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Research Paper

10-Year community prevalence and trends of severe asymptomatic hypertension among patients with hypertension in the USA: 2007–2016

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ABSTRACT

Background: Severe asymptomatic hypertension (SAH) is associated with significant health cost, morbidity and mortality.
Aim: Establish the nationwide prevalence, trends and associated sociodemographic characteristics of SAH among patients with hypertension in the USA.
Methods: We utilized the National Health and Nutrition Examination data collected over five survey cycles (2007–2016). Included were participants aged 20–80 years with self-reported diagnosis of hypertension. SAH was defined as having a mean systolic blood pressure (SBP) ≥180 mmHg and/or mean diastolic blood pressure (DBP) ≥120 mmHg at the time of examination. The Chi square test was used to compare prevalence across different categories. Associations between sociodemographic variables and SAH were assessed using multivariate binary logistic regression.
Results: The prevalence of SAH among patients with hypertension is 2.15% (95% CI 1.80–2.56), mainly explained by isolated mean SBP≥180 mmHg (86% of all cases), with no statistically significant change between 2007: 2.66% (95% CI 2.10–3.36) and 2016:2.61% [95% CI 1.73–3.94), p-trend = 0.17. Increasing age (OR 1.07, 95% CI 1.04–1.09), NH Blacks (OR 2.20, 95% CI 1.37–3.54), BMI< 25 (OR 2.52, 95% CI 1.48–4.28), lack of health insurance OR 4.92% (95% CI 2.53–9.54) and never married individuals (OR = 2.59%, 95% CI 1.20–5.60) were more likely to have SAH, comparatively. There was no significant association between duration of hypertension and SAH.
Conclusion: The prevalence of SAH in the USA is 2.15% and has been stable over the past decade. Our study underscores the importance of identifying barriers to screening and treatment of hypertension which is a major treatable risk factor for cardiovascular disease.

1. Introduction

Cardiovascular diseases constitute a major global health concern responsible for the highest rate of premature disability and death worldwide [1]. Hypertension remains the strongest risk factor for cardiovascular diseases such as stroke, ischemic heart disease and heart failure [2,3]. In 2010, 31.1% of adults globally were living with hypertension, representing a population of about one billion [1]. In 2018, 49.69% of US adults 20 years and older were living with hypertension, corresponding to 115 million persons [4].

Severe hypertension is defined as systolic blood pressure (SBP) ≥ 180 mmHg and/or a diastolic blood pressure (DBP) ≥120 mmHg. About three-quarters of these persons are usually asymptomatic and without any acute or impending change in target organ damage or dysfunction; termed severe asymptomatic hypertension (SAH). The most recent US guidelines no longer make this distinction in

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classifying hypertension. However, the European Society of Cardiology defines this severity of blood pressure as Grade 3 hypertension [6], underscoring its importance and highlighting classification challenges. Non-adherence to therapy among patients with hypertension remains the leading predisposing factor for hypertensive crises [5–10]. However, the absence of discernible clinical or laboratory end organ damage does not necessarily equate SAH to a purely benign state and thus must not be overlooked. Treatment for SAH consists in resumption of antihypertensive medications for non-adherent patients; intensification of antihypertensive therapy in adherent patients; and initiation of therapy for newly diagnosed patients [11–13], often without the need for hospitalization.

While it is common knowledge that appropriate treatment of hypertension remains the best preventive approach of hypertensive crises, a significant proportion of patients will eventually experience hypertensive crises [5,6,14,15]. Though there is considerable literature on the incidence of hypertensive crises in emergency departments, there is limited data on the community prevalence and sociodemographic characteristics. We aim to assess the community prevalence and trend of SAH and its determinants among participants with hypertension in the USA from 2007 to 2016.

2. Materials and methods

2.1. Survey design

The NHANES (National Health And Nutrition Examination Survey), conducted by the Centers for Disease Control and Prevention/National Center for Health, is a nationally representative survey on the health and nutritional status of non-institutionalized US population. It utilizes a multistage probability sampling design and collects information from approximately 5000 persons per year. Detailed information on the NHANES survey is available from the survey documentation [16].

2.2. Data collection

Survey participants were interviewed in their homes to ascertain demographic characteristics (age, gender, level of education, ethnicity, marital status, place of birth, health insurance, and smoking status among others); and comorbidities (diabetes, hypertension, age at diagnosis of hypertension and treatment status [whether issued a prescription for antihypertensive pills or not], and dyslipidemia). Questions on disease conditions were generally followed by 4 categorical response options ("Yes" "No" "Refuse" "Don't know"). Persons who responded "Refuse" and "Don't know" were classified as "No", which in most instances constituted less than 0.1% of all respondents. Persons who reported having smoked ≥100 cigarettes were classified as smokers. Body Mass Index (BMI) was calculated from measured weight and height and grouped into 3 categories (BMI<25.00, BMI 25.00–29.99, BMI≥30.00). The family poverty index (PIR) was calculated by dividing the total family income by the poverty threshold, as defined by the US census bureau, adjusting for family size at the time of the interview [17]. Family PIR was grouped into three categories (PIR<1.00, PIR 1.00–2.99 and PIR≥3.00).

Persons who had been told by their physicians as having hypertension on at least two separate occasions and/or reported being on antihypertensive medications were considered to have hypertension. At mobile examination centers (MEC), up to four separate blood pressure measurements were obtained using standardized protocols. Mean systolic (SBP) and diastolic (DBP) blood pressures were then computed and persons with mean SBP ≥ 180 mmHg and/or a mean DBP ≥120 mmHg were classified as having SAH. Persons with SBP <180 mmHg and DBP <120 mmHg were considered as not having SAH. All study questionnaires, exact question wording and response options are freely accessible [16]. Informed consent was obtained from all participants, and the institutional review board of the National Center for Health Statistics approved the protocol.

2.3. Statistical analysis

Relevant datasets from five survey cycles (2007–2016) were combined and analytical weights computed in keeping with analytic guidelines [18] to generate disease prevalence estimates representative of the USA civilian, noninstitutionalized population. Included in our analysis were participants≥20 years with previous diagnosis of hypertension or on antihypertensive pills. Participants were classified into two groups depending on the presence or absence of severe asymptomatic hypertension. The Chi square test for categorical variables was used to compare prevalence across the two categories. Trends of SAH was evaluated using binary logistics regression. Determinants of SAH were assessed using multivariate binary logistic regression. Analysis was done using STATA 16 (STATA IC 16.1, College Station, TX: StataCorp LP) with two-tailed p values < 0.05 considered statistically significant.

3. Results

3.1. Participant characteristics

A total of 50,588 individuals participated in the NHANES surveys from 2007 to 2016. Of these, 29,201 (57.7%) persons were in the age range 20–80 years, with a median age of 49 years (IQR 34 to 64). 9785 persons reported having been diagnosed of hypertension. About 75% of participants with hypertension were ≥50 years with a median duration since diagnosis of 9 years (IQR = 4–17), of which 91% reported having been issued prescriptions for antihypertensive pills. Most participants were married, US born, NH Whites and 56% had at least some form of college education. About 90% of study participants had health insurance while 17% lived in poverty. The prevalence of smoking, dyslipidemia and diabetes was 51%, 58% and 21%, respectively (Table 1).

3.2. Prevalence of severe asymptomatic hypertension and trend

The prevalence of hypertension among persons ≥20 years was 31.8%, corresponding to 72 million (95% CI 67–76 million) persons. The prevalence of severe asymptomatic hypertension was 2.15% (95% CI 1.80–2.56), corresponding to an absolute head count of 1.39 million (95% CI 1.15–1.63million) persons. The proportion of SAH explained by an isolated elevated SBP, isolated elevated DBP and by both elevated SBP and DBP was 85.8%, 7.3% and 6.9%, respectively. The prevalence of severe asymptomatic hypertension remained stable throughout the study period, 2.66% (95% CI 2.10–3.36) in 2007 and 2.61% (95% CI 1.73–3.94) in 2016, with p-trend of 0.17 as shown on Fig. 1.

In univariate models, severe asymptomatic hypertension was significantly and positively associated with increasing age and duration of hypertension. Participants with less than high school certificate, NH Blacks, widow (er)s, persons without health insurance and individuals living in poverty also had significantly higher prevalence compared to their respective counterparts. There was no statistically significant difference in prevalence of SAH by categories of smoking, dyslipidemia, diabetes, place of birth, antihypertensive treatment status and gender.

In a multivariate model, older persons, NH Blacks, participants with BMI<25 kg/m^2, never married and those without health insurance were more likely to have SAH, comparatively. NH Blacks were 2.20 (95% CI 1.37–3.54) times likely to have SAH compared to NH Whites. Also, persons without health insurance were 4.92 (95% CI 2.53–9.54) times likely to have SAH compared to those with health insurance. Persons with BMI <25 kg/m^2 (normal weight) were 2.52 (95% CI 1.48–4.28) times likely to have SAH compared to those with BMI≥30 kg/m^2 (obese). On a similar note, persons who had never been married were more likely to have SAH compared to those who were married or living together.

Table 1
Characteristics of study participants and prevalence of severe asymptomatic hypertension.

Variable	Categories	All (%) (n = 9785)	Hypertensive Urgency (%)		Odds ratio	*p*-value[a]
			Yes (n = 281)	No (n = 9504)		
Age (Years)	Overall (Median-IQR)	59 (49–70)	64 (55–80)	59 (49–69)	2.09 (1.75–2.49)	<0.001
	20 to <35	6.223	1.272	6.328	0.43 (0.13–1.38)	<0.001
	35 to <50	19.94	12.62	20.0	1.32 (0.84–2.06)	
	50 to <65	37.56	29.61	37.72	1.65 (1.08–2.52)	
	≥65	36.28	56.50	35.85	3.25 (1.72–2.54)	
Duration of hypertension (Years)	Overall (median-IQR)	9 (4–17)	12 (6–22)	9 (4–17)	NA	0.01
	0 to <5	28.42	17.97	28.64	1.30 (0.84–2.00)	0.006
	5 to <10	22.18	18.23	22.26	1.69 (1.06–2.68)	
	≥10	49.40	63.80	49.10	2.65 (2.11–2.65)	
Gender	Male	46.13	40.69	46.25	1.84 (1.33–2.55)	0.29
	Female	53.87	59.31	53.75	2.30 (1.80–2.94)	
Educational status	Less than HS	19.72	26.2	19.58	2.76 (2,06–3.69)	0.012
	HS or GED	24.30	28.39	24.21	2.43 (1.62–3.64)	
	Some college or Associate degree	32.18	33.98	32.14	2.20 (1.52–3.17)	
	College and above	23.80	11.44	24.07	1.00 (0.66–1.51)	
Ethnicity	Hispanic	9.00	9.065	12.30	2.83 (2.02–3.96)	0.001
	NH Black	14.18	14.37	14.37	3.4 (2.70–4.28)	
	NH White	71.04	70.80	59.91	1.77 (1.32–2.36)	
	Others	5.789	5.76	4.403	1.60 (0.86–2.95)	
Marital status	Never married	9.134	13.53	9.04	3.10 (1.94–4.91)	<0.001
	Married	63.43	44.24	63.84	1.46 (1.12–1.90)	
	Divorce	15.75	20.94	15.64	2.78 (1.75–4.40)	
	Widowed	11.69	21.29	11.49	3.81 (2.72–5.31)	
Place of Birth	USA	87.60	83.07	87.70	1.96 (1.41–2.73)	0.16
	Non-USA	12.40	16.93	12.30	2.83 (1.91–4.17)	
Health Insurance	Yes	89.60	79.15	89.82	1.84 (1.51–2.26)	<0.001
	No	10.40	20.85	10.18	4.19 (2.68–6.49)	
Poverty Index Ratio	<1	17.24	30.53	16.98	3.31 (2.25–4.85)	0.002
	1 to 3	42.05	38.84	42.11	1.73 (1.38–2.16)	
	≥3	40.71	30.62	40.90	1.41 (0.92–2.14)	
Body Mass Index	<25	15.92	30.63	15.62	3.92 (2.99–5.13)	<0.001
	25–30	31.93	32.87	31.91	2.10 (1.46–3.00)	
	≥30	52.14	36.5	52.47	1.43 (0.99–2.05)	
Smoking	Yes	51.06	51.24	51.05	2.10 (1.60–2.75)	0.97
	No	48.94	48.76	48.95	2.08 (1.61–2.70)	
Dyslipidemia	Yes	58.74	57.84	58.76	1.93 (1.42–2.63)	0.85
	No	41.26	42.16	41.24	2.01 (1.55–2.59)	
Diabetes	Yes	21.94	26.25	21.84	2.49 (1.83–3.38)	0.26
Hypertension treatment	No	78.06	73.75	78.16	1.96 (1.52–2.53)	
	Yes	90.89	96.67	90.77	2.22 (1.83–2.71)	0.06
	No	9.11	3.33	9.23	0.78 (0.25–2.38)	

HS: High school; GED: General education diploma; USA: United States of America.
[a] p-values obtained from comparison of prevalence of severe asymptomatic hypertension across categories.

There were no statistically significant associations between poverty, duration of hypertension and current treatment status and SAH. Full display of associations between socio-demographic characteristics and select comorbidities with SAH are shown on Table 2.

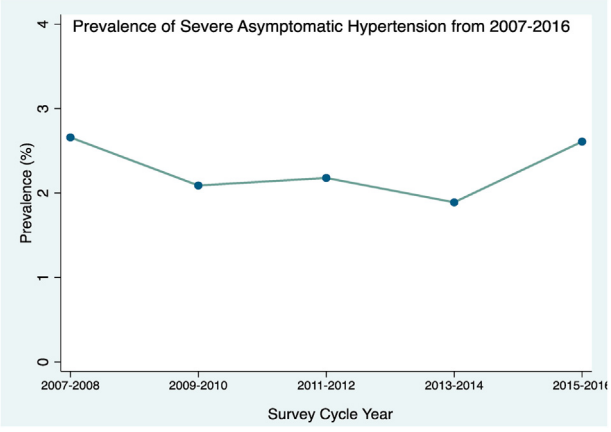

Fig. 1. Line plot showing prevalence of Severe Asymptomatic Hypertension by survey year ($p_{trend} = 0.17$).

4. Discussion

Using cumulative nationally representative data spanning a decade, we report a nationwide community prevalence of severe asymptomatic hypertension among persons with hypertension of 2.15% in the USA. This prevalence remained stable from 2007 through 2016. Older persons, NH Blacks, individuals with BMI<25, never married, individuals with higher levels of education and participants without health insurance were more likely to have SAH than their respective counterparts.

Our prevalence of 2.15%, corresponding to about 1.3 million individuals, is similar to the 2.0% reported by Caligiuri et al. in a hypertension awareness campaign in Canada [19]. Though with similar prevalence, the health awareness campaign included all-comers who were willing to participate in the study in contrast to the subset with hypertension in the current study. Our prevalence is however lower than the modal 5% reported by other authors [8,20,21]. This discrepancy is partly explained by the fact that these studies were carried out in health care settings, capturing both patients with severe asymptomatic hypertension and emergency, contrary to NHANES study that is conducted in a non-healthcare setting that captured participants with SAH. This suggests that a significant proportion of hypertensive patients live in a chronic state of severe hypertension and thus more likely to present with long term hypertension related complications as opposed to hypertensive emergencies.

Table 2
Factors associated with severe asymptomatic hypertension.

Variable	Categories	OR (95% CI)	p-value
Age		1.07 (1.04–1.09)	<0.001
Gender	Female	1	
	Male	1.23 (0.73–2.07)	0.430
Ethnicity	NH whites	1	
	Hispanics	1.77 (0.92–3.42)	0.090
	NH Blacks	2.20 (1.37–3.54)	0.001
	Others	0.68 (0.30–1.57)	0.363
Educational level	First degree and above	1	
	Less than high school	1.48 (0.72–3.06)	0.290
	High school or GED	2.05 (1.02–4.14)	0.045
	Some college/associate degree	2.01 (1.02–3.94)	0.043
Marital Status	Married or living with partner	1	
	Never married	2.59 (1.2–5.6)	0.016
	Divorce or separated	1.77 (0.92–3.4)	0.084
	Widowed	1.59 (0.83–3.05)	0.161
Health Insurance	Yes	1	
	No	4.92 (2.53–9.54)	<0.001
Poverty index ratio (PIR)	PIR≥3	1	
	less than 1	1.18 (0.6–2.33)	0.619
	PIR 1 to <3	0.67 (0.38–1.18)	0.162
Body mass index (in kg/m2)	BMI≥30	1	
	BMI less than 25	2.52 (1.48–4.28)	0.001
	BMI 25 to less than 30	1.39 (0.77–2.50)	0.268
Antihypertensives	Yes	1	
	No	0.54 (0.12–2.4)	0.421
Duration of hypertension		1.00 (0.99–1.02)	0.707

OR = Odds ratio, CI = Confidence interval, NH = Non-Hispanic, GED = General education diploma.

Studies have shown disparate results with regards to outcomes of hypertensive crises with some studies showing a benign course with low rate of MACE and others showing increased event rates. In one study by Patel et al., SAH when diagnosed in a clinic setting is associated with a low rate of conversion to hypertensive emergency and onset of major adverse cardiovascular event within 6 months [21]. However increased event rates of MACE have been observed in hypertensive crises seen in those presenting as emergency or needing hospitalization [22]. The stable prevalence of severe asymptomatic hypertension is despite the fact that there has been a trend in improved hypertension control [23]. There appears to be an unmet need in identifying individuals with SAH in the community underscoring the need for identifying the responsible factors and interventions in this subgroup.

We observed that participants without health insurance are five times likely to harbor severe asymptomatic hypertension. Lack of health care coverage can be an impedance to seek medical care and also afford medications. Nonadherence to prescribed medical therapy is the main predisposing factor for hypertensive crises, with laboratory confirmation through measurements of drug metabolites [6,8]. While medication acquisition is no guarantee for treatment adherence, it is certainly an undeniable pre-requisite. Finally, persons without health insurance are less likely to follow up with care providers for treatment review as well as adhering to recommended dietary and lifestyle modifications [24]. Interventions like "polypill" have been studied in underserved population with benefits observed in terms of reduction in blood pressure and low density lipoprotein cholesterol [25]. Consistent with prior studies, older age, NH blacks and never married individuals were more likely to have hypertensive crises [15,26–28].

Hypertensives with lower BMI were more likely to have SAH compared to obese participants. This observation, though counterintuitive, is not entirely novel and clear reasons remain poorly elucidated. However, previous authors have reported an obesity paradox in which obese individuals had a somewhat better cardiovascular disease profile comparatively. Possible explanations include increased disease awareness, decreased global sympathetic activity and increased access to healthcare services among others [29–31]. Also, we observed a nonlinear association between level of education and SAH which runs counter to the widely reported increased burden and poor control rates in less educated individuals [4]. Being a cross sectional study, this might be explained by residual confounding. Also, this may suggest that while a higher proportion of less educated individuals have poorly controlled blood pressure, they are largely below the range for SAH. We encourage researchers to consider exploring the associations between obesity and level of education and SAH in future projects.

4.1. Strengths and limitations

Though the first nationally representative study on the community prevalence of SAH among patients with hypertension, lack of clinical and laboratory data might have led to misclassification of a few participants with end organ damage. However, it is very unlikely that persons with hypertensive emergency would have remained asymptomatic to show up at MEC for appointments and complete the data collection procedures. Also, hypertension status was self-reported which could lead to misclassification. Furthermore, participants were examined once and thus we are unable to establish if the severely elevated blood pressure was a transient observation (maybe related to the whitecoat phenomenon) or a persistent state. Notwithstanding, the use of standardized BP measuring procedures with up to 4 values allowed for accurate determination of blood pressure and classification of patients. Despite these limitations, we have been able to identify subgroups with disproportionately higher burden of severe asymptomatic hypertension. Studies to identify barriers and the impact of interventions both from health policy and health care provider standpoint are needed.

5. Conclusion

The community prevalence of SAH among patients with hypertension in the USA is 2.15% and has remained stable over of the past decade. Increasing age, never married individuals, persons without health insurance, NH Blacks, individuals with BMI <25 kg/m^2 and higher level of education persons harbor disproportionately higher prevalence of SAH. Interventions aimed at reducing the burden of severe hypertension at the community level are much needed.

Author contributions

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Supervision: Sudarshan Balla

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Declaration of competing interest

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