HHS Public Access

Author manuscript

Am J Prev Med. Author manuscript; available in PMC 2025 March 01.

Published in final edited form as:

Am J Prev Med. 2024 March ; 66(3): 492–502. doi:10.1016/j.amepre.2023.10.016.

Hypertension Prevalence and Control among U.S. Women of Reproductive Age

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Abstract

Introduction: Hypertension is a risk factor for cardiovascular disease, a leading cause of death among women of reproductive age (women aged 18-44 years). This study estimated hypertension prevalence and control among women of reproductive age at the national and state levels using electronic health record data.

Methods: Nonpregnant women of reproductive age were included in this cross-sectional study using 2019 IQVIA Ambulatory Electronic Medical Records – U.S. national data (analyzed in 2023). Suspected hypertension was identified using any of these criteria: ≥1 hypertension diagnosis code, ≥2 blood pressure readings ≥140/90 mmHg on separate days, or ≥1 antihypertensive medication. Among women of reproductive age with hypertension, the latest blood pressure in 2019 was used to identify hypertension control (blood pressure <140/90 mmHg). Estimates were age standardized and stratified by race or Hispanic ethnicity, region, and states with sufficient data. Tukey tests compared estimates by race or Hispanic ethnicity, region, and comorbidities.

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Conflict of Interest Statement:
No conflict of interest was reported by the authors of this paper.

Financial Disclosure:
No financial disclosures were reported by the authors of this paper.

Credit Author Statement
Xingran Weng: Conceptualization, Methodology, Software, Validation, Writing - Original Draft, Visualization. **Rebecca C. Woodruff:** Conceptualization, Supervision, Writing – Review and Editing. **Soyoun Park:** Software, Methodology, Formal Analysis, Writing – Review and Editing. **Angela M. Thompson-Paul:** Conceptualization, Supervision, Writing – Review and Editing. **Siran He:** Writing – Review and Editing. **Donald Hayes:** Writing – Review and Editing. **Elena V. Kuklina:** Writing – Review and Editing. **Nicole L. Therrien:** Writing – Review and Editing. **Sandra L. Jackson:** Conceptualization, Supervision, Writing – Review and Editing.

Results: Among 2,125,084 women of reproductive age (62.1% White, 8.8% Black, and 29.1% other [including Hispanic, Asian, other, or unknown]) with a mean age of 31.7 years, hypertension prevalence was 14.5%. Of those with hypertension, 71.9% had controlled blood pressure. Black women of reproductive age had a higher hypertension prevalence (22.3% vs 14.4%, $p<0.05$) but lower control (60.6% vs 74.0%, $p<0.05$) than White women of reproductive age. State-level hypertension prevalence ranged from 13.7% (Massachusetts) to 36% (Alabama), and control ranged from 82.9% (Kansas) to 59.2% (the District of Columbia).

Conclusions: This study provides the first state-level estimates of hypertension control among women of reproductive age. Electronic health record data complements traditional hypertension surveillance data and provides further information for efforts to prevent and manage hypertension among women of reproductive age.

Introduction

Hypertension is a major health concern for women.[1,2] It is a key modifiable risk factor for cardiovascular disease (CVD), a leading cause of mortality among women of reproductive age (WRA).[3,4] Hypertension impairs quality of life, complicates pregnancies (e.g., fetal growth restriction and preterm birth), and causes adverse health problems in newborns.[5,6] Depending on the study population, hypertension definition, and blood pressure (BP) assessment method, prior studies have estimated that 10%-20% of WRA in the U.S. have hypertension, among whom only half have their BP controlled.[2,7] Given the negative health impacts of hypertension on WRA, including before pregnancy, during pregnancy, and in the postpartum period,[6,8] it is important to perform surveillance on hypertension prevalence and control to evaluate prevalence and control patterns and racial disparities.

The U.S. Surgeon General underscored the importance of improving maternal health through improvement of factors that contribute to pregnancy related complications or death, including hypertension. The *2020 Call to Action to Improve Maternal Health* emphasized the necessity of closely monitoring BP and identifying warning signs among WRA to prevent excess maternal and infant morbidity and mortality due to hypertension.[9] Up-to-date national and subnational prevalence and control estimates among WRA, including information on racial disparities, may support better health services related to hypertension in women. Hypertension estimates in the U.S. have been derived from large surveys such as the Behavioral Risk Factor Surveillance System (BRFSS), the National Health and Nutrition Examination Survey (NHANES), and the National Health Interview Survey (NHIS). Both BRFSS and NHIS use self-reported hypertension information rather than objectively measured BP and thus cannot estimate hypertension control. Although NHANES measures participants' BP and could generate control estimates, those estimates cannot be disaggregated to the state level.[10,11] In addition, surveys relying on participants' self-reported data (e.g., BRFSS) are subject to recall bias, and NHANES only collects BP on a single day, which may lead to misclassification of hypertension status.[2,12] Long lag times, such as the 2 years necessary for national surveys' data preparation prior to public release, can also limit usability and timeliness of survey data.[13]

The objective of this study was to use a large national outpatient electronic health record (EHR) data set from IQVIA to estimate hypertension prevalence and control among WRA at both national and state levels in 2019. This study also compared EHR-based prevalence estimates with national prevalence estimates from NHANES.

Method

Study Sample

This study used the IQVIA Ambulatory Electronic Medical Record (AEMR) – U.S. data in the Observational Medical Outcomes Partnership Common Data Model (OMOP CDM), version 5 format from the May 2021 release.[14] This standardized EHR data set consisted of deidentified medical records of patients who sought outpatient care from January 1 to December 31, 2019. The AEMR – U.S. data captures roughly 15 million patients who completed at least 1 outpatient visit from 1 of over 100,000 providers (60% specialists) at roughly 800 ambulatory practices using major EHR systems across all 50 states and the District of Columbia annually.

In this cross-sectional study, 2,876,436 WRA (women aged 18-44 years) were identified in 2019 (Figure 1).[3] To identify a cohort among whom hypertension prevalence and control could be assessed, patients were excluded if they had no paired BP in 2019 (n=493,079). In addition, patients with documentation of hospice, palliative care, or end-stage renal disease were excluded (n=2,669).[15] Patients were also excluded if they had a suspected pregnancy in 2019 (n=254,884), as identified by any individuals who had pregnancy related events on the basis of the OMOP CDM Concept ID mapped from the Systematized Nomenclature of Medicine (Appendix Table 1). A total of 2,125,804 nonpregnant WRA (subsequently referred to as WRA) from the 2019 AEMR – U.S. data were included in this study.

Data from NHANES 2011-2018 were also used to generate estimates of hypertension prevalence and control. NHANES is a complex, multistage probability sample of the resident, civilian, noninstitutionalized U.S. population designed to evaluate health and nutritional status.[16] NHANES data were collected from participant interviews and physical examinations, including BP readings, at the Mobile Examination Center (MEC).[17] WRA's BP readings taken during the physical examination and health history interview responses on hypertension treatment and control were used to generate estimates, with MEC weights applied.

Measures

To identify WRA with suspected hypertension (subsequently referred to as hypertension) from the AEMR – U.S. data, this study implemented an algorithm on the basis of any of the following 3 criteria: (1) at least 1 diagnosis code for hypertension (Appendix Table 2), (2) at least 2 elevated BP readings (≥140/90 mmHg) on separate outpatient visits,[18] or (3) any prescribed antihypertensive medication (Appendix Table 3). For the NHANES cohort, WRA were classified as having hypertension if their averaged BP readings were ≥140/90 mmHg, or if they reported taking medication to control their BP or had been told by a healthcare provider to take medication to control BP.[19] Although the 2017 American Heart Association/

American College of Cardiology (AHA/ACC) clinical practice guideline updated the cutoffs for elevated BP readings from 140/90 mmHg to 130/80 mmHg, hypertension was classified on the basis of the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure cut off to be consistent with existing literature and quality of care measures.[2,15,20-22] Using the 140/90 mmHg cutoff allows for ascertainment of antihypertensive medication eligibility among WRA because some women with BP between 130/80 mmHg and 140/90 mmHg would be recommended lifestyle modification rather than medication.[23]

To measure hypertension control, this study used the National Committee for Quality Assurance specification. Among the WRA with hypertension in the IQVIA sample, hypertension was classified as controlled if the most recent BP was <140/90 mmHg.[15] For the NHANES cohort, hypertension was classified as controlled if the average BP was <140/90 mmHg among those taking antihypertensive medications.[18]

Demographic variables included age group (18-34 and 35-44 years) and race or Hispanic ethnicity (White, Black, Hispanic, Asian, other, and unknown). Body mass index (BMI, kg/m^2) was calculated using the growthcleanr algorithm after removing biologically implausible measurements of height and weight from EHR data.[24] BMI was then categorized into underweight, healthy weight, overweight, and obese on the basis of appropriate pediatric (ages 18-19 years) and adult (ages 20-44 years) BMI thresholds.[25-27] Individuals with no BMI data were grouped as missing. Diabetes (yes/no) was assessed using an established algorithm in IQVIA (SUPREME-DM).[28] Current tobacco usage status (yes/no) was based on available EHR data related to current usage of any tobacco products. WRA were also grouped by U.S. Census region (Northeast, Midwest, South, and West).[29] Estimates by state were generated for states with sufficient numbers of patients (defined as states having at least 1% of the WRA population included in IQVIA on the basis of 2010 U.S. Census data for the state).

Statistical Analysis

This study performed chi-square tests to assess associations between included variables (e.g., age group, race or Hispanic ethnicity, census region, BMI, current tobacco usage, and diabetes) and hypertension and hypertension control status. All hypertension prevalence and control estimates were age standardized on the basis of the 2010 U.S. Census population counts for females aged 18-34 years and 35-44 years.[30] Age-standardized estimates were then stratified by included variables (race or Hispanic ethnicity, census region, BMI, current tobacco usage, and diabetes). Tukey tests were used to compare the age-standardized estimates by included variables (except by state).[31]

This study compared estimates from the AEMR – U.S. data with NHANES 2011-2018 estimates that were weighted and age standardized. Specifically, we examined prevalence estimates from each component of the hypertension definition from each data set (Appendix Figures 1 and 2). Estimates using the 2017 AHA/ACC hypertension guideline threshold (130/80 mmHg) were also presented in Appendix Table 4.[20] All statistical analyses were performed in SAS, version 9.4 (SAS Institute Inc., Cary, NC) with a 0.05 significance level; SAS-callable SUDAAN (RTI International, Research Triangle Park, NC) was used

for analyzing NHANES data. All analyses were performed in 2023. IRB approval was not required for this secondary deidentified data analysis.

Results

Among the 2.1 million WRA, the mean (SD) age was 31.7 (7.8) years; among those with hypertension, the mean (SD) age was 35.3 (7.0) years. The largest race or Hispanic ethnicity group among WRA was White (62.1%), followed by Black (8.8%), Asian (2.8%), Hispanic (0.6%), other race (5.0%), and unknown race (20.7%) (Table 1). Most WRA had a BMI in the obese (32.4%) or overweight (21.4%) categories; 30.3% had a BMI in the healthy weight category, 1.8% were underweight, and the rest (14.2%) were missing BMI. Approximately 8.1% of WRA currently used tobacco and 3.7% had diabetes. The census region with the largest representation of WRA was the South (46.0%), followed by the West (21.3%), Midwest (17.4%), and Northeast (15.3%).

A higher proportion of WRA with hypertension were in the older age group (61.2% vs 37.5%, $p<0.0001$) and Black (14.0% vs 7.9%, $p<0.0001$) than WRA without hypertension (Table 1). WRA with hypertension more frequently had obesity (57.0% vs 28.1%, $p<0.0001$), were currently using tobacco (13.4% vs 7.2%, $p<0.0001$), and had diabetes (12.4% vs 2.2%, $p<0.0001$) than WRA without hypertension.

The age-standardized prevalence of hypertension among the WRA cohort from the AEMR – U.S. data was 14.5% (Table 2). Based on the crude estimates, at least 1 in 5 WRA aged 35-44 years WRA had hypertension, but only 1 in 10 WRA aged 18-34 years had hypertension. Stratified by race or Hispanic ethnicity, the age standardized hypertension prevalence was highest among Black WRA (22.3%), followed by White WRA (14.4%), Hispanic WRA (9.0%), and Asian WRA (8.0%). Hypertension prevalence was significantly higher among Black WRA than all other race or Hispanic ethnicity groups ($p<0.05$).

Across all BMI categories, the highest age-standardized hypertension prevalence was among WRA who had obesity (24.2%), followed by those who were overweight (12.5%). Nearly a quarter (22.8%) of WRA who currently used tobacco products had hypertension versus 13.7% of WRA who did not use tobacco ($p<0.05$). Almost half of WRA with diabetes had hypertension (43.7%), versus 13.3% of WRA without diabetes ($p<0.05$).

By region (Table 2), hypertension prevalence among WRA from the South (17.5%) was significantly higher than that of WRA from the Midwest (13.3%), Northeast (11.4%), or West (11.2%; $p<0.05$ for all comparisons). Among 40 included states, estimates ranged from a low of 13.7% in Massachusetts to a high of 36% in Alabama (Figure 2A). States with the lowest age-standardized hypertension estimates were concentrated in the Northeast region; states with the highest age-standardized hypertension estimates among WRA were concentrated in the South.

Comparing the crude percentages with controlled hypertension, almost 75.0% of WRA in the younger age group (18-34 years) had controlled hypertension, whereas 67.3% of WRA in the older age group (35-44 years) had controlled hypertension (Table 2). After age standardization, 71.9% of WRA with hypertension had controlled BP. Across race

and ethnic groups, age-standardized hypertension control ranged from 60.6% among Black WRA to 74.0% among White WRA and to 75.5% among Asian WRA. Black WRA had significantly lower hypertension control than White WRA ($p<0.05$). Hypertension control varied by BMI category, ranging from 68.6% among WRA with obesity to over 85% among those with healthy weight or underweight ($p<0.05$ for all comparisons except underweight versus healthy weight).

By region, the lowest hypertension control was observed in the South (69.8%, $p<0.05$ for all comparisons). Figure 2B illustrates hypertension control among WRA from all included states. Hypertension control was lowest in the District of Columbia and Mississippi (<60%), whereas some Northeastern states (i.e., Pennsylvania, New Jersey, New York, Massachusetts, and New Hampshire) and Midwestern states (i.e., Minnesota, South Dakota, Iowa, and Colorado) had hypertension control ≥ 75%.

Overall, the prevalence of hypertension among WRA in NHANES was 8.0%, which was lower than the AEMR – U.S. data (14.5%). Upon assessing each component of the hypertension definition (Appendix Figure 1), using BP readings alone to identify hypertension showed similar prevalence among WRA in both data sets (3.6% in NHANES and 3.1% in the AEMR – U.S. data). However, when hypertension was defined by antihypertensive medication usage, the hypertension prevalence in NHANES (5.3%) was much lower than in the AEMR – U.S. data (12.1%). The age-standardized hypertension control estimates differed substantially between the 2 data sets: 49.7% (95% CI: 41.2%-58.2%) in NHANES compared with 71.9% in the AEMR – U.S. data (Appendix Figure 2).

Discussion

Using a large-scale, nationwide, outpatient EHR database, this study estimated that over 1 in 7 WRA had hypertension, among whom, one quarter had uncontrolled hypertension. Hypertension prevalence and control differences were observed by race or Hispanic ethnicity, with Black patients having the highest hypertension prevalence but the lowest proportion with control. Variation in hypertension prevalence and control among WRA was also observed across BMI strata as well as by state and region. In addition to providing the estimates of hypertension prevalence and control among WRA at the national level, this study provided the first state-level estimates of hypertension control. This study highlighted 2 benefits of using EHR data for hypertension surveillance. First, the rich clinical information (e.g., diagnoses, vital signs, and medications) from the EHR data allowed this study to identify hypertension on the basis of BP readings measured in a clinical setting rather than relying on survey participants' recall or 1-day BP readings.[18] Second, state-level estimates were generated from the EHR data for 40 states, whereas traditional survey-based data cannot estimate hypertension control at the state level.

Geographic, demographic, and clinical patterns in hypertension prevalence and control were generally consistent between estimates identified by the ePhenotype from the AEMR – U.S. data[32] and NHANES and other surveys. For example, regional patterns showing higher hypertension burden in the South were consistent with previous work.[33] These geographic

variabilities in hypertension prevalence and control further justify the need for increasing hypertension prevention and control resources in jurisdictions with significant hypertension burdens, where local public health programs could offer more tailored strategies.

In addition, higher hypertension prevalence and lower control among Black WRA in the IQVIA data were similar to patterns documented in prior studies.[1,2,34-36] Other studies have found that non-Hispanic Black women experience sharper increases in hypertension prevalence from early to mid-life than other racial and ethnic groups; hypertension prevalence among Black women increases from 3% among adolescents to 32% during their reproductive years.[35,36] The observed racial disparities in hypertension prevalence and control among WRA could contribute to disparities in maternal morbidity and mortality and in CVD among Black women.[37] Hypertension, alone or in combination with preeclampsia, can increase the risk of delivery or birth complications among non-Hispanic Black women, including caesarean delivery, preterm delivery (<37 weeks' gestation), lower birth weight, neonatal intensive care unit admission, and perinatal death.[37-40] Hypertension was also less well controlled among non-Hispanic Black women than their White counterparts.[41,42] Moreover, inequitable access to high-quality healthcare and other health-promoting resources that result from systemic racism drive and exacerbate the inequities in hypertension prevention and control.[43-45] Over time, those disparities among WRA may contribute to widening racial disparities in cardiovascular morbidity (e.g., about 1.7 hazard ratio of gestational hypertension and CVD among Black females versus White counterparts) and mortality (e.g., Black females had the second highest death rate [46.9 death per 100,000 people] attributed to hypertension in 2020 than other race and sex groups).[8,46-48]

This study demonstrated higher hypertension prevalence among WRA (14.5% vs 8.0%) and hypertension control (71.9% vs 49.7%) in AEMR – U.S. than NHANES.[2] The higher hypertension prevalence and control estimates among WRA from the AEMR – U.S. data may be due to differences in the study populations, case definitions, and other methodological differences associated with these 2 datasets. First, the AEMR – U.S. data were collected from patients receiving clinical care, whereas NHANES data were collected from the general U.S. population. As care-seeking individuals, patients in the AEMR – U.S. data had a higher likelihood of having chronic health conditions, such as hypertension, which required them to routinely visit healthcare providers. These individuals may differ from young and middle-aged adult women in the general U.S. population.[49] They may also have had more access to health care than NHANES participants and may have had higher engagement in ongoing care.[2,34,50] Both of these differences may have contributed to higher percentages of hypertension control among patients with hypertension in the AEMR – U.S. data than in NHANES. Second, data collection differences between the NHANES survey and the AEMR – U.S. data as well as differences in the criteria for assessing hypertension (using self-reported hypertension condition and control or BP readings from the MEC for NHANES; using diagnosis codes, BP readings on separate days, or antihypertensive medications for the AEMR – U.S. data) could have contributed to differences in apparent prevalence and control. For example, antihypertensive medication records from the AEMR – U.S. data may inflate hypertension prevalence estimates because WRA may have been taking antihypertensive medications for other purposes, such as heart failure.[32] In addition, participation bias may underestimate hypertension prevalence in NHANES, if individuals

with complex health conditions did not participate in the survey or did not complete the physical examination in the MEC.[51]

Limitations

This study had limitations. First, as described earlier, the IQVIA AEMR – U.S. population is not representative of the entire WRA population in the U.S., and the extent to which these findings could be generalized to the entire WRA population is unknown.[49,52] Second, incomplete race or Hispanic ethnicity (>20% unknown race) information in the EHR data may have introduced bias in generating estimates by race or Hispanic ethnicity in this study. Third, misclassification of hypertension could have occurred using IQVIA data. This could overestimate the hypertension prevalence among WRA. The selection process for the EHR-based hypertension algorithm, including diagnosis codes, BP readings, and medications, has been described elsewhere and is consistent with other work.[32,53]

Conclusions

This study used national outpatient EHR data to report that hypertension prevalence affected 1 in 7 WRA and that hypertension control was suboptimal with significant geographic variability in the U.S. Public health practitioners, healthcare systems, and clinicians could leverage EHR data to perform hypertension surveillance (e.g., the Multi-State EHR-Based Network for Disease Surveillance program), evaluate, and inform hypertension prevention and control programs (e.g., Million Hearts) for WRA across the nation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

This study was reviewed by the Centers for Disease Control and Prevention and conducted consistent with applicable federal law and the Centers for Disease Control and Prevention policy (5 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.).

References

1. Azeez O, Kulkarni A, Kuklina EV, Kim SY, Cox S. Hypertension and Diabetes in Non-Pregnant Women of Reproductive Age in the United States. Prev Chronic Dis. 2019;16:E146. doi:10.5888/pcd16.190105 [PubMed: 31651378]
2. Ford ND, Robbins CL, Hayes DK, Ko JY, Loustalot F. Prevalence, Treatment, and Control of Hypertension Among US Women of Reproductive Age by Race/Hispanic Origin. Am J Hypertens. 2022;35(8):723–730. doi:10.1093/ajh/hpac053 [PubMed: 35511899]
3. Centers for Disease Control and Prevention. Indicator Definitions - Reproductive Health. Updated January 2015. Accessed November 21, 2022. https://www.cdc.gov/cdi/definitions/reproductive-health.html.
4. Heron M. Deaths: leading causes for 2017. Updated June 2019 Accessed September 28, 2023. https://pubmed.ncbi.nlm.nih.gov/32501203/.

5. The American Congress of Obstetricians and Gynecologists. Preeclampsia and High Blood Pressure During Pregnancy. Updated April 2022. Accessed November 21, 2022. https://www.acog.org/womens-health/faqs/preeclampsia-and-high-blood-pressure-during-pregnancy.
6. Ghazi L, Bello NA. Hypertension in Women Across the Lifespan. Curr Atheroscler Rep. 2021;23(8):43. doi:10.1007/s11883-021-00941-4 [PubMed: 34146177]
7. Kovell LC, Meyerovitz CV, Skaritanov E, et al. Hypertension and contraceptive use among women of child-bearing age in the United States from 2001 to 2018. J Hypertens. 2022;40(4):776–784. doi:10.1097/HJH.0000000000003077 [PubMed: 35081582]
8. Centers for Disease Control and Prevention, National Center for Health Statistics. National Vital Statistics System, Mortality 1999-2020 on CDC WONDER Online Database. Updated May 2023. Accessed November 21, 2022. http://wonder.cdc.gov/ucd-icd10.html.
9. U.S. Department of Health & Human Services. Healthy women, healthy pregnancies, healthy futures: Action plan to improve maternal health in America. Updated December 2020. Accessed November 21, 2022. https://www.hhs.gov/sites/default/files/call-to-action-maternal-health.pdf.
10. National Center for Health Statistics. National Health and Nutrition Examination Survey: Analytic Guidelines, 2011-2014 and 2015-2016. Updated December 2018. Accessed November 21, 2022. https://wwwn.cdc.gov/nchs/data/nhanes/analyticguidelines/11-16-analytic-guidelines.pdf.
11. Centers for Disease Control and Prevention. LLCP 2019 Codebook Report Overall version data weighted with _LLCPWT Behavioral Risk Factor Surveillance System. Updated July 2020. Accessed November 21, 2022. https://www.cdc.gov/brfss/annual_data/2019/pdf/codebook19_llcp-v2-508.HTML.
12. Robbins C, Boulet SL, Morgan I, et al. Disparities in Preconception Health Indicators - Behavioral Risk Factor Surveillance System, 2013-2015, and Pregnancy Risk Assessment Monitoring System, 2013-2014. MMWR Surveill Summ. 2018;67(1):1–16. doi:10.15585/mmwr.ss6701a1
13. National Center for Health Statistics. NHANES Data Release and Access Policy. Accessed December 15, 2022. https://www.cdc.gov/nchs/data/nhanes/nhanes_release_policy.pdf.
14. The Observational Health Data Sciences and Informatics. Data Standardization. Accessed August 30, 2022. https://www.ohdsi.org/data-standardization/.
15. National Committee for Quality Assurance. Controlling High Blood Pressure (CBP). Accessed June 2, 2023. https://www.ncqa.org/hedis/measures/controlling-high-blood-pressure/.
16. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey (NHANES). Updated June 2023. Accessed September 26, 2022. https://www.cdc.gov/nchs/hus/sources-definitions/nhanes.htm.
17. National Center for Health Statistics. About the National Health and Nutrition Examination Survey. Updated May 2023. Accessed November 22, 2022. https://www.cdc.gov/nchs/nhanes/about_nhanes.htm.
18. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003;289(19):2560–72. doi:10.1001/jama.289.19.2560 [PubMed: 12748199]
19. Crim MT, Yoon SS, Ortiz E, et al. National Surveillance Definitions for Hypertension Prevalence and Control Among Adults. Circ Cardiovasc Qual Outcomes. 2012;5(3):343–351. doi:10.1161/circoutcomes.111.963439 [PubMed: 22550130]
20. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension. 2018;71(6):e13–e115. doi:10.1161/HYP.0000000000000065 [PubMed: 29133356]
21. Muntner P, Miles MA, Jaeger BC, et al. Blood Pressure Control Among US adults, 2009 to 2012 Through 2017 to 2020. Hypertension. 2022;79(9):1971–1980. doi:10.1161/HYPERTENSIONAHA.122.19222 [PubMed: 35616029]
22. Muntner P, Hardy ST, Fine LJ, Jaeger BC, Wozniak G, Levitan EB, Colantonio LD. Trends in Blood Pressure Control Among US adults With Hypertension, 1999-2000 to 2017-2018. JAMA. 2020;324(12):1190–1200. doi:10.1001/jama.2020.14545 [PubMed: 32902588]

23. World Health Organization. Guideline for the pharmacological treatment of hypertension in adults. Updated 2021. Accessed July 11th, 2023. https://www.who.int/publications/i/item/9789240033986.
24. Daymont C, Ross ME, Russell Localio A, Fiks AG, Wasserman RC, Grundmeier RW. Automated identification of implausible values in growth data from pediatric electronic health records. J Am Med Inform Assoc. 2017;24(6):1080–1087. doi:10.1093/jamia/ocx037 [PubMed: 28453637]
25. Centers for Disease Control and Prevention. About Child & Teen BMI. Updated September 2022. Accessed November 22, 2022. https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html.
26. Centers for Disease Control and Prevention. Data Table of BMI-for-age Charts. Updated August 2001. Accessed November 22, 2022. https://www.cdc.gov/growthcharts/html_charts/bmiagerev.htm#females.
27. Centers for Disease Control and Prevention. About Adult BMI. Updated June 2022. Accessed November 22, 2022. https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html.
28. Nichols GA, Schroeder EB, Karter AJ, et al. Trends in diabetes incidence among 7 million insured adults, 2006-2011: the SUPREME-DM project. Am J Epidemiol. 2015;181(1):32–9. doi:10.1093/aje/kwu255 [PubMed: 25515167]
29. U.S. Census Bureau. Census Regions and Divisions of the United State. Accessed November 22, 2022. https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf.
30. U.S. Census Bureau. Annual Estimates of the Resident Population by Single Year of Age and Sex for the United States: April 1, 2010 to July 1, 2019. Updated June 2020. Accessed November 28, 2022. https://www.census.gov/newsroom/press-kits/2020/population-estimates-detailed.html.
31. SAS Institute. The GLM Procedure - Multiple Comparisons. Accessed March 31, 2023. https://support.sas.com/documentation/cdl/en/statug/66859/HTML/default/viewer.htm#statug_glm_details29.htm.
32. He S, Park S, Kuklina E, et al. Leveraging electronic health records to construct a phenotype for hypertension surveillance in the United States. Am J Hypertens. Sep 11 2023;doi:10.1093/ajh/hpad081
33. Fang J, Gillespie C, Ayala C, Loustalot F. Prevalence of self-reported hypertension and antihypertensive medication use among adults aged >/=18 Years - United States, 2011-2015. MMWR Morb Mortal Wkly Rep. 2018;67(7):219–224. doi:10.15585/mmwr.mm6707a4 [PubMed: 29470459]
34. Bateman BT, Shaw KM, Kuklina EV, Callaghan WM, Seely EW, Hernandez-Diaz S. Hypertension in women of reproductive age in the United States: NHANES 1999-2008. PLoS One. 2012;7(4):e36171. doi:10.1371/journal.pone.0036171 [PubMed: 22558371]
35. Rao G, Connor S. Correlates of hypertensive-level BP in African American adolescents. J Racial Ethn Health Disparities. 2023;10(2):536–541. doi:10.1007/s40615-022-01243-4 [PubMed: 35088391]
36. Hardy ST, Holliday KM, Chakladar S, et al. Heterogeneity in Blood Pressure Transitions Over the Life Course: Age-Specific Emergence of Racial/Ethnic and Sex Disparities in the United States. JAMA Cardiol. 2017;2(6):653–661. doi:10.1001/jamacardio.2017.0652 [PubMed: 28423153]
37. Chappell LC, Enye S, Seed P, Briley AL, Poston L, Shennan AH. Adverse perinatal outcomes and risk factors for preeclampsia in women with chronic hypertension: a prospective study. Hypertension. 2008;51(4):1002–9. doi:10.1161/HYPERTENSIONAHA.107.107565 [PubMed: 18259010]
38. Battarbee AN, Sinkey RG, Harper LM, Oparil S, Tita ATN. Chronic hypertension in pregnancy. Am J Obstet Gynecol. 2020;222(6):532–541. doi:10.1016/j.ajog.2019.11.1243 [PubMed: 31715148]
39. Guedes-Martins L. Chronic Hypertension and Pregnancy. Adv Exp Med Biol. 2017;956:395–407. doi:10.1007/5584_2016_81 [PubMed: 27722962]
40. Sabol BA, Porcelli B, Diveley E, et al. Defining the risk profile of women with stage 1 hypertension: a time to event analysis. Am J Obstet Gynecol MFM. 2021;3(4):100376. doi:10.1016/j.ajogmf.2021.100376 [PubMed: 33878494]

41. Smith SM, Huo T, Gong Y, et al. Mortality Risk Associated With Resistant Hypertension Among Women: Analysis from Three Prospective Cohorts Encompassing the Spectrum of Women's Heart Disease. J Womens Health (Larchmt). 2016;25(10):996–1003. doi:10.1089/jwh.2015.5609 [PubMed: 27224417]

42. Petersen EE, Davis NL, Goodman D, et al. Racial/Ethnic Disparities in Pregnancy-Related Deaths - United States, 2007-2016. MMWR Morb Mortal Wkly Rep. 2019;68(35):762–765. doi:10.15585/mmwr.mm6835a3 [PubMed: 31487273]

43. Oliver MN, Wells KM, Joy-Gaba JA, Hawkins CB, Nosek BA. Do physicians' implicit views of African Americans affect clinical decision making? J Am Board Fam Med. 2014;27(2):177–88. doi:10.3122/jabfm.2014.02.120314 [PubMed: 24610180]

44. Forde AT, Sims M, Muntner P, Lewis T, Onwuka A, Moore K, Diez Roux AV. Discrimination and Hypertension Risk Among African Americans in the Jackson Heart Study. Hypertension. 2020;76(3):715–723. doi:10.1161/HYPERTENSIONAHA.119.14492 [PubMed: 32605388]

45. Meyerovitz CV, Juraschek SP, Ayturk D, et al. Social Determinants, Blood Pressure Control, and Racial Inequities in Childbearing Age Women With Hypertension, 2001 to 2018. J Am Heart Assoc. 2023;12(5):e027169. doi:10.1161/JAHA.122.027169 [PubMed: 36847043]

46. Parikh NI, Gonzalez JM, Anderson CAM, et al. Adverse Pregnancy Outcomes and Cardiovascular Disease Risk: Unique Opportunities for Cardiovascular Disease Prevention in Women: A Scientific Statement From the American Heart Association. Circulation. 2021;143(18):e902–e916. doi:10.1161/CIR.0000000000000961 [PubMed: 33779213]

47. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart Disease and Stroke Statistics-2023 Update: A Report From the American Heart Association. Circulation. 2023;147(8):e93–e621. doi:10.1161/CIR.0000000000001123 [PubMed: 36695182]

48. Cirillo PM, Cohn BA. Pregnancy complications and cardiovascular disease death: 50-year follow-up of the Child Health and Development Studies pregnancy cohort. Circulation. Sep 29 2015;132(13):1234–42. doi:10.1161/CIRCULATIONAHA.113.003901 [PubMed: 26391409]

49. Rao A, Shi Z, Ray KN, Mehrotra A, Ganguli I. National Trends in Primary Care Visit Use and Practice Capabilities, 2008-2015. Ann Fam Med. 2019;17(6):538–544. doi:10.1370/afm.2474 [PubMed: 31712292]

50. Britton LE, Berry DC, Hussey JM. Comorbid hypertension and diabetes among U.S. women of reproductive age: Prevalence and disparities. J Diabetes Complications. 2018;32(12):1148–1152. doi:10.1016/j.jdiacomp.2018.09.014 [PubMed: 30291018]

51. Fakhouri THI, Martin CB, Chen TC, et al. An Investigation of Nonresponse Bias and Survey Location Variability in the 2017-2018 National Health and Nutrition Examination Survey. Accessed May 17, 2023. https://www.cdc.gov/nchs/data/series/sr_02/s02-185-508.pdf.

52. Bower JK, Patel S, Rudy JE, Felix AS. Addressing Bias in Electronic Health Record-Based Surveillance of Cardiovascular Disease Risk: Finding the Signal Through the Noise. Curr Epidemiol Rep. 2017;4(4):346–352. doi:10.1007/s40471-017-0130-z [PubMed: 31223556]

53. Hohman KH, Zambarano B, Klompas M, Wall HK, Kraus EM, Carton TW, Jackson SL. Development of a Hypertension Electronic Phenotype for Chronic Disease Surveillance in Electronic Health Records: Key Analytic Decisions and Their Effects. Prev Chronic Dis. Sep 14 2023;20:E80. doi:10.5888/pcd20.230026 [PubMed: 37708339]

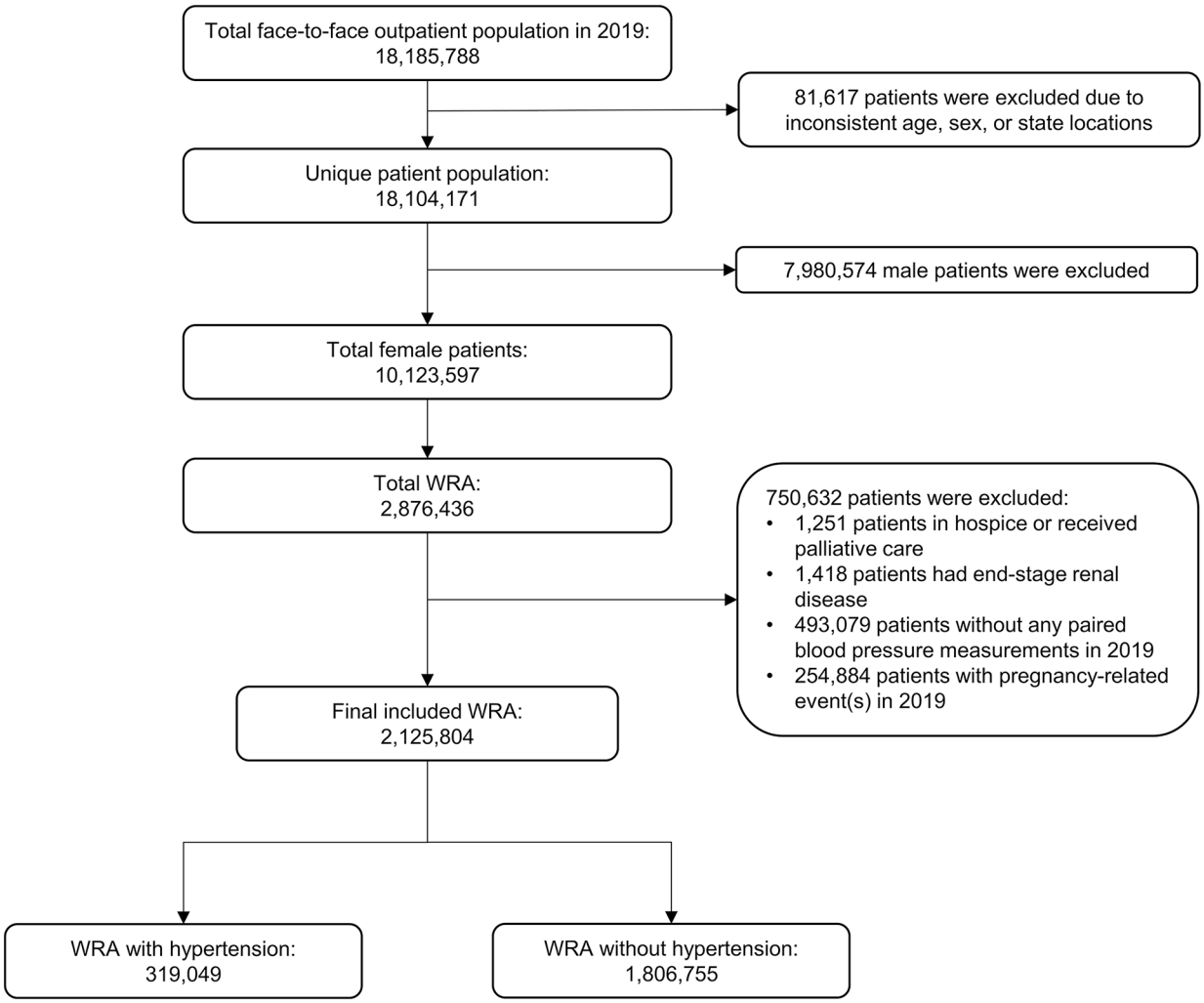
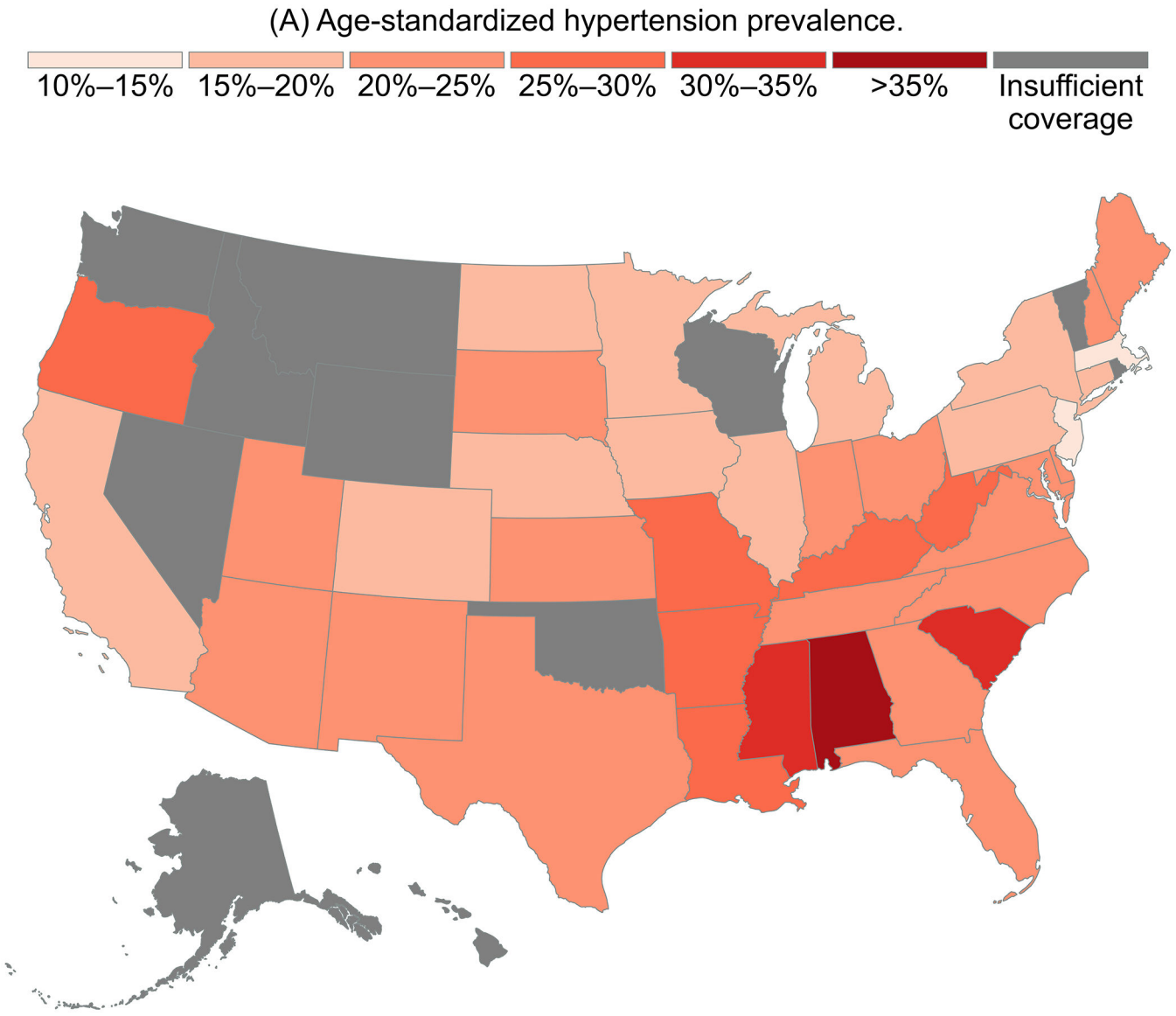


Figure 1. Study population creation flowchart

WRA, women of reproductive age.



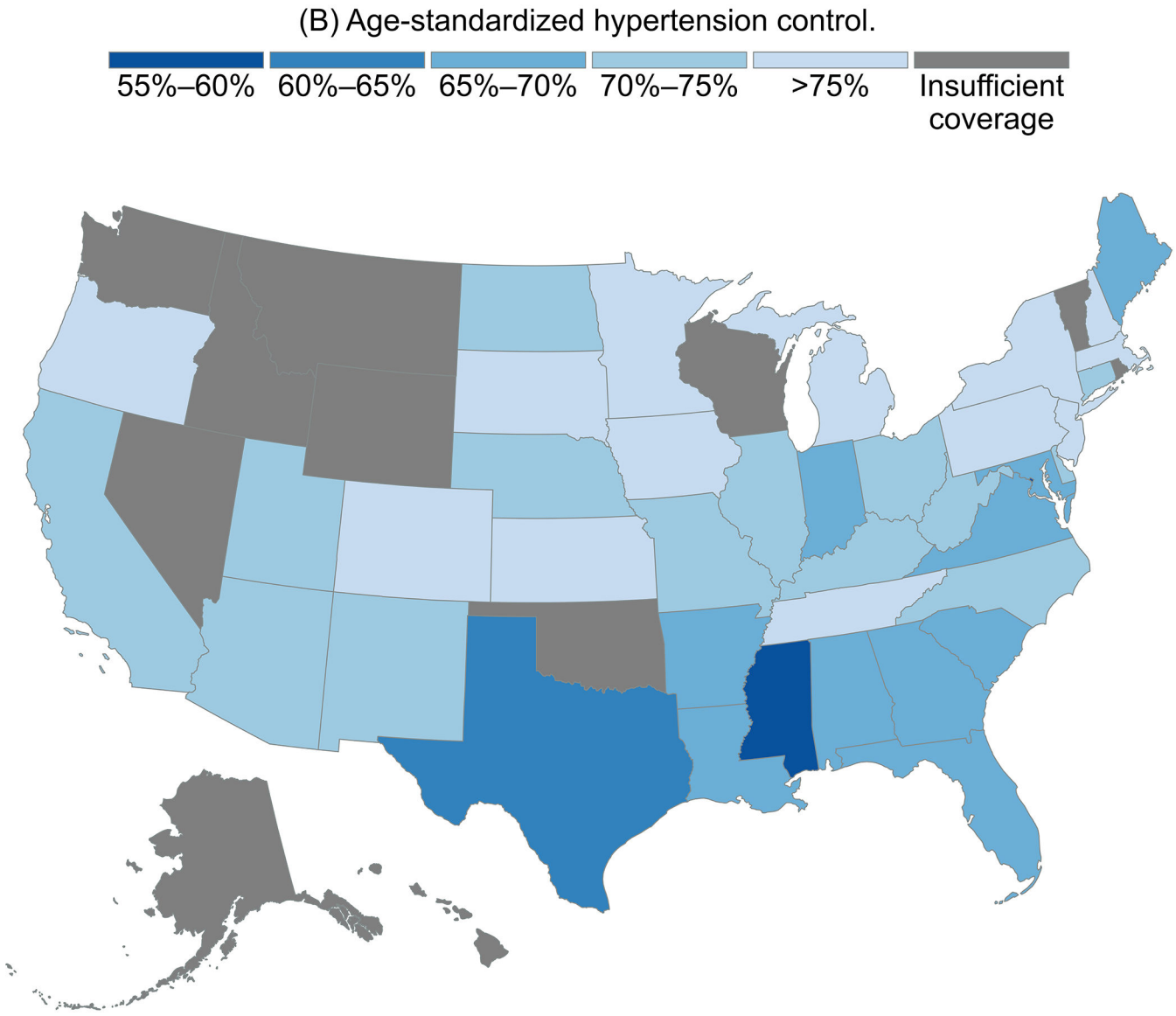


Figure 2. Age-standardized hypertension prevalence and age-standardized hypertension control by state; IQVIA AEMR – U.S. 2019 data.

Estimates could not be generated for states in grey owing to insufficient patient population (<1% women of reproductive age population of the state).

AEMR, Ambulatory Electronic Medical Records.

Table 1.

Demographic Characteristics Among WRA by Hypertension and Control Status from IQVIA AEMR – U.S. 2019 Data

Characteristics	Total WRA, % (N=2,125,804)	WRA with hypertension, % (n=319,049)	WRA without hypertension, % (n=1,806,755)	*p-value* [a]	Controlled BP, % (n=223,585)	Uncontrolled BP, % (n=95,464)	*p-value* [a]
Age group, years							
18-34	58.9	38.8	62.5	**<0.0001**	41.2	33.0	**<0.0001**
35-44	41.1	61.2	37.5		58.8	67.0	
Race or Hispanic ethnicity [b]							
White	62.1	61.7	62.2	**<0.0001**	63.9	56.7	**<0.0001**
Black	8.8	14.0	7.9		11.8	19.0	
Asian	2.8	1.7	3.0		1.7	1.5	
Hispanic	0.6	0.3	0.6		0.3	0.4	
Other	5.0	5.6	4.9		5.7	5.2	
Unknown	20.7	16.7	21.4		16.6	17.2	
Census region [c]							
Northeast	15.3	11.9	15.9	**<0.0001**	12.6	10.3	**<0.0001**
Midwest	17.4	15.8	17.7		16.5	14.1	
South	46.0	56.0	44.3		54.5	59.5	
West	21.3	16.3	22.1		16.4	16.1	
BMI, kg/m^2							
Underweight	1.8	1.0	1.9	**<0.0001**	1.2	0.5	**<0.0001**
Healthy Weight	30.3	17.4	32.6		20.8	9.1	
Overweight	21.4	18.6	21.8		20.2	14.9	
Obese	32.4	57.0	28.1		55.2	61.5	
Missing	14.2	6.0	15.6		2.6	14.0	
Currently used tobacco	8.1	13.4	7.2	**<0.0001**	13.7	12.7	**<0.0001**
Diabetes	3.7	12.4	2.2	**<0.0001**	12.2	12.8	**<0.0001**

Note:

Boldface indicates statistical significance ($p<0.05$).

BP cutoff for hypertension was ≥140/90 mmHg and hypertension control was <140/90 mmHg.

a: p-values were generated on the basis of Rao-Scott chi-square tests.

b: IQVIA combines race or Hispanic ethnicity in 1 field

c: Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania), Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota), South (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Los Angeles, Oklahoma, Texas), West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, Carolina, Hawaii, Oregon, Washington).

AEMR, Ambulatory Electronic Medical Records; BP, blood pressure; BMI, body mass index; WRA, women of reproductive age.

Table 2.

Hypertension Prevalence and Control Among WRA from IQVIA AEMR – U.S. 2019 Data

Characteristics	Crude Hypertension Prevalence, %	Age-standardized Hypertension Prevalence, %	Crude Hypertension Control, %	Age-standardized Hypertension Control, %
All WRA	15.0	14.5	70.1	71.9
Age group, years				
18-34	9.9	6.3	74.5	47.1
35-44	22.4	8.2	67.3	24.8
Race or Hispanic ethnicity [a]				
White	14.9	14.4	72.5	74.0 [e]
Black	23.7	22.3	59.3	60.6 [d,f]
Asian	8.8	8.0 [c]	72.6	75.5 [e,f]
Hispanic	9.0	9.0 [c]	62.0	64.8 [d]
Other	16.8	16.0	72.0	73.9 [e,f]
Unknown	12.2	11.9	69.3	71.4
Census region [b]				
Northeast	11.6	11.4	74.1	75.8 [g]
Midwest	13.7	13.3	73.3	75.0 [g]
South	18.3	17.5	68.2	69.8
West	11.5	11.2	70.5	72.7
BMI, kg/m^2				
Underweight	8.5	9.3	86.3	86.3 [h]
Healthy Weight	8.6	8.8	84.1	85.0 [h]
Overweight	13.1	12.5	76.0	77.9
Obese	26.4	24.2	67.7	68.6
Missing	6.4	6.2	30.7	33.0
Currently used tobacco				

Characteristics	Crude Hypertension Prevalence, %	Age-standardized Hypertension Prevalence, %	Crude Hypertension Control, %	Age-standardized Hypertension Control, %
Yes	24.7	22.8	71.6	73.4
No	14.2	13.7	69.8	71.6
Diabetes				
Yes	50.5	43.7	69.1	69.9
No	13.7	13.3	70.2	72.0

Note:

BP cutoff for hypertension was ≥140/90 mmHg and hypertension control was <140/90 mmHg.

Pairwise Tukey test was performed among all age standardized estimates. Pairs with nonsignificant comparisons (*p-value* ≥ 0.05) were annotated using the same superscript ("c", "d", "e", "f", "g", "h") in the table.

a: IQVIA combines race or Hispanic ethnicity in 1 field

b: Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania), Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota), South (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Los Angeles, Oklahoma, Texas), West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, Carolina, Hawaii, Oregon, Washington).

AEMR, Ambulatory Electronic Medical Records; BP, blood pressure; BMI, body mass index; WRA, women of reproductive age