Hypertension care in demographic surveillance sites: a cross-sectional study in Bangladesh, India, Indonesia, Malaysia, Viet Nam

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Objective To determine the proportion of adults with hypertension who reported: (i) having been previously diagnosed with hypertension; (ii) taking blood pressure-lowering medication; and (iii) having achieved hypertension control, in five health and demographic surveillance system sites across five countries in Asia.

Methods Data were collected during household surveys conducted between 2016 and 2020 in the five surveillance sites in Bangladesh, India, Indonesia, Malaysia and Viet Nam. We defined hypertension as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg or taking blood pressure-lowering medication. We defined hypertension control as systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg. We disaggregated hypertension awareness, treatment and control by surveillance site, and within each site by sex, age group, education, body mass index and smoking status.

Findings Of 22,142 participants, 11,137 had hypertension (Bangladesh: 211; India: 487; Indonesia: 1641; Malaysia: 8164; and Viet Nam: 634). The mean age of participants with hypertension was 60 years (range: 19–101 years). Only in the Malaysian site were more than half of individuals with hypertension aware of their condition. Hypertension treatment ranged from 20.8% (341/1641; 95% CI: 18.8–22.8%) in the Indonesian site to 44.7% (3649/8164; 95% CI: 43.6–45.8%) in the Malaysian site. Less than one in four participants with hypertension had achieved hypertension control in any site. Hypertension awareness, treatment and control were generally higher among women and older adults.

Conclusion While hypertension awareness and treatment varied widely across surveillance sites, hypertension control was low in all sites.

Abstracts in العربية, 中文, Français, Русский и Español at the end of each article.

Introduction

We established the Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network to begin harmonizing data collection efforts and synthesize evidence on noncommunicable diseases across health and demographic surveillance system sites in Asia. Health and demographic surveillance systems are research sites that conduct ongoing detailed demographic and health surveillance of a geographically defined population.¹ These sites could play an important role in guiding the response of Asian countries to the growing burden of noncommunicable diseases.² Their regular surveillance of an entire geographically defined population could allow for unique and detailed insight into epidemiological and health services changes, including the effects on individuals, households and entire communities. In addition, their routine long-term follow-up and often rich data linkage to health system and administrative data could provide the ideal infrastructure for trialling interventions to prevent or treat noncommunicable diseases.

This joint analysis of the Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network focuses on the management of hypertension. Hypertension is a major cause of morbidity and mortality globally and increasingly in low- and middle-income countries.³ Diagnosing hypertension does not require expensive equipment or a laboratory,⁴ and the condition can be effectively treated using inexpensive medications with few side-effects.⁵ Six Monitoring and improving the diagnosis and management of hypertension should, thus, be a priority for health systems in low- and middle-income countries.

Understanding where individuals are lost in the care process from diagnosis to successful hypertension control can help inform which step in the care process should be prioritized for improvement. In addition, evidence on which population groups are more likely to achieve each of these care steps could inform the targeting of appropriate interventions. Therefore, this study aimed to determine: (i) the proportion of adults with hypertension living in each of the five health and demographic surveillance systems in our network (located in Bangladesh, India, Indonesia, Malaysia and Viet Nam) who were aware of their hypertension (i.e. had been previously diagnosed), reported taking medication to lower blood pressure, and had achieved control of their hypertension; and (ii) how these proportions varied within the population of each surveillance site by age, sex, body mass index (BMI) and smoking status.

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Methods

Data sources

The Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network includes the Chakaria surveillance system (Bangladesh), the Vadu surveillance systems (India), the Sleman surveillance system (Indonesia), the South East Asia Community Observatory (SEACO) surveillance system (Malaysia) and the Chililab surveillance system (Viet Nam). Table 1 gives an overview of the characteristics of each site. A detailed description of each surveillance system has been published separately. These sites were selected for the Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network, and hence this analysis because of their interest in engaging in data collection and harmonization efforts on noncommunicable diseases and to ensure coverage of a range of different settings in Asia (e.g. rural and urban areas).

Data for this analysis were collected in 2019–2020 in the Chakaria surveillance system, 2016 in the Vadu surveillance system, 2018 in the Sleman surveillance system, 2018–2019 in the SEACO surveillance system and 2017 in the Chililab surveillance system. Each surveillance system, with the exception of the SEACO system, used a two-stage cluster random sampling strategy to select participants. In the first stage, we sampled villages or neighbourhoods (the number sampled in each surveillance system is shown in Table 1) through either simple random sampling or sampling with probability proportionate to population size. Households were sampled in the second stage using systematic random sampling. The SEACO site sampled all households in five of 11 randomly selected subdistricts of the surveillance system. Each surveillance system sampled all adult household members, except for the Sleman site, which sampled (at random) one adult household member per household. The eligible age range for household members was 18 years and older in all five surveillance systems except for the SEACO site (35 years and older) and the Vadu site (30 years and older). During the interview with the participants, each surveillance system measured blood pressure three times in the left upper arm in a seated position using an automated digital blood pressure metre. The data collection teams left at least 1 minute between blood pressure measurements.
All the surveillance systems obtained approval from the relevant local research ethics committees before data collection. Hanoi University of Public Health gave approval for the Chililab surveillance system (017–352/DD-YTCC); the Ethics Review Committee of the International Centre for Diarrhoeal Disease Research, Bangladesh, gave approval for the Chakaria surveillance system (ACT00230); the Monash University Human Research Ethics Committee gave approval for the SEACO surveillance system (2018–13142–45226); the Medical and Health Research Ethics Committee of the Universitas Gadjah Mada gave approval for the Sleman surveillance system (KE/FK/0434/EC/2018); and the KEM Hospital Research Centre Institutional Ethics Committee gave approval for the Vadu surveillance system (KEMHRC/RVM/EC/733).

**Outcome variables**

In line with the World Health Organization’s (WHO) HEARTS guideline, hypertension was defined as having a systolic blood pressure of at least 140 mmHg or a diastolic blood pressure of at least 90 mmHg, or reporting taking blood pressure-lowering medication. As recommended by the WHO STEPwise approach to noncommunicable disease risk factor surveillance manual, we discarded the first blood pressure measurement and used the mean of the last two blood pressure measurements for each participant to define hypertension. We defined awareness of hypertension status as the participant reporting that they had been told they had hypertension by a health-care worker before the household survey. We defined hypertension treatment as self-reporting to be currently taking blood pressure-lowering medication. Lastly, we defined hypertension control as having a systolic blood pressure < 140 mmHg and a diastolic blood pressure < 90 mmHg. We again used the mean of the last two blood pressure measurements for each participant to define hypertension control. The Chakaria surveillance system did not ask participants whether they had ever been told they had hypertension by a health-care worker; therefore, we excluded this site from the analyses on hypertension awareness.

**Independent variables**

We included four sociodemographic characteristics in our analysis – age, sex, education and marital status – as these were collected in all five surveillance systems. We categorized education into four groups: no formal education; at least some primary schooling; at least some secondary schooling; and at least some tertiary education. We categorized marital status into three groups: unmarried; married; and widowed, divorced or separated. Only the Chililab, SEACO and Vadu surveillance systems measured participants’ height and weight and collected data on smoking. We therefore excluded the Chakaria and Sleman sites from the analyses that included BMI or smoking. We categorized BMI into three groups: normal (< 25.0 kg/m²); overweight (25.0–29.9 kg/m²); and obese (≥ 30.0 kg/m²). We defined smoking as reporting ever having smoked cigarettes on a regular basis.

**Statistical analysis**

We calculated the proportion of participants with hypertension who: were aware of their hypertension; were being treated for their hypertension; and had achieved hypertension control. To reach each care step, a participant must have reached the preceding care step, that is, every participant who was treated was considered to also be aware of their hypertension, and participants could not have achieved hypertension control if they were not aware and treated. We calculated these proportions separately for each surveillance system. Within each surveillance system sample, we further disaggregated the data by age group, sex, education, marital status, BMI and smoking status. We used sampling weights to adjust for the survey sampling strategy in each site in all analyses except when showing the sample characteristics. We adjusted standard errors for clustering at the highest sampling unit level: the village for the Chakaria, Chililab, SEACO and Vadu surveillance systems, and the household for the Sleman surveillance system.

We used Stata version 13 (StataCorp. LP, College Station, United States of America) for data cleaning and R statistical software version 3.6.0 (R Foundation for Statistical Computing, Vienna, Austria) for statistical analyses.

**Results**

**Sample characteristics**

Across the five health and demographic surveillance system sites, 22 142 adults participated in the household surveys, of whom 11 137 had hypertension (Table 1). The response rate across the five sites ranged from 81.6% in the Sleman surveillance system to 98.0% in the Vadu surveillance system. The mean age of survey participants varied from 38.5 years in the Chakaria surveillance system to 57.8 years in the SEACO surveillance system. The sample size for our analyses, i.e. the number of participants with hypertension, was largest for the SEACO surveillance system (8164 participants) and smallest for the Chakaria surveillance system (211 participants).

Of the participants with hypertension, 53.6% (5915/11 045) were 60 years and older and 57.0% (6351/11 136) were women (Table 2). Educational attainment among the participants with hypertension varied widely across the surveillance system sites. In the Chakaria and Vadu sites, 50.2% (106/211) and 53.7% (261/486), respectively, of the participants with hypertension had no formal education, whereas this proportion was only 4.4% (28/634) in the Chililab site, 9.6% (778/8079) in the SEACO site and 10.9% (179/1636) in the Sleman site. Of the three sites that measured height and weight, BMI was highest among participants with hypertension in the SEACO surveillance system. About one in four participants with hypertension in the SEACO and Sleman sites reported ever having smoked, 25.3% (2067/8163) and 28.0% (459/1641), respectively, while only 6.5% (30/463) of participants with hypertension in the Vadu surveillance system reported doing so.

**Hypertension care measures**

Participants’ awareness of their hypertension was highest in the SEACO surveillance system, where 66.0% (5391/8164; 95% confidence interval, CI: 65.0–67.1) of the participants reported having been diagnosed, compared with 49.9% (819/1641; 95% CI: 47.5–52.4) in the Sleman, 44.2% (280/634; 95% CI: 40.3–48.0) in the Chililab and 36.8% (179/486; 95% CI: 32.5–41.1) in the Vadu surveillance systems (Fig. 1). At 44.7% (3649/8164; 95% CI: 43.6–45.8) and 42.7% (90/211; 95% CI: 36.0–49.3), respectively, the proportion of treated participants for hypertension in the SEACO and Chakaria surveillance systems was about twice as high as the proportion in the Sleman (20.8% (341/1641); 95% CI: 18.8–22.8), Vadu (22.8% (111/486); 95% CI: 19.1–26.5) and Chililab (23.0%...
(146/634); 95% CI: 19.8–26.3) surveillance systems. The proportion of participants achieving hypertension control, however, was low across all five surveillance system sites, ranging from 11.5% (189/1641; 95% CI: 10.0–13.0) in the Sleman site to 20.4% (43/211; 95% CI: 14.9–25.8) in the Chakaria site. Female participants with hypertension were more likely to be aware of and treated for their hypertension and have achieved hypertension control in each surveillance system site. An exception was the SEACO site for treatment and hypertension control and the Chakaria site for hypertension control.

Variation across population groups

Although there was some variation across surveillance systems, older age groups...
tended to have a higher proportion of awareness, treatment and control of their hypertension (Fig. 2). Of our five surveillance system sites, the absolute differences in the proportion of awareness, treatment and control between different age groups tended to be greatest in the SEACO surveillance system. We saw no clear pattern in hypertension awareness, treatment and control by educational attainment or by BMI (available from the data repository). Participants with hypertension who reported never having smoked tended to be more aware of their hypertension, being on treatment and achieving control (data repository), particularly in the Sleman and Vadu sites. Generally, the absolute differences in hypertension awareness, treatment and control by educational attainment, BMI and smoking status were substantially smaller than those by age group.

**Discussion**

Hypertension control was low in all five sites in the Asian Health and Demographic

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**Fig. 1.** Hypertension awareness, treatment and control among participants with hypertension, by sex in the five health and demographic surveillance systems

| Country          | Sex     | Awareness (%) | Treatment (%) | Control (%) |
|------------------|---------|---------------|---------------|-------------|
| Chakaria, BD     | Males   | 100           | 75            | 25          |
|                 | Females | 100           | 75            | 25          |
| Vadu, IN         | Males   | 100           | 75            | 25          |
|                 | Females | 100           | 75            | 25          |
| Sleman, ID       | Males   | 100           | 75            | 25          |
|                 | Females | 100           | 75            | 25          |
| SEACO, MY        | Males   | 100           | 75            | 25          |
|                 | Females | 100           | 75            | 25          |
| Chililab, VN     | Males   | 100           | 75            | 25          |
|                 | Females | 100           | 75            | 25          |

CI: confidence interval.

Note: The Chakaria health and demographic surveillance system did not collect data on hypertension awareness.

**Fig. 2.** Hypertension awareness, treatment and control among participants with hypertension, by age group in the five health and demographic surveillance systems

| Country          | Age Group | Awareness (%) | Treatment (%) | Control (%) |
|------------------|-----------|---------------|---------------|-------------|
| Chakaria, BD     | 18–29     | 100           | 75            | 25          |
|                 | 30–39     | 100           | 75            | 25          |
|                 | 40–49     | 100           | 75            | 25          |
|                 | 50–59     | 100           | 75            | 25          |
|                 | 60–69     | 100           | 75            | 25          |
|                 | 70+       | 100           | 75            | 25          |
| Vadu, IN         | 18–29     | 100           | 75            | 25          |
|                 | 30–39     | 100           | 75            | 25          |
|                 | 40–49     | 100           | 75            | 25          |
|                 | 50–59     | 100           | 75            | 25          |
|                 | 60–69     | 100           | 75            | 25          |
|                 | 70+       | 100           | 75            | 25          |
| Sleman, ID       | 18–29     | 100           | 75            | 25          |
|                 | 30–39     | 100           | 75            | 25          |
|                 | 40–49     | 100           | 75            | 25          |
|                 | 50–59     | 100           | 75            | 25          |
|                 | 60–69     | 100           | 75            | 25          |
|                 | 70+       | 100           | 75            | 25          |
| SEACO, MY        | 18–29     | 100           | 75            | 25          |
|                 | 30–39     | 100           | 75            | 25          |
|                 | 40–49     | 100           | 75            | 25          |
|                 | 50–59     | 100           | 75            | 25          |
|                 | 60–69     | 100           | 75            | 25          |
|                 | 70+       | 100           | 75            | 25          |
| Chililab, VN     | 18–29     | 100           | 75            | 25          |
|                 | 30–39     | 100           | 75            | 25          |
|                 | 40–49     | 100           | 75            | 25          |
|                 | 50–59     | 100           | 75            | 25          |
|                 | 60–69     | 100           | 75            | 25          |
|                 | 70+       | 100           | 75            | 25          |

CI: confidence interval.

Note: The Chakaria health and demographic surveillance system did not collect data on hypertension awareness.
Surveillance Systems Noncommunicable Diseases Network. However, we saw important variation in the proportion of hypertension awareness and treatment across the sites. Notably, with two thirds of participants with hypertension being aware of their condition, the population in the SEACO surveillance system has a similar proportion of hypertension awareness as has been estimated for some high-income countries.15 We also observed large differences in hypertension awareness, treatment and control by age group within each surveillance system site, with older individuals having a substantially higher level of awareness, treatment and control. Overall, the prevalence of hypertension diagnosis, treatment and control in our five sites, and their wide variation across sites, is broadly similar to rates reported from nationally representative surveys in low- and middle-income countries.16

Our study also showed a gender difference in hypertension care in our surveillance system sites. Despite having a higher prevalence of hypertension, male participants were less likely than female participants to reach each step of the hypertension care pathway. This discrepancy by sex has been previously reported in low- and middle-income countries.15,17 It is, in fact, an observation that is not unique to hypertension but appears to apply to chronic disease care more broadly, including human immunodeficiency virus infection and diabetes.18-25 The reasons for this discrepancy may include: the fact that blood pressure measurements are a core component of antenatal care visits;24 that in general men use health-care services less often than women and thus have fewer chances for opportunistic screening for hypertension by the health system;26 and that gendered social norms and cultural beliefs discourage men from seeking preventive services.26

Given their population-based longitudinal design, health and demographic surveillance systems are a unique resource for monitoring the rise of noncommunicable diseases in low- and middle-income countries and establishing the population-level effects of epidemiological changes and interventions. Population-based cohort studies are able to determine individual-level risk factors of noncommunicable diseases. However, unless such studies are truly representative of an entire population, they are unable to determine what changes at the population level drive population-level changes in noncommunicable disease epidemiology. An additional unique advantage of health and demographic surveillance systems is that their data can be used to assess so-called spillover effects of epidemiological changes and health service interventions on entire households and communities.27,28 For example, the prescription of antihypertensive medications to individuals may affect the behaviour of their household members or neighbours through various channels. Seeing others obtain free medications that prevent adverse health outcomes may influence household members or neighbours to visit a health care facility for hypertension screening. Conversely, being asked to take medications despite not having any symptoms may dissuade these individuals from seeking hypertension screening. These spillover effects, which can be substantial,29 are usually ignored in studies that focus on individual patients or cohort study participants. Furthermore, given that health and demographic surveillance systems conduct routine follow-up of their surveillance population, they may also be an ideal setting for trialling interventions because ascertainment of the long-term outcome is assured.

Our study has some limitations. First, we conducted a cross-sectional rather than a longitudinal assessment of hypertension care. Each step of the care process therefore includes a different set of individuals who are unlikely to be exchangeable with each other. As such, we cannot assume that the proportion of people who achieved hypertension control among those diagnosed would remain the same if all those with hypertension were diagnosed. In addition, the cross-sectional nature of our study prevented us from determining how long individuals take to transition from diagnosis to treatment and control, and to what degree they move backward, i.e. from being controlled to becoming uncontrolled or being treated to being untreated. A recent analysis showed that such backward movement is common for hypertension care in China, Indonesia, Mexico and South Africa.30 Second, despite our efforts to harmonize the data, typically by matching similar questions and grouping similar answers, variation in data collection methods (e.g. how participants were sampled and how questions were asked and responses categorized) across sites could account for some of the variation between the sites that we observed in this analysis. We see the Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network as an important first step to improved harmonization of data collection efforts and collaboration across health and demographic surveillance systems in Asia. Third, health and demographic surveillance systems only survey a geographically restricted population. As such, they are not designed to be representative of an entire country’s population. Similarly, while the countries in which our five surveillance systems are located represent 61% of the population in Asia outside of China (and 42% when China is included),31 they are not representative of Asia as a whole. Therefore, our results should be interpreted as applying to the specific setting in which each surveillance system is located. Lastly, the surveys were not all conducted in the same year. Time trends in hypertension awareness, treatment and control may therefore explain some of the differences that we observed between surveillance system sites.

In conclusion, this first collaborative analysis of the Asian Health and Demographic Surveillance Systems Noncommunicable Diseases Network found that hypertension control is low across all five health and demographic surveillance systems. However, the proportions of participants being aware of their hypertension and treated vary widely between sites and among population groups within each site. Health and demographic surveillance systems in general, and our collaboration in particular, could serve as a unique resource to monitor the rise of noncommunicable diseases in Asia and to assess the population-level effects of epidemiological changes and health service interventions.

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Prise en charge de l'hypertension sur les sites de surveillance démographique: étude transversale au Bangladesh, en Inde, en Indonésie, en Malaisie et au Vietnam

Objectif Déterminer le pourcentage d'adultes souffrant d'hypertension qui ont indiqué: (i) avoir déjà été diagnostiqués hypertendus; (ii) prendre des antihypertenseurs; et enfin, (iii) avoir réussi à garder leur hypertension sous contrôle. Et ce, dans cinq sites de surveillance démographique et sanitaire à travers cinq pays différents en Asie.

Méthodes Des données ont été recueillies lors d'enquêtes menées auprès des ménages entre 2016 et 2020, sur les cinq sites de surveillance démographique et sanitaire ci-dessus.

Résultats Sur les sites de surveillance démographique et sanitaire mentionnés ci-dessus, le pourcentage d'adultes souffrant d'hypertension a été calculé à partir des données recueillies lors de l'enquête de l'année 2020. Les résultats vont être présentés en détail dans le manuscrit final, qui sera soumis pour publication scientifique à une revue de prestige.

Conclusion Les résultats de cette étude montrent que la prise en charge de l'hypertension varie considérablement d'un site à l'autre. Il est donc nécessaire d'améliorer la prise en charge de la hypertension dans ces régions pour prévenir les complications liées à cette maladie.
Objetivo Determinar el porcentaje de adultos con hipertensión arterial que informaron: (i) haber sido diagnosticados previamente con hipertensión; (ii) tomar hipotensores; y (iii) haber logrado el control de la hipertensión, en cinco sitios del sistema de vigilancia sanitaria sobre la población de cinco países en Asia.

Métodos Los datos se recopilaron durante las encuestas de hogares que se realizaron entre 2016 y 2020 en los cinco sitios de vigilancia en Bangladesh, India, Indonesia, Malasia y Vietnam. Se definió la hipertensión arterial como una tensión arterial sistólica ≥140 mmHg, una tensión arterial diastólica ≥90 mmHg o la toma de hipotensores. Se definió el control de la hipertensión como una tensión arterial sistólica <140 mmHg y una tensión arterial diastólica <90 mmHg. Se desglosaron los datos por categoría de edad, sexo y nivel de estudios. Se consideró el estado de control de la hipertensión como el cumplimiento de al menos dos de los siguientes factores: (i) haber sido diagnosticado; (ii) tomar hipotensores; y (iii) haber logrado el control de la hipertensión.

Resultados De los 22 142 participantes, 11 137 tenían hipertensión arterial: Bangladesh: 211; India: 487; Indonesia: 1641; Malasia: 8164; y Vietnam: 634. La edad media de los participantes con hipertensión fue de 60 años (rango: 19-101 años). En todos los países, la hipertensión fue más prevalente en hombres que en mujeres. La prevalencia de hipertensión fue mayor en los participantes mayores de 60 años. El control de la hipertensión fue bajo en todos los sitios. Mientras que el conocimiento y el tratamiento de la hipertensión varían, el control de la hipertensión es bajo en todos los sitios.
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