | 4844                     | 33.6                             | 54.2                                  | 46.3                                                 | 57.4                                                     |
| Oman                     | 934                     | 12 689                  | 3783                     | 29.8                             | 52.4                                  | 47.8                                                 | 34.9                                                     |
| Benin                    | 7260                    | 12 413                  | 8435                     | 67.9                             | 84.4                                  | 81.7                                                 | 40.3                                                     |
| Ecuador                  | 6984                    | 11 922                  | 4563                     | 38.3                             | 71.5                                  | 71.5                                                 | 28.6                                                     |
| Malawi                   | 4009                    | 10 791                  | 2404                     | 22.3                             | 14.7                                  | 12.6                                                 | 33.3                                                     |
| Georgia                  | 6144                    | 10 756                  | 6037                     | 56.1                             | 82.8                                  | 79.9                                                 | 61.8                                                     |
| Mexico                   | 1116                    | 10 139                  | 2187                     | 21.6                             | 42.0                                  | 38.0                                                 | 33.5                                                     |
| Chile                    | 4754                    | 9344                    | 2726                     | 29.2                             | 64.0                                  | 56.1                                                 | 38.0                                                     |
| Cameroon                 | 16 093                  | 8883                    | 1867                     | 21.0                             | 34.5                                  | 27.2                                                 | 52.2                                                     |
| Cabo Verde               | 2630                    | 8008                    | 2666                     | 33.3                             | 74.8                                  | 55.8                                                 | 60.9                                                     |
| Spain                    | 3849                    | 7646                    | 3058                     | 40.0                             | 74.4                                  | 69.6                                                 | 36.4                                                     |
| Libya                    | Not included            | 7279                    | 2567                     | 35.3                             | 63.4                                  | 55.8                                                 | 49.1                                                     |
| Albania                  | 1008                    | 7046                    | 2624                     | 37.2                             | 52.1                                  | 48.3                                                 | 49.6                                                     |
| Ghana                    | Not included            | 6907                    | 2354                     | 34.1                             | 48.4                                  | 35.2                                                 | 52.2                                                     |
| Poland                   | 5834                    | 6450                    | 2114                     | 32.8                             | 61.3                                  | 53.1                                                 | 39.2                                                     |
| Nigeria                  | 19 904                  | 6398                    | 2328                     | 36.4                             | 51.1                                  | 41.8                                                 | 56.9                                                     |
| Republic of the Congo    | 3842                    | 6169                    | 1371                     | 22.2                             | 40.2                                  | 36.0                                                 | 55.5                                                     |
| Italy                    | 10 076                  | 5554                    | 1462                     | 26.3                             | a                                     | a                                                    | a                                                         |
| Mauritius                | 2302                    | 5471                    | 786                      | 14.4                             | a                                     | a                                                    | a                                                         |
| Bangladesh               | 11 418                  | 5208                    | 1750                     | 33.6                             | 75.0                                  | 64.7                                                 | 33.6                                                     |
| United Kingdom and Ireland | 7714                    | 5000                    | 1716                     | 34.3                             | 51.3                                  | 42.8                                                 | 48.5                                                     |
| Slovenia                  | Not included            | 4883                    | 2841                     | 58.2                             | 78.4                                  | 70.1                                                 | 51.5                                                     |
| Malaysia                 | 4116                    | 4866                    | 1405                     | 28.9                             | 76.3                                  | 71.0                                                 | 37.0                                                     |
| Botswana                 | 1657                    | 4599                    | 1510                     | 32.8                             | 47.1                                  | 35.2                                                 | 45.6                                                     |
| Australia                | 3817                    | 3352                    | 1026                     | 30.6                             | 49.0                                  | 40.5                                                 | 57.1                                                     |
| South Africa             | 3250                    | 2965                    | 1025                     | 34.6                             | 56.7                                  | 49.2                                                 | 42.5                                                     |

*aUse of antihypertensive medication not recorded for these countries.*
selection bias resulting from the recruitment method and a potential favouring of those with pre-existing hypertension or with greater hypertensive awareness, to participate. Consequently, in order not to mislead that the proportions found to be hypertensive, or on treatment for hypertension may be directly comparable, we present in each paper the unadjusted proportions within each country.

It might, however, be less unreasonable to compare control rates among treated patients, since, by stratifying on one of the major confounding factors, we may reduce some of the sampling bias. These potential shortcomings notwithstanding, as in the MMM17 national analyses, it is remarkable how often the various measures of hypertension detection and management are similar to previously available representative data.

A clear limitation of MMM, as a cross-sectional study, is the lack of definitive evidence of benefit for those individuals identified as having raised BP either on or off antihypertensive medication. The cost and logistic implications of incorporating follow-up of these screenees on such a large scale pre-empt our being able to do so. However, we know that about one-third of a million adults were given non-pharmacological lifestyle and dietary advice to lower their BPs and advised to obtain further follow-up of their BP measurement. We also know that MMM has generated significant coverage in traditional and social media outlets, and hopefully this will translate into increased awareness, treatment, and control and thereby reduced BP-associated disease burden.

Prospects for the MMM campaign

Both the numbers of countries and screenees involved with MMM have increased in each of the three annual campaigns to date. We plan to continue the campaign as long as funding can be raised with only small changes to the data collected each year. Meanwhile, we intend to use the MMM data for the development of documents designed to influence governments and health policymakers to improve the detection and management of raised BP at a national and international level.

Supplementary material

Supplementary material is available at European Heart Journal Supplements online.

Acknowledgements

Our sincere thanks to Judith Bunn (MMM Project Manager) and Ranjit Rayat (Editing Assistant) for their superb dedicated efforts towards this national supplement project. We should also like to thank the thousands of people who volunteered to help MMM18 to succeed. Without their selfless support, the impact of MMM would not have been achieved.

Funding

ISH provided most of the central funding for MMM18 with additional generous support from Servier Pharmaceutical Co. In addition, in 2017 OMRON Healthcare kindly donated 20 000 BP recording devices most of which were shipped out to MMM sites around the world in 2017 and 2018. Finally, our sincere thanks to all the national leaders and their teams in each collaborating country who raised funds to make MMM possible at a local level.

Conflict of interest: N.R.P. has received financial support from several pharmaceutical companies which manufacture BP-lowering agents, for consultancy fees (Servier), research projects and staff (Servier, Pfizer) and for arranging and speaking at educational meetings (AstraZeneca, LRI Therapharma, Napi, Servier, Sanofi, Eva Pharma, and Pfizer). He holds no stocks and shares in any such companies. R.R.C. is a member of advisory boards and speakers bureau of the Philippine affiliates of: Servier, Boehringer Ingelheim, Menarini, AstraZeneca, LRI Therapharma, UAP Pharma, Sanofi, Trianon International; chairman of For God’s Glory Foundation which receives medical donations from various Pharma companies for its medical missions. S.I. has received honorarium from Daiichi-Sankyo, Takeda, Boehringer Ingelheim, Kyowa-Kirin, Teijin Pharma. He holds no stocks. P.M.N. has lectured for several pharmaceutical companies (AstraZeneca Ltd, Boehringer-Ingelheim, Merck, Novo Nordisk A/S) but holds no stocks in such companies. M.P.S. is supported by an NHMRC Senior Research Fellowship and has received consulting fees, and/or travel and research support from Medtronic, Abbott, Novartis, Servier, Pfizer, and Boehringer-Ingelheim. A.E.S. received speaker honoraria from Omron Healthcare, Servier, Novartis, and Takeda, and serve on a research advisory board for Abbott Pharmaceuticals. G.S. has received research grants and consulting and lecturing fees from several pharmaceutical companies and manufactures of blood pressure measuring technologies, including AstraZeneca, Omron, Pfizer, Sanofi, and Servier. He has no stocks and shares in any such companies. The other authors declare no conflicts of interest.

References

1. GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018; 392:1923.
2. Beaney T, Schutte AE, Tomaszewski M, Arti C, Burrell LM, Castillo RR, Charchar FJ, Damasceno A, Kruger R, Lackland DT, Nilsson PM, Prabhakaran D, Ramirez AJ, Schlaich MP, Wang J-G, Weber MA, Poulter NR. May Measurement Month 2017: an analysis of blood pressure screening results worldwide. Lancet Global Health 2018; 6:736-743.
3. Beaney T, Burrell LM, Castillo RR, Charchar FJ, Cro S, Damasceno A, Kruger R, Nilsson PM, Prabhakaran D, Ramirez AJ, Schlaich MP, Schutte AE, Tomaszewski M, Touyz R, Wang J-G, Weber MA, Poulter NR. May Measurement Month 2018: a pragmatic global screening campaign to raise awareness of blood pressure by the International Society of Hypertension. Eur Heart J 2019;40:2006-2017.
4. Poulter NR, Borghi C, Castillo RR, Charchar FJ, Ramirez AJ, Schlaich MP, Schutte AE, Stergiou G, Unger T, Wainford RD, Beaney T. May Measurement Month 2017: results of 39 national blood pressure screening programmes. Eur Heart J Suppl 2019;21(Suppl D):D1-D132.