Predictors of Congruency between Self-reported Hypertension Status and Measured Blood Pressure in the Stroke Belt

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Abstract:

Background:

Few studies have comprehensively investigated the validity of self-reported hypertension (HTN) and assessed predictors of HTN status in the stroke belt. This study evaluates validity self-reporting as a tool to screen large study populations and determine predictors of congruency between self-reported HTN and clinical measures.

Methods:

Community Initiative to Eliminate Stroke project (n = 16,598) was conducted in two counties of North Carolina in 2004 to 2007, which included collection of self-reported data and clinical data of stroke-related risk factors. Congruency between self-reported HTN status and clinical measures was based on epidemiological parameters of sensitivity, specificity, and predictive values. McNemar's test and Kappa agreement levels assessed differences in congruency, while odds ratios and logistic regression determined significant predictors of congruency.

Results:

Sensitivity of self-reported HTN was low (33.3%), but specificity was high (89.5%). Prevalence of self-reported HTN was 16.15%. Kappa agreement between self-report and clinical measures for blood pressure was fair (k = 0.25). Females, whites, and young adults were most likely to be positively congruent, whereas individuals in high risk categories for total blood cholesterol, low density lipoproteins, triglycerides, and diabetes were least likely to accurately capture their HTN status.

Conclusion:

Self-report HTN information should be used with caution as an epidemiological investigation tool.

Keywords: Hypertension | validation | self-reports | sensitivity | systolic blood pressure | diastolic blood pressure

Article:

Introduction

Hypertension (HTN) is a silent killer affecting one in three U.S. adults.[1] In 2010, it was estimated that HTN cost the U.S. $76.6 billion in missed days from work and medical care, including medications.[2] HTN is a major risk factor for cardiovascular disease (CVD) and stroke, which are among the three leading causes of death in the U.S.[3] According to the Framingham Heart Study, the lifetime risk for developing HTN after the age of 55 years is 90% for both nonhypertensive men and women.[4] Since the inception of the National High Blood Pressure Education Program in 1972, there have been continued efforts to raise awareness, treat, and control HTN, but unfortunately, uncontrolled blood pressure (BP) levels continue to remain high.[2, 5, 6 and 7]Therefore, it is imperative to enhance epidemiological surveillance and population-based public health strategies aimed at secondary prevention of HTN and primary prevention of CVDs and stroke.

Typically, epidemiological studies that are focused on HTN, its risk factors, and its outcomes require large sampling populations and assessment of clinical measures. These studies can get very time-consuming and expensive.[5, 8, 9, 10 and 11] Therefore, emphasis is placed on conducting small-scale, cross-sectional or cohort studies, and rely on self-reported information about one's HTN status.[5, 8, 9, 10, 11, 12 and 13] These small-scale studies can be conducted at local or state levels and are practical, inexpensive, and can be comprehensively assessed. Results from these studies would enable health researchers and practitioners to design community-based interventions targeting populations in most need. The Community Initiative to Eliminate Stroke (CITIES) project of North Carolina (NC) was a 3-year small-scale project implemented in two NC counties, Guilford and Forsyth, and targeted persons of color, low-income, and rural residency as well as persons for whom English was a second language. The main components of the project were: (a) to screen individuals and assess self-reported and clinical risk factors of stroke; (b) make recommendations and referrals as appropriate for identified risk factors; and (c) provide health education and health promotion activities to reduce the prevalence of stroke risk factors.

The National Health and Nutrition Examination Survey (NHANES) program has collected self-reported data in combination with physical data since 1960.[14] Studies examining the trends in NHANES data found between 1999 and 2010 the prevalence of HTN remained high while awareness, management, and control of HTN remained poor. Their findings were consistent with those from other studies as well.[15, 16 and 17] The Centers for Disease Control has recognized the bias and possible errors in using self-reported data, but determined that, for large population-based studies, self-reported data may be most accurate.[14] In assessing self-reported risk factor data, it is important to pay particular attention to the validity of the information collected and how well this information reflects the clinical measures of BP levels.[5, 9, 10, 11, 18 and 19] Validity studies involve epidemiologic assessment and reporting of sensitivity, specificity, and predictive values. Few studies have evaluated the validity of self-reported information in the U.S., particularly at regional and state levels.[9, 11 and 20] Furthermore, very little is known about the predictors of congruency between self-reported information and one's actual HTN status.

Albeit these studies have found mild to moderate sensitivity and high specificity, recommendations to utilize self-report as a valid tool to screen large numbers of individuals have been mixed. Even guidelines and definitions for both self-report and clinical measures of BP have evolved over the last three decades. Therefore, the interpretation of results in some of these studies becomes difficult in light of the current Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) guidelines and definition of HTN.

The purpose of this paper is two-fold: (a) to assess the validity of self-reported HTN status compared with clinical measures of BP levels in a cross-sectional pool of participants from the CITIES project using the most current JNC guidelines; and, (b) to determine predictors of the level of congruency between one's self-reported information and actual BP measures at the state level. This assessment will not only allow investigators to evaluate self-reported data as an expedient and reliable tool to screen larger numbers, but also enable health professionals to design and implement targeted educational messages aimed at raising awareness of HTN and its risk factors.

Methods

Settings and Procedures

Registered nurses (RNs) used mobile units to screen individuals at sites such as churches, factories, health fairs, etc. within the two respective counties. A total of 19,621 individuals were screened for stroke risk factors in the CITIES project. Participation was voluntary, and each participant was included in this study if they were 18 years or older and signed the consent form. The RNs used a standard questionnaire that was divided into three distinct categories, including demographic information, self-reported stroke risk factors, and clinical and biomedical measures of stroke risk factors.[21] The participants were asked to self-report their HTN status by answering the following question: "Do you suffer from high blood pressure and/or has a physician/doctor/nurse diagnosed you as a hypertensive?" Inclusion criteria was based on a 'yes' response to the question.

The RNs measured the blood pressure of each participant using an electronic machine, DINAMAP (General Electric Healthcare, Bukinghamshire, UK), which was wet-tested and calibrated every week. A minimum of two measures were taken in the seated position with the arms outstretched, and the lowest BP reading was recorded. If the first reading was high, then BP was measured again after 2 minutes in the same arm. If the readings on the machine were found to be high on both occasions, then the registered nurses would manually measure the blood pressure twice in the other arm using a calibrated sphygmomanometer, and then record the lowest readings.

Other self-reported information included overweight status, smoking, exercise status, and use of BP-lowering and lipid-lowering medications. All self-reported information was collected prior to measuring BP and collection of blood samples. Clinical and biomedical measures included blood low density lipoproteins, high density lipoproteins (HDL), total cholesterol, triglycerides, and glucose levels. Blood measures were obtained using finger prick blood screening procedures. Body mass index (BMI) was calculated based on height and weight measures. The RNs also collected demographic information such as age, gender, education, etc. from all participants. The project was approved by the respective Institutional Review Boards for all institutions.

Statistical Analyses

JNC 7 defines HTN as having a systolic BP level of 140 mm Hg or more and/or diastolic BP levels of 90 mm Hg or more. Our gold standard, that is, possible diagnosis of HTN in our sample, was computed based on systolic and diastolic blood pressure levels and classification parameters of HTN proposed by JNC 7.[4] Thus, possible diagnosis of HTN was defined as systolic BP levels of 140 mm Hg and/or diastolic BP of 90 mm Hg or more. MS Access (Microsoft Corp, Redmond, Wash) was used to input data, which was analyzed using SPSS 18 (IBM, Armonk, NY).[22 and 23]

The final sample excluded individuals who were taking BP-lowering medications in order to avoid confounding and overestimation of sensitivity of the screening test. The participants' demographic characteristics, self-reported information, and clinical measures were described using frequencies and percentages. Bivariate associations were calculated using cross-tabulations to compare self-reported information ('yes' and 'no') from the questionnaire with possible diagnosis of HTN ('yes' and 'no') based on BP measures. The validity of the self-reported information was evaluated on the basis on sensitivity, specificity, and positive and negative predictive values. In addition, we also conducted separate analysis to test the validity of self-reported information by including, in our final sample, a subsample of previously excluded individuals (those taking antihypertensive medications). McNemar's test was used to ascertain differences between positively congruent individuals and those who were negatively congruent. Kappa (κ) scores were used to assess agreement between self-reported status and possible diagnosis of HTN. A κ score of less than 0.20 was considered poor agreement, 0.20 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and more than 0.81 as almost perfect agreement.[24]

The dependent outcome variable between self-reported information and clinical data was computed using the cross-tabulations for self-reported and possible diagnosis of HTN. The outcome variable ‑ congruence (positive or negative) ‑ was defined as the state of agreement between self-reported (yes or no) and possible diagnosis of HTN (yes or no). Positive congruence was taken as a measure of being aware of one's HTN status given a possible diagnosis of HTN, whereas negative congruence was taken as a measure of being unaware of one's HTN status given a possible diagnosis of HTN. Odds ratios and confidence intervals (CI) at 95% were calculated using standard procedures to assess determinants of positive congruency. The outcome variable that is the state of agreement between self-reported and possible diagnosis of HTN was modeled as a function of independent variables including demographic characteristics, self-reported information, and clinical measures. Binary logistic regression and forward likelihood ratio method were used to evaluate statistically significant predictors of HTN congruency. The statistical significance for all analyses was based on the conventional alpha level of significance of 0.05.

Results

Table 1 presents the demographic characteristics of the participants. A majority of the participants in the CITIES project were females. Approximately 50% of the participants were Caucasians. More than half (62.2%) of the participants were aged 41 years or older, with a mean age of 45.26 (standard deviation, 13.9). Approximately 60% of the participants reported an annual income of less than $35,000, while more than half of the participants had more than high school education.

Table 1. Demographic characteristics of respondents* in CITIES project, NC (2004‑2007)

Personal Characteristics	Totals	
	N (16,598)	%
Gender		

Male	5747	36.3
Female	10,087	63.7
Race		
Caucasian	7329	47.1
African American	6758	40.7
Hispanic	514	3.3
Asian/Pacific Islander	456	2.9
Other	513	3.1
Age		
18 to 40 years old	5965	38.0
41 to 55 years old	6285	40.0
≥56 years old	3454	22.0
Income		
<$35,000	9735	64.7
≥$35,000	5308	35.3
Education		
Less than high school	1122	7.2
High school or General Educational Development	4598	29.5
More than high school	9859	63.3
Ethnicity		
Hispanic/Latino	514	3.3
Non-Hispanic/Latino	15,056	96.7

∗Totals do not sum to the sample size due to missing data.

Self-reported risk information is presented in Table 2. Almost 85% of the participants self-reported ‘no,’ when they were asked, “Do you suffer from high blood pressure and/or has a physician/doctor/nurse diagnosed you as a hypertensive?" The results of the clinical measures of the participants are reported in Table 3. Less than one-quarter, that is 20.5% and 14.2%, of the participants had systolic or diastolic HTN in stages I or II, respectively. Among those who self-reported as having HTN, slightly more than half of the participants were confirmed to have clinical HTN stages I or II for a positive predictive value of 51.2%. More than three-quarters (80.3%) of the participants who self-reported as nonhypertensive were confirmed not to have a possible diagnosis of clinical HTN stages I or II. Overall, the sensitivity of self-report for correctly identifying those who have HTN was 33.31%, while the specificity, that is, correctly identifying those who did not have HTN, was 89.5%. The prevalence of HTN in this sample was 16.15% based on self-reporting and 24.81% based on clinical measures of BP. A separate analysis using our original sample (n = 16,598) and adding previously excluded individuals, that is those taking antihypertensive medications (n = 2663), found the sensitivity and specificity self-reporting was 49.56% and 80.29%, respectively. The overall prevalence rate of HTN with the sub-sample (n = 2663) included to our final sample was 28.1%. McNemar's test showed that there was a statistically significant difference between those who were positively congruent and those who were not ($P < .05$). The overall κ score for agreement between self-reported and clinical measures of BP was 0.25. The multivariate logistic regression found that gender ($P < .01$), race ($P < .01$), age ($P < .01$), family history of CVD ($P < .01$), self-reported diabetes status ($P < .05$), total blood cholesterol ($P < .15$), HDL levels ($P < .01$), blood triglyceride levels ($P < .01$), and BMI ($P < .01$) were statistically significant predictors of congruency (see Table 4). These results were similar to the bivariate associations discussed above. Cross-tabulations and unadjusted odds ratios (ORs) were conducted to further explore level of congruency between select groups of individuals that were found to be significant predictors. Approximately four-fifths of the participants (88%) that were white females aged 18 to 40 years old were positively congruent, that is, more aware of their HTN status (n = 3768).

Table 2. Self-reported characteristics of respondents* in CITIES project, NC (2004‑2007)

Self-reported Characteristics	Totals	
	N (16,598)	%
Personal history of CVD		
Yes	701	4.2
No	15,897	95.8
History of atrial fibrillation		
Yes	7329	47.1

No	6758	40.7
Family history of CVD		
Yes	3868	23.3
No	12,730	76.7
Smoking status		
Yes	2880	17.4
No	13,718	82.6
Overweight status		
Yes	8248	49.7
No	8350	50.3
Lack of exercise status		
Yes	7891	47.5
No	8707	52.5
Hypertension status		
Yes	2555	15.4
No	14,043	84.6
High blood cholesterol status		
Yes	2771	16.7
No	13,827	83.3
Diabetes status		
Yes	868	5.2
No	15,730	94.8
Stress status		
Yes	3726	22.4

No	12,872	77.6

CVD, cardiovascular disease.
∗Totals do not sum to the sample size due to missing data.

Table 3. Clinical characteristics of respondents* in CITIES project, NC (2004‑2007)

Clinical Characteristics	Totals		
	N (16,598)	%	Mean
Low density lipoprotein			108.54 mg/dL
Very high risk (≥190 mg/dL)	297	2.3	
High risk (160–189 mg/dL)	892	7.0	
Borderline high risk (130–159 mg/dL)	2646	20.7	
Near optimum/above optimum (100–129 mg/dL)	5076	39.7	
Optimum (≤99 mg/dL)	3874	30.3	
High density lipoprotein			50.32 mg/dL
High risk (<40 mg/dL)	4072	26.1	
Normal (40–59 mg/dL)	7678	49.1	
Preventive (≥60 mg/dL)	3876	24.8	
Total cholesterol			189.1 mg/dL
High risk (≥240 mg/dL)	1537	9.8	
Moderate risk (200–239 mg/dL)	4214	26.8	
Normal (≤199 mg/dL)	9959	63.4	
Triglyceride			155.55 mg/dL
High risk (≥200 mg/dL)	3605	23.0	
Borderline high risk (150–199 mg/dL)	2696	17.2	

Optimum (≤149 mg/dL)	9378	59.8	
Blood glucose			100.91 mg/dL
High risk (≥200 mg/dL)	261	1.7	
Moderate risk (150–199 mg/dL)	472	3.0	
Normal (50–149 mg/dL)	14,995	95.3	
Body mass index			28.60
Obese (≥30)	5318	34.0	
Overweight (25–29.9999)	5496	35.1	
Normal (18.5–24.9999)	4623	29.5	
Underweight (≤18.5)	209	1.4	
Systolic blood pressure			127 mm Hg
Hypertension stage II (≥160 mm Hg)	666	4.2	
Hypertension stage I (140–159 mm Hg)	2560	16.3	
Prehypertension (120–139 mm Hg)	7079	45.0	
Normal (≤119 mm Hg)	5428	34.5	
Diastolic blood pressure			78.98 mm Hg
Hypertension stage II (≥100 mm Hg)	431	2.7	
Hypertension stage I (90–99 mm Hg)	1816	11.5	
Prehypertension (80–89 mm Hg)	5128	32.6	
Normal (≤79 mm Hg)	8358	53.2	
Combined blood pressure (systolic and diastolic)			NA
Hypertension stages I and/or II	1519	9.7	
Normal and/or prehypertension	14,122	90.3	

∗Totals do not sum to the sample size due to missing data.

Table 4. Logistic regression: predictors of negative congruency by demographic, self-reported, and clinical characteristics in CITIES project, NC (2004‑2007)

Participant Characteristics	β	Odds Ratio (95% CI)	*P*
Gender			
Female (reference)	–	–	–
Male	0.329	1.389 (1.261, 1.530)*	.00
Race			
Caucasian (reference)	–	–	–
African Americans	0.163	1.178 (1.069, 1.296)*	.00
Hispanics/Latinos	0.313	1.367 (1.028, 1.817)*	.03
Asians/Pacific Islander	0.152	1.165 (0.883, 1.537)	.28
Others	0.145	1.156 (0.887, 1.507)	.28
Family history of CVD			
No (Reference)	–	–	–
Yes	0.175	1.191 (1.078, 1.316)*	.00
Diabetes status			
No (Reference)	–	–	–
Yes	0.214	1.238 (1.021, 1.281)*	.03
Triglycerides			
Normal (reference)	–	–	–
Moderate risk	0.129	1.137 (1.010, 1.281)*	.03
High risk	0.210	1.234 (1.095, 1.391)*	.00
High density lipoprotein levels			
Preventive (reference)	–	–	–

Normal	−0.156	0.856 (0.761, 0.962)*	.00
High risk	−0.051	0.950 (0.824, 1.097)	.48
Age			
18 to 40 years old (reference)	–	–	–
41 to 55 years old	0.632	1.881 (1.688, 2.097)*	.00
Older than 55 years old	1.088	2.969 (2.628, 3.354)*	.00
Total blood cholesterol levels			
Normal (reference)	–	–	–
Moderate risk	0.140	1.151 (1.041, 1.272)*	.00
High risk	0.235	1.264 (1.096, 1.459)*	.00
Body mass index			
Normal (reference)	–	–	–
Underweight	−0.150	0.861 (0.538, 1.371)	.53
Overweight	0.295	1.343 (0.842, 2.143)	.22
Obese	0.610	1.841 (1.152, 2.941)*	.11

CVD, cardiovascular disease.
$\chi^2 = 4.654$*.
*Significant at $P < .05$.

Discussion

Our results indicate that the overall prevalence of hypertension was approximately 23%, less than the national prevalence of 29.5% during 2009 to 2010.[25] Two reasons why our sample exhibited lower prevalence compared with the national trends are: 1) our sample excluded individuals who were taking any BP-lowering medications to avoid confounding and inflating the number of true negatives or false positives. Upon conducting a separate analysis by including these individuals in the original sample, we found that the overall prevalence of HTN was 28.1%, which is comparable to the national trends. 2) Our sample also included younger individuals who were 18 to 20 years old as opposed to national results that typically include individuals 20 years and older. Our results indicate that the level of congruency between self-reported and clinical measures of HTN is low. The sensitivity of self-reported HTN status was only 33%. In comparison, other studies that have employed a heterogeneity of research methodologies to investigate validity reported a moderate to high sensitivity of approximately 50% to 90%.[9, 10, 11, 13, 18, 20, 26, 27, 28, 29, 30, 31 and 32] Only one study, the Utrecht Health Project, reported results similar to ours with a sensitivity of 34.5%.[19]Conversely, the specificity of self-reported HTN status of 89.5% in our sample was high and was similar to specificity reported in other studies.[9, 10, 11, 13, 18, 19, 20, 26, 27, 28, 30, 31 and 32] The results of high specificity are particularly encouraging, since it has been postulated that, in the long-term, new incident cases of HTN will be eventually diagnosed upon long-term follow-up.[5]

We used McNemar's test and kappa score classification to measure the strength of agreement between self-reported and clinical measures of HTN.[24] The overall κ scores indicated only fair agreement between the two in comparison to other studies that have shown a moderate to substantial agreement.[5, 9, 10, 12, 28, 32 and 33]Two reasons why validity of self-reported HTN was low in our sample could be because HTN has a less clear-cut diagnostic criterion in comparison to other diseases, like diabetes, fractures, and breast cancer, and HTN is a silent killer that does not present clinical signs and symptoms on a daily basis.[8 and 19] As a result, the clinical measures, diagnosis, and short- and long-term implications of having HTN may not be easily perceived and understood by the patient. Therefore, it becomes increasingly important for physicians to accurately assess, diagnose, and treat HTN and for health professionals to raise awareness of the condition among both physicians and patients.

We also found that certain subgroups in our sample were more congruent, that is, able to report their HTN status more accurately compared with others. Females, whites, and younger adults were more accurately aware of their HTN status. Similarly, persons who self-reported as normal weight, without a personal or family history of CVD, and without diabetes were also generally more aware of their HTN status compared with those who reported a history of CVD, diabetes, and/or felt they were overweight or obese. Similar findings have been reported by Muhajarine et al.[34] Interestingly, our analysis found that individuals who fell into high-risk categories for blood cholesterol, low density lipoproteins, HDL, triglycerides, glucose levels, and/or BMI were least likely to be congruent compared with individuals who were found to be within normal limits for any of those levels. Based on these findings, it seems that individuals who feel that they are unhealthy based on their self-reported overweight and exercise status or those who have high risk factors for developing HTN or any other CVD appear to be least aware of their HTN status. One hypothesis for this occurrence could be that these individuals are less likely to see a physician for annual check-ups, thereby falling into a vicious cycle of not knowing what their actual health assessment is, leading to a lack of awareness of clinical correlates of HTN and CVD and its associated prevention strategies. These individuals then continue to engage in unhealthy behaviors and are thus less likely to change or modify lifestyle behaviors for the betterment of their health.

Giles et al have found that individuals who had a preventive health care check-up in the last year were more likely to be aware of their HTN status.[13] This finding supports the notion that public health campaigns designed to raise awareness of HTN and its correlates should also focus on encouraging individuals to access preventive care services, that is, getting annual physical check-ups. The diabetes education and screening program conducted at Smith Island showed that participants became more aware of their health risks associated with diabetes, HTN, and high cholesterol as a result of the screenings and counseling offered during the screening services.[35] Moreover, the follow-up rates for annual clinic visits increased due to continued efforts to raise awareness and educate residents about these conditions. Although this program was focused on diabetes, interventions targeting HTN could be modeled after the Smith Island program to raise awareness of the risk factors of HTN and highlight the importance of periodic health check-ups.

The strengths of this study include a large cross-sectional sample size and the availability of clinical measures of BP and other associated correlates. Almost half of our sample included African Americans, who are at the highest risk of developing hypertension at an early age, reach advanced levels of hypertension, are prone to experience further complications, and are less likely to attain control of their hypertension.[36]Furthermore, this study was conducted in one of the stroke belt states, NC, which has higher than average stroke mortality rates. Therefore, the results from this study could be used to inform future education strategies and interventions, especially in other southeastern states with high stroke mortality rates targeting minority populations. All individuals who self-reported as taking BP-lowering medications were excluded from this study. Since these individuals were automatically considered as self-reported hypertensive, their inclusion would have led to an over-estimation of sensitivity of the screening test.

One limitation of this study was that participation in this study was voluntary as opposed to recruitment of a more generally representative segment of the population. As a result, this study may have missed capturing information from nonparticipants with a different set of knowledge about HTN and its correlates. Another limitation of the study was the use of only two readings of clinical BP in order to determine possible diagnosis of HTN. The clinical measures of BP varies during the day and from day-to-day; therefore, more stringent criteria have been suggested to diagnose HTN in order to avoid over-estimation of clinical HTN.[6, 9, 37,38 and 39] Another possible limitation is ‘white-coat HTN,’ which reflects the stressful influence of nurses and the presence of clinical staff on one's BP.[9 and 40]

In summary, self-reported information for HTN should be used only with great care as a screening tool in large, population-based studies. This study found that individuals who had a possible diagnosis of HTN based on their clinical measures were likely to report as not having HTN. Thus self-reporting could lead to an under-estimation of the prevalence of HTN in our population. Several participant characteristics were identified as potential predictors of decreased awareness of one's HTN status, including males, African-Americans, those age 55 years and older, and those who were in a high-risk category for several HTN and CVD correlates. Future interventions should employ strategies that increase availability and encourage participation of individuals in preventative care services, including getting an annual physical. Although the diagnosis of HTN is a more involved process, future research could focus on evaluating the accuracy of screening data as an indicator of actual diagnosis of HTN.

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