Measuring the Effects of Screening Programs in Asymptomatic Employees: Detection of Hypertension Through Worksite Screenings

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Objective: To evaluate the effectiveness of workplace screenings on identification, subsequent follow-up, and treatment of patients with undiagnosed hypertension. **Methods:** Claims data and screening values for 31,281 individuals from 21 self-insured employer groups were combined with zip code–level information and analyzed using multilevel logit models. **Results:** Up to 17.6% of individuals without a previous indication of hypertension in the administrative data exhibited high blood pressure (140/90 or greater) at screening. In the month following workplace screening, significant increases were noted, using administrative claims, in the number of new diagnoses for hypertension (odds ratio: 1.81; $P < 0.0001$) and new prescriptions for antihypertensive drugs (odds ratio: 2.27; $P < 0.0001$), primarily among individuals with high blood pressure at screening. **Conclusions:** Workplace screening programs offer a potential approach to identify undiagnosed hypertension in employees and ensuing therapeutic management.

Hypertension affects approximately 30% of the adult population in the United States.[1] Early diagnosis and management of hypertension are important in preventing disease progression. Two thirds of people with hypertension in the United States may be untreated or undertreated.[2] Many individuals may be asymptomatic in the early stages of mild disease and remain undiagnosed.

In the United States, African Americans have the highest prevalence of hypertension as well as lower blood pressure control compared with non-Hispanic whites.[1,3–5] Lower rates of antihypertensive medication adherence have also been demonstrated in the African American population.[6] Socioeconomic status also impacts blood pressure; a higher prevalence of hypertension exists among low-income and less-educated individuals.[1,7]

Access to health care services is an important factor in the appropriate diagnosis and ongoing management of hypertension. The lack of health insurance has been implicated as a barrier to accessing health care.[8] Nevertheless, in the National Health and Nutrition Examination Survey III study, 92% of individuals with undiagnosed hypertension had health insurance, indicating that barriers to proper hypertension diagnosis remain even within the insured population.[2,9] There are also disparities in care within insured populations on the basis of sex, race, income, education, and urban versus rural geography.[10,11] For example, insured African Americans are still at increased risk for hypertension, and insured rural residents have historically had decreased access to care.[10]

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The United States Preventive Services Task Force recommends screening for high blood pressure in adults 18 years and older.[12] Although screening at a physician's office or other medical establishment is fairly routine, screening in the workplace is another method for identifying patients with undiagnosed chronic conditions, such as hypertension. Although gaining popularity among employers, more research is needed to understand the effects of such workplace disease prevention programs.[13] Workplace hypertension has been documented in several studies and is often thought to be related to job stress.[14,15] Nevertheless, individuals with workplace hypertension have been shown to have higher blood pressures at their medical checkups than individuals without workplace hypertension.[15] This study focuses on whether patients with undiagnosed hypertension are being identified during worksite screenings and their medical follow-up. This study also explores demographic characteristics that may predict which employees are more likely to have undiagnosed or poorly controlled hypertension.

METHODS

The data in this study are based on a subset of individuals from 21 self-insured employer groups utilizing a preferred provider organization and for whom both medical and pharmacy claims data were available. The employer groups utilize various regional and national health plans, both for-profit and not-for-profit, and pharmacy benefit managers. All data were provided directly by the health plans. The sample is restricted to individuals who are at least 18 years of age and took the opportunity to participate in an on-site screening from January 1, 2012, to December 31, 2013, and for whom medical claims data were available 24 months before the screening date through 3 months after the screening date ($N = 32,846$). In addition, the sample excludes individuals with evidence of (1) pregnancy during the 12-month period before the biometric screening event ($N = 684$) and (2) heart disease ($N = 720$) or (3) end-stage renal disease in the available medical history before the screening event ($N = 53$). Administrative claims data are commonly used to identify health conditions for surveillance and research[16,17] and are used here to identify individuals with hypertension or diabetes. Individual-level data are combined with zip code–level race/ethnicity, education, and income information extracted from tables B03002, B15002, and B19013, respectively, from the 2008 to 2012 American Community Survey 5-year estimates.[18] The level of urbanization was based on the 2010 urban area to zip code tabulation area relationship file[19] using the residential zip code of the respondent. Individuals with missing zip code information were dropped from the sample ($N = 108$). The study sample is composed of a total of 31,281 individuals with medical and pharmacy claims data, biometric screening data, and zip code information. Characteristics of the sample are detailed in Table 1.

The workplace screenings used in this study are conducted by primary emergency medical technicians and paramedics trained in manual blood pressure measurement, including proper body positioning during measurement. Blood pressures are measured manually using a stethoscope and the appropriate size brachial pressure cuff with a sphygmomanometer. Equipment is inspected on a routine basis to ensure accuracy. Individuals with measurements outside of

TABLE 1. Sample Characteristics ($N = 31,281$)

Individual-Level Characteristics	*N*	%
Sex		
Male	16,615	53.1%
Female	14,666	46.9%
Age (yrs)		
18–34	7,632	24.4%
35–49	12,728	40.7%
50–64	10,278	32.9%
65+	643	2.1%
Conditions		
Diagnosis of hypertension (12 mo prior)	4,555	14.6%
Prescription for antihypertensives (12 mo prior)	4,863	15.6%
High BP at screening (≥140/90 mm Hg)	6,458	20.7%
Diabetes identification (using 24 mo of claims prior)	1,321	4.2%
Obese (BMI ≥30.0 kg/m^2)	11,241	35.9%
Urbanization		
Rural	3,526	11.3%
Urban	27,755	88.7%
Zip code–level characteristics	**Mean**	**Median**
Share urban	84.2%	97.6%
Median education	13.7 yrs	14.0 yrs
Median income ($10,000)	6.2	5.9
Race/ethnicity		
Non-Hispanic white	70.4%	76.4%
African American	11.5%	5.0%
Asian/Pacific Islander	4.3%	2.4%
Hispanic	11.5%	6.0%
Other	2.4%	2.0%

BMI, body mass index; BP, blood pressure.

the recommended range during screening are advised to follow up with their personal physician.

For individuals with multiple screening events during the study period, only the latest screening date is used. Hypertension diagnosis in the claims data is based on the presence of a related International Classification of Diseases, Ninth Revision (ICD-9) diagnosis code in the medical claims data (ICD-9 dx: 401.xx in any setting). Typically, a hypertension diagnosis by a medical doctor is based on measurements during multiple visits on distinct days. Thus, a blood pressure measurement at a single screening event is not sufficient by itself to identify an individual with hypertension. For the purposes of identifying individuals at risk for hypertension or individuals with uncontrolled hypertension, high blood pressure at the time of screening is defined as a systolic blood pressure of 140 mmHg or higher or a diastolic blood pressure of 90 mmHg or higher.[20] Diabetes and obesity are important confounders for hypertension and the diagnosis of hypertension. Obese individuals are identified based on their body mass index (BMI 30.0 kg/m^2 or greater) measured at the time of screening. Individuals with diabetes are identified using an administrative claims-based algorithm if they experienced the following during the 24 months preceding the screening: (1) a diagnosis of diabetes (ICD-9 dx: 250.xx, 357.2x, 362.0x, 366.41, 648.0x) rendered at a minimum of two outpatient or nonacute inpatient settings on different dates of service, (2) a diagnosis of diabetes during an encounter in an acute inpatient or emergency department setting, or (3) received insulin or oral hypoglycemic/antihyperglycemic medications on an ambulatory basis (using criteria defined by the Healthcare Effectiveness Data and Information Set[21]).

Statistical Analyses

Multilevel logit models are estimated for the prevalence of high blood pressure or hypertension at the time of screening and the prevalence of high blood pressure consistent with undiagnosed hypertension at screening. The models are estimated at individual and zip code levels, with a random intercept at the zip code level to account for the correlation in the residuals due to the geographic clustering of individuals. This use of a hierarchical model using random effects has been implemented by others to account for unobserved variation and improve the estimates of standard errors when working with aggregate zip code–level data.[22] Each model is estimated separately with and without obesity and diabetes identification to evaluate whether this information meaningfully changes the association with demographic and socioeconomic variables and the outcomes of interest. All models are also estimated controlling for employers to address potential confounding at the employer level. Because of random effects, the models are estimated by applying pseudo-likelihood techniques.

The impact of screening on health care–seeking behavior is analyzed by identifying individuals who, after their worksite screening, were newly diagnosed with hypertension or received a prescription for a blood pressure–lowering medication for the first time. Incidence of new diagnosis or prescription is calculated using a discrete-time hazard framework. Monthly incidence is calculated on the basis of the number of new cases in a 30-day period divided by the number of individuals who had not been identified at the beginning of the period, using the time of screening as the reference time ($t = 0$). Incidence is calculated for six 30-day intervals, starting 90 days before screening. The odds of receiving a new hypertension diagnosis or prescription for antihypertensives subsequent screening versus the 90 days before screening is evaluated by modeling period incidence as a sequence of logit-hazards, with indicator variables for each 30-day period after screening, and testing for the estimates for each period relative to the 90 days before screening.[23]

This study was conducted using fully de-identified data obtained through Health Advocate, Inc, received and managed in compliance with the Health Insurance Portability and Accountability Act of 1996 and therefore is exempt from institutional review board review. Logit models were estimated with PROC GLIMMIX using SAS software, version 9.3 (Cary, NC).

RESULTS

This study consisted of 31,281 individuals from 21 self-insured employer groups. At the biometric screening, a total of 6458 individuals had a blood pressure greater than 140/90 (20.7%). Of the 31,281 individuals included in the study, 14.6% had a prior diagnosis of hypertension in the claims data, and 15.6% had received antihypertensive medications during the 12 months before screening.

The results of multivariate analyses for the probability of having hypertension (Table 2) were consistent with existing literature. The adjusted probability of having high blood pressure consistent with hypertension was lower for females, increasing with age, decreasing with education, and decreasing with income. African Americans were more likely and Asians/Pacific Islanders were less likely to have high blood pressure consistent with hypertension at screening compared with non-Hispanic whites. The significance of these findings was not affected by controlling for obesity and diabetes; however, both obesity and diabetes were strongly associated with the probability of having high blood pressure consistent with hypertension at screening. The results were not meaningfully altered after including employer information in the model and are not reported here.

Of the individuals with no previous records of hypertension at screening, a total of 4414 individuals (17.6%) had a blood pressure

TABLE 2. Multivariate Model for the Probability of Having High Blood Pressure Consistent With Hypertension at Screening (Individuals Prescribed Antihypertensives During the Previous 12 Months or Individuals With BP 140/90 or Greater at Screening; $N = 31,281$)

	Model 1		Model 2	
Hypertension (Rx or BP >140/90)	**OR**	**CI**	**OR**	**CI**
Female	0.85*	0.79–0.90	0.89*	0.83–0.95
Age (yrs) (18–34 = reference)				
35–49	4.55*	3.94–5.24	3.93*	3.40–4.54
50–64	13.40*	11.66–15.40	11.00*	9.55–12.67
65+	26.61*	21.63–32.72	22.43*	18.08–27.82
Rural	0.98	0.87–1.09	0.98	0.87–1.11
Education (median years, OR: Q3 vs Q1)†	0.91*	0.87–0.95	0.95*	0.91–0.99
Income (median household, OR: Q3 vs Q1)‡	0.91*	0.86–0.98	0.92*	0.85–0.98
Race/ethnicity (non-Hispanic white = reference)				
African American (zip code%)	1.59*	1.27–2.00	1.37*	1.08–1.73
Asian/Pacific Islander (zip code%)	0.37*	0.19–0.74	0.49*	0.24–0.99
Hispanic (zip code%)	0.86	0.65–1.12	0.76	0.57–1.00
Other (zip code%)	3.29	0.88–10.77	2.07	0.52–8.17
Obese	—	—	2.46*	2.30–2.63
Diabetes	—	—	7.10*	6.24–8.01

*Significant value at 95% confidence level.
†Odds ratio for education is calculated for the third quartile (14 years of education) versus the first quartile (13 years of education).
‡Odds ratio for income is calculated for the third quartile ($73,400) versus the first quartile ($46,500).
BP, blood pressure; CI, confidence interval; OR, odds ratio.

greater than 140/90 at screening. On the basis of multivariate regression (Table 3), the probability of high blood pressure consistent with undiagnosed hypertension was lower for females, increasing with age, decreasing with income, and higher for individuals residing in rural areas. African Americans were significantly more likely to have high blood pressure consistent with undiagnosed hypertension compared with non-Hispanic whites. Obese individuals were more likely to have high blood pressure consistent with undiagnosed hypertension, but no significant association was observed for diabetes.

A significantly higher rate of new hypertension diagnosis was noted in the first 30 days after screening compared with 3 months before the screening date (month 1, odds ratio [OR]: 1.81; 95% confidence interval [CI], 1.57 to 2.10; $P < 0.0001$), with 61% of new diagnoses attributed to individuals who had high blood pressure during screening. A significant increase was also observed in new antihypertensive prescriptions in months 1 and 2 after screening compared with the 3 months before screening (month 1, OR: 2.27, 95% CI, 1.92 to 2.68, $P < 0.0001$; month 2, OR: 1.38, 95% CI, 1.13 to 1.68, $P = 0.0013$), with 60% of new antihypertensive prescriptions in the first month attributed to individuals who had high blood pressure during screening (Fig. 1). The increase was more pronounced for individuals with high blood pressure at screening, with higher rates of new hypertension diagnosis (month 1, OR: 2.92, 95% CI, 2.34 to 3.59; month 2, OR: 1.47, 95% CI, 1.14 to 1.90) and new antihypertensive prescriptions (month 1, OR: 4.13, 95% CI, 3.22 to 5.29, $P < 0.0001$; month 2, OR: 2.34, 95% CI, 1.76 to 3.12). There may be an upward bias because this subsample is restricted to individuals with high blood pressure at screening.

DISCUSSION

This study highlights the potential impact of worksite screening programs among insured populations. Out of 6458 individuals with a high blood pressure reading at screening, 4414 individuals (68.3%) had no previous record in the administrative data indicating diagnosis of or treatment for hypertension. Although a single blood pressure measurement from a biometric screening cannot be used to diagnose hypertension, it can help identify a potential problem and provide the impetus for an individual to become engaged with the health care system. A systematic review of 27 studies found that between 35% and 95% of individuals with elevated blood pressure at screening also had elevated blood pressure at confirmatory testing.[24] Individuals were approximately twice as likely to be identified as hypertensive by a provider or fill a prescription for an antihypertensive drug during the month after biometric screening compared with before the screening.

Accessing the medical system is central to timely identifying risk factors and disease. Given that self-insured employers have an increased financial exposure associated with adverse health outcomes, employers have an incentive to promote timely identification and treatment of hypertension and cardiovascular risk factors for their employees and dependents. Ascertaining the effect of employers' programs in improving access to medical care supports the design of programs to improve employees' health and measure investment returns.

Disparities in hypertension prevalence and treatment have been partially attributed to issues with access to care.[25] Lack of insurance is an important barrier to timely care; however, this study depicts that disparities still exist in a fully insured population, and other barriers persist for insured individuals. Individuals living in rural areas exhibited an increased prevalence of high blood pressure readings at screenings without prior diagnoses of hypertension, suggesting that distance or provider density barriers potentially prevent these individuals from engaging with the health system. In this study, African Americans had a higher prevalence of high blood pressure consistent with hypertension compared with non-Hispanic whites, which is consistent with other findings in the literature,[4,10,26] and a higher prevalence of high blood pressure at screening without previous diagnoses of hypertension (proxy for undiagnosed hypertension), suggesting that gaps in care exist within the insured population and highlighting the importance of identifying at-risk individuals with

TABLE 3. Multivariate Model for the Probability of High Blood Pressure Consistent With Undiagnosed Hypertension at Screening (BP 140/90 or Greater at Screening for Individuals Who Have Not Been Previously Identified as Hypertensive Either Through a Diagnosis or Prescription; $N = 25{,}156$)

	Model 1		Model 2	
Undiagnosed Hypertension	**OR**	**CI**	**OR**	**CI**
Female	0.46*	0.43–0.49	0.46*	0.43–0.49
Age (yrs) (18–34 = reference)				
35–49	1.51*	1.38–1.65	1.44*	1.31–1.57
50–64	2.24*	2.04–2.46	2.17*	1.97–2.38
65+	3.27*	2.52–4.24	3.37*	2.58–4.40
Rural	1.15*	1.02–1.31	1.18*	1.04–1.33
Education (median years, OR: Q3 vs Q1)†	0.97	0.93–1.02	1.01	0.97–1.06
Income (median household, OR: Q3 vs Q1)‡	0.89*	0.83–0.95	0.89*	0.83–0.95
Race/ethnicity (non-Hispanic white = reference)				
African American (zip code%)	1.42*	1.10–1.82	1.33*	1.03–1.72
Asian/Pacific Islander (zip code%)	1.06	0.57–1.97	1.49	0.80–2.78
Hispanic (zip code%)	1.00	0.76–1.32	1.05	0.79–1.39
Other (zip code%)	1.31	0.27–6.50	1.05	0.21–5.28
Obese	—	—	2.55*	2.38–2.74
Diabetes	—	—	1.30	1.00–1.69

*Significant value at 95% confidence level.
†Odds ratio for education is calculated for the third quartile (14 years of education) versus the first quartile (13 years of education).
‡Odds ratio for income is calculated for the third quartile ($73,400) versus the first quartile ($46,500).
BP, blood pressure; CI, confidence interval; OR, odds ratio.

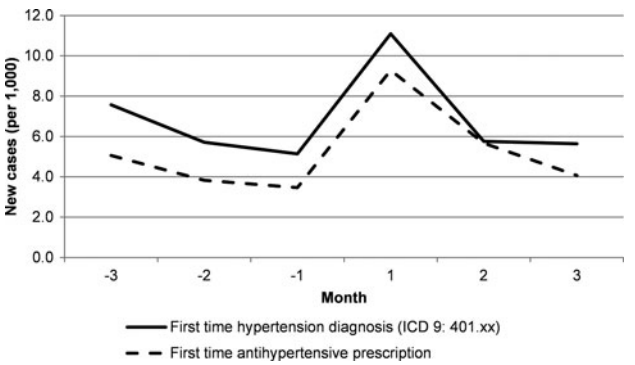

FIGURE 1. New hypertension diagnosis and new prescription for antihypertensive drugs before and after a biometric screening event for individuals without an antihypertensive prescription during the 12 months before the study period [$t-3$ months, $t+3$ months] (monthly incidence per 1000).

previously undiagnosed conditions. Socioeconomic disparities were also noted, for overall prevalence of high blood pressure and undiagnosed hypertension. Workers with a low socioeconomic status have more chronic diseases and lower health status; therefore, it is important to target this group in employer or workplace interventions.[27]

Understanding comorbid conditions, which may put individuals at a higher risk for developing hypertension or complications from hypertension, is important for employers because they implement screening and wellness programs. This study assessed two comorbid conditions that are often associated with hypertension—diabetes and obesity. Although no significant increase was noted in undiagnosed high blood pressure in people with diabetes, obese individuals were more than 2.5 times more likely to have previously undiagnosed high blood pressure at screening. People with diabetes are the most likely to be already engaged in the health care system for their diabetes care and receive regular monitoring where comorbid conditions are identified and treated. Nevertheless, obese individuals are at risk for a number of comorbidities, including diabetes and hypertension, and may or may not be engaged in the health care system.[28]

Worksite screening programs provide an opportunity to identify individuals with latent hypertension at an earlier stage in their disease progression than might otherwise be possible and may prompt individuals to access medical care available to them through their employer's health insurance. The immediate effects of worksite screening were significant in this study, with both new antihypertensive medications and de novo hypertension diagnoses significantly increasing within a month after screening, and most of the increase was attributed to individuals identified with high blood pressure at screening. Despite having insurance through their workplace, these individuals were not accessing the health care system before the worksite screening event. The impact of the screening not only led employees to seek care from their providers and confirm a hypertension diagnosis, but they were also prescribed blood pressure medications. This finding underscores an approach for employers and insurers alike to provide employees with actionable information to improve long-term health.

This is a real-world study; therefore, there are some limitations associated with it. The use of zip code–level variables for race/ethnicity, income, education, and rural/urban residence limits the interpretation of these variables at the individual level. The worksite screening event provides only one blood pressure measurement for an individual, precluding the classification of individuals as hypertensive on the basis of the screening alone. Administrative claims data are generally of high quality for both surveillance and research; however, similar to medical records, information may be missing. Nevertheless, the aggregate effect of these limitations had no material effect on the findings because the study measures changes before

and after screening, and the rate of underreporting was assumed constant over a short period of time.

CONCLUSIONS

Employer participation through worksite wellness events seems to be an effective method of identifying risk factors, detecting undiagnosed disease, and triggering the initiation of proper therapeutic and long-term management. Furthermore, even within a fully and equally insured population, different cultural or social barriers to medical care exist that may require a segmented approach for any large employer. The traditional clinical self-directed model under which the patient seeks medical care only when perceived necessary may be enhanced by employer-sponsored worksite screening programs. Further studies are required to assess the long-term implication of these programs.

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