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Diagnostic status and age at diagnosis of hypertension on adherence to lifestyle recommendations

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ABSTRACT

Regular physical activity, smoking cessation, and moderate alcohol consumption are important lifestyle behaviors that can be modified when managing hypertension. This study examined the associations of diagnostic status and age at hypertension diagnosis with lifestyle behaviors among individuals with hypertension. Data came from the National Health and Nutrition Examination Survey (NHANES) from 2007 to 2012 (N = 5231). Multinomial logistic regression models were used to estimate the relative risk (RR) of adopting lifestyle behaviors. A diagnosis of hypertension was associated with an individual being a past smoker (RR = 1.26, 95% CI: 1.05, 1.52). There was an association between duration since diagnosis and being a past smoker (RR = 1.01; 95% CI 1.01, 1.02; $P = 0.004$). Excessive drinking was inversely associated with duration since diagnosis (RR = 0.95; 95% CI 0.94, 0.96; $P < 0.001$). Older age at diagnosis was associated with the risk of being a past smoker (RR = 1.03; 95% CI 1.02, 1.04; P-value < 0.001) and negatively associated with excessive drinking (RR = 0.96; 95% CI 0.95, 0.97; $P < 0.001$). Individuals who exercised, even though less than the recommended time, were more likely to have younger age at diagnosis (RR = 0.98; 95% CI 0.97, 0.99; $P < 0.001$) and shorter duration since diagnosis (RR = 0.98; 95% CI 0.96, 0.99; $P < 0.001$) compared to individuals with who did not engage in physical activity. Individuals with diagnosed hypertension were more likely to quit smoking, and those with younger age at diagnosis or shorter duration tended to exercise regularly. Regular visits to doctors should focus on hypertension control and health behavior modifications.

1. Introduction

Hypertension has been identified as a leading risk factor of disease burden, particularly heart diseases (Lim et al., 2013). Hypertension prevention and management have been main targets of the American Heart Association (Lloyd-Jones et al., 2010). Adopting a healthy lifestyle, such as maintaining adequate weight, quitting smoking, limiting alcohol intake, and engaging in physical activity are helpful in reducing blood pressure, complementing antihypertensive treatment, and reducing the risk of coronary heart disease. (Lloyd-Jones et al., 2010; Artinian et al., 2010; Appel et al., 2003; Bacon et al., 2004; Blumenthal et al., 2010; Gelber et al., 2007; Go et al., 2014; Chrysant and Chrysant, 2015) Current treatment guidelines emphasize the modification of lifestyle behaviors and health professionals often provide advice for patients to modify health behaviors. As a result of these efforts, 87% of the adults in the US who self-reported having hypertension engage in two or more activities to reduce blood pressure, such as taking medication, engaging in physical activity, changing diet, and reducing alcohol consumption (Ayala et al., 2005). However, these changes are less than optimum for most patients (Valderrama et al., 2010). In addition, those who already engage in unhealthy lifestyles (e.g. smoke, drink excessively, have low levels of physical activity or are obese) are less likely to engage in behaviors to reduce their blood pressure (Ayala et al., 2005).

Another challenge to improve blood pressure treatment and management is to increase awareness of the disease. From 1999 to 2002 to 2011–2014, the proportion of adults with hypertension who were unaware of their condition declined from 29.5% to 16% (Paulose-Ram et al., 2017). The diagnosis of a chronic health condition can be positively associated with better health behaviors (Wayne et al., 2004; Kim and Andrade, 2016), but changing health behaviors may be difficult, irrespective of the diagnostic status (Bellizzi et al., 2005). For example, individuals diagnosed with hypertension are less likely to adhere to the principles of the Dietary Approaches to Stop Hypertension (DASH), which is a widely recommended diet for individuals with hypertension than those not diagnosed with hypertension (Kim and Andrade, 2016).

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However, there is some evidence that time since diagnosis may influence the adoption of health behaviors. A study focusing on cancer diagnosis found that a recent diagnosis did not seem to be associated with smoking cessation, engaging in physical activity or improving alcohol consumption behaviors (Bellizzi et al., 2005). However, individuals who have been diagnosed for a longer time period (5–9 years) showed a reduction in smoking and an upward trend in physical activity level compared to those with more recent diagnosis (Bellizzi et al., 2005). Nonetheless, these positive changes were not observed among those with longer time since diagnosis (Bellizzi et al., 2005). Besides diagnosis status, demographic, geographic, clinical, and psychological characteristics have been shown to be associated with lifestyle changes (Cooper et al., 2002; Gee et al., 2012). Although among individuals with hypertension both smoking cessation and physical activity have been reported to increase, these two behavioral changes are more prevalent among those also taking anti-hypertensive medication (Neutel and Campbell, 2008).

Given the high prevalence of hypertension in the U.S., it is important to understand how the medical diagnosis influences health behaviors. This study examines whether individuals with diagnosed hypertension differed from those who have the disease, but have not been diagnosed, on lifestyle behaviors including physical activity, smoking, and alcohol consumption. We hypothesized a diagnosis of hypertension is associated with better health behaviors than undiagnosed hypertension. One would expect individuals who are aware of their health condition to be more engaged in healthier behaviors through increased knowledge and potentially greater exposure to information provided in the health care system. However, changing addictive behaviors, such as smoking and drinking, may be more difficult, so differences by diagnostic status may be more evident in physical activity. In addition, this study also examined among those previously diagnosed, whether duration since diagnosis and age at diagnosis of hypertension were associated with the adoption of better lifestyle behaviors.

2. Methods

Data from the National Health and Nutrition Examination Survey (NHANES) collected in the periods of 2007–2008, 2009–2010, and 2011–2012 were used in the analyses. NHANES is a stratified, multistage probability sample of the civilian, non-institutionalized US population. The analytic data included sections from personal interviews, physical examinations, and demographic information. This study was deemed exempt by the Institutional Review Board at the University of Illinois at Urbana-Champaign.

The study sample is based on the pooled data from the three periods and included individuals aged 20–80 years old with a total of 17,713 survey participants in this age range. The analytic data excluded those with missing data on self-reported hypertension or blood pressure measurements. The final sample was restricted to 5653 individuals with hypertension based on self-reports and blood pressure measurements and with complete data on selected variables. For the analysis using the duration of hypertension and age at diagnosis, the study focused on those with previous diagnosis of hypertension (n = 4315). After excluding those with missing data on age at their diagnosis of hypertension from the home interview (n = 165), the final sample was restricted to 4150 individuals with hypertension.

2.1. Hypertension status

Diagnosed hypertension was defined when an affirmative answer was given to the question “Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?”. Individuals who responded negatively to this question, but who had mean systolic blood pressure of ≥140 mm Hg or mean diastolic blood pressure of ≥90 mm Hg were classified as having undiagnosed hypertension.

2.2. Outcome measures

Lifestyle behaviors include smoking, drinking, and physical activity. In NHANES, each survey participant was asked whether he/she smoked at least 100 cigarettes in his or her lifetime and whether he/she currently smokes cigarettes. These two questions were used to create the smoking variable, which consisted of three categories: current, past, and non-smokers. Current smokers were those who reported smoking currently. Former smokers were individuals who had smoked at least 100 cigarettes in their lifetime but were not currently smoking. Non-smokers were those who had not smoked at least 100 cigarettes in their lifetime and were not currently smoking.

Moderate drinking is defined as one drink per day for women and two drinks per day for men following the Dietary Guidelines for Americans by the United States Department of Health and Human Services (USDHHS). Drinking more than moderate levels was defined as excessive alcohol consumption, and an individual's average number of alcoholic drinks per day during the past 12 months was used as a drinking behavior outcome in this study. Alcohol consumption was classified as: 1) no alcohol consumption, 2) moderate consumption, and 3) excessive consumption.

The 2008 physical activity guidelines for Americans recommends that adults and older adults should engage in 150 min or more of moderate-intensity activities every week such as brisk walking or swimming, or 75 min of vigorous-intensity activities, such as running and basketball every week, or an equivalent mix of the two (Haskell et al., 2007; Committee PAGA, 2008). For an equivalent mix of the two activities, 1 min of vigorous-intensity activity is counted as 2 min of moderate-intensity activity based on the physical activity guidelines. In addition to moderate- and vigorous-intensity aerobic activities, two or more days per week of muscle-strengthening activities are also recommended to work all major muscle groups. The survey question on physical activity asked how many days per week an individual participated in any moderate or vigorous-intensity sports, fitness, or recreational activities, and how much time per day he or she spends doing these activities. From these two questions in NHANES, the total minutes of moderate or vigorous-intensity activities per week were calculated by multiplying time spent per day by the number of days spent on physical activity per week. The three categories reported for this variable were: 1) those with no physical activity, 2) those with physical activity who did not spend the recommended time (< 150 min of moderate-intensity activities, 75 min of vigorous-intensity activities or the equivalent), and 3) those who satisfied the recommended time for weekly physical activity (more than or equal to 150 min of moderate-intensity activities or 75 min of vigorous-intensity activities).

2.3. Age at diagnosis and duration of hypertension

At each survey, during an at-home interview, survey participants who had been previously diagnosed with hypertension were asked the age they were first told by a doctor or other health professional that they had hypertension or high blood pressure. Since NHANES had the participants' current age and age at the first diagnosis, duration of hypertension diagnosis was computed by subtracting age at the first diagnosis from their current age.

2.4. Additional variables

The analyses were adjusted for demographic characteristics, including age, gender, ethnicity, education, income level, marital status, and health insurance status, body mass index (BMI), using a special diet, self-reported health conditions, and self-rated health. Ethnicity included four categories: non-Hispanic White, non-Hispanic Black, Hispanic, and other racial groups (which include Asian and multi-

racial). Education was grouped into four levels: less than high school, completed high school, some college, and college graduate or above. Marital status was dichotomized into not married and married. Annual household income was grouped into four levels, below $20,000, $20,000–$44,999, $45,000–$74,999, and $75,000 or more. The health insurance variable was dichotomized into not having health insurance nor any other health care plan such as Medicare and Medicaid, versus having any insurance or a plan. Individuals with BMI under 18.5 kg/m^2 were classified as underweight, those between 18.5 and 24.9 as normal weight, those between 25.0 and 29.9 as overweight, and those with a BMI 30.0 or greater were classified as obese. Any special dietary status was dichotomized into using it or not. Other self-reported medical conditions (i.e. heart disease and diabetes) were also considered as a dichotomous variable in the study, because hypertension was known as a major risk factor for these conditions. In addition, self-rated health status was categorized into three categories: excellent, very good/good/fair, and poor. In addition, smoking, drinking, and physical activity variables were included in regressions of the other outcome of interest.

2.5. Statistical analyses

Lifestyle health behaviors including smoking, drinking, and physical activity had multinomial outcomes: 1) smoking: non-smoker, past-smoker, and current-smoker 2) drinking: no consumption, moderate consumption, and excessive consumption 3) physical activity: no physical activity, < 150 min a week (level does not satisfy the recommendation of physical activity), and ≥150 min a week (level satisfies the recommendation of physical activity). Chi-square was used to compare individuals with diagnosed versus undiagnosed hypertension for each outcome variable (Table 1). Multinomial logistic regression models were used to test whether a diagnosis of hypertension was associated with lifestyle behaviors. For each analysis, the hypertension diagnosis variable specified whether an individual had a diagnosis of hypertension, which allowed the study to compare how lifestyle behaviors of individuals with diagnosed hypertension are different from those of individuals with undiagnosed hypertension. Additional models are restricted to those with previous diagnosis and explored whether duration and age at diagnosis influenced health behaviors. All statistical analyses were performed with STATA S.E. software (version 11; StataCorp).

Table 1
Sample characteristics by hypertension status: National Health and Nutrition Examination Surveys (2007–2012).

Characteristic	Undiagnosed hypertension		Diagnosed hypertension		*P*
	%	Standard deviation	%	Standard deviation	
Smoking status					
Non-Smoker	53.9%	(0.50)	49.1%	(0.50)	0.005
Past-Smoker	26.3%	(0.44)	32.4%	(0.47)	0.001
Current-Smoker	19.9%	(0.40)	18.5%	(0.37)	0.316
Alcohol consumption					
No consumption	35.1%	(0.48)	42.6%	(0.50)	< 0.001
Moderate consumption	32.6%	(0.47)	32.7%	(0.47)	0.983
Excessive consumption	32.2%	(0.47)	24.7%	(0.43)	< 0.001
Physical activity					
No physical activity	57.8%	(0.49)	63.4%	(0.48)	0.001
< 150 min a week	13.1%	(0.34)	13.9%	(0.35)	0.458
≥150 min a week	29.2%	(0.46)	22.7%	(0.42)	< 0.001
n	916		4737		

3. Results

Table 1 presents the descriptive statistics by hypertension diagnosis status. Among individuals with diagnosed hypertension, 32.4% were past smokers compared to 26.2% among undiagnosed individuals (Table 1). Among those with diagnosed hypertension, 24.7% had excessive alcohol consumption compared to 32.2% among those with undiagnosed hypertension. In contrast, among individuals diagnosed with hypertension, 63.4% did not engage in physical activity, compared to 58% among adults with no previous diagnosis of hypertension.

Adults with hypertension who have been diagnosed have higher risk reporting being a past smoker than those who have not been diagnosed (RR: 1.26; 95% CI: 1.05, 1.52). However, being diagnosed with hypertension was not associated with currently smoking, nor alcohol consumption or physical activity behaviors (Table 2). Further results in Table 2 show the positive associations between smoking and drinking. Adults with hypertension who moderately or excessively drank were more likely to report being past smokers or current smokers. Moreover, individuals categorized as excessive drinkers were more likely to be past smokers (RR: 2.37; 95% CI: 1.98, 2.85) or current smokers (RR: 4.08; 95% CI: 3.31, 5.02). Individuals who exercise regularly were less likely to smoke (RR: 0.47; 95% CI: 0.37, 0.58). However, those who exercised more were also more likely to drink moderately or excessively.

Table 3 shows the results from the additional analysis with duration since diagnosis and age at diagnosis of hypertension. Adults with duration since diagnosis or who were older at diagnosis were more likely to report being past smokers than never smokers (RR: 1.01; 95% CI 1.01, 1.02 and RR: 1.03; 95% CI: 1.02, 1.04; respectively). Those who were older at diagnosis were more likely to smoke (RR: 1.01; 95% CI 1.01, 1.02), although duration since diagnosis was not statistically significant. Adults with longer duration or who were older at diagnosis were less likely to drink excessively (RR: 0.95; 95% CI: 0.94, 0.96; and RR: 0.96; 95% CI: 0.95, 0.97; respectively). Individuals who exercised less than the recommended time were more likely to be younger age at diagnosis (RR: 0.98; 95% CI: 0.97, 0.99) and to have shorter duration (RR: 0.98; 95% CI: 0.96, 0.99) compared to those who did not engage in physical activity. There were no associations between duration and age at diagnosis with recommended time for physical activity.

4. Discussion

This study examined a large, nationally representative sample of US adults and found that a large proportion of individuals who have hypertension engage in unhealthy lifestyle behaviors. Although over 70% of the individuals with self-reported hypertension in the US report to have changed eating habits, reduced alcohol consumption, and increased physical activity (Ayala et al., 2005), the study find that over half of the adults with hypertension do not exercise regularly and many smoke and drink excessively. Being aware of hypertension status was associated with individuals being more likely to be a past smoker but was not associated with different levels of alcohol consumption or physical activity. Our study results also indicate that individuals with older age at diagnosis were more likely to be past or current smokers. Longer duration since diagnosis was also associated with being a past-smoker, although it was not associated with being a current smoker. Adults who were older at diagnosis were less likely to drink excessively and to exercise less than recommended.

Individuals diagnosed with hypertension were more likely to report being past smokers, which may be associated with higher levels of smoking cessation after diagnosis. In fact, the longer the duration since diagnosis, the more likely individuals with hypertension were to be past smokers. It is possible that individuals with a diagnosis have had more exposure to professional advice toward reducing smoking. On the other hand, this study found no differences in alcohol consumption between those diagnosed and undiagnosed with hypertension. Our study also

Table 2
Relative risk ratio (RRR) of each independent variable, including diagnostic status of hypertension, on lifestyle behaviors (dependent variables) among adults aged 20–80 years participating in the National Health and Nutrition Examination Surveys (2007–2012)[a,b].

	Smoking		Alcohol consumption		Physical activity (PA)	
	Past-smoker	Current-smoker	Moderate consumption	Excessive consumption	PA < 150 min	PA ≥ 150 min
Diagnostic status of hypertension	1.26* [1.05,1.52]	1.22 [0.97,1.53]	1.02 [0.84,1.24]	0.85 [0.69,1.04]	1.09 [0.87,1.38]	0.94 [0.78,1.13]
Smoking status						
Past-smoker			1.60*** [1.37,1.87]	2.35*** [1.96,2.82]	1.13 [0.93,1.37]	1.01 [0.86,1.19]
Current-smoker			1.43** [1.16,1.78]	4.12*** [3.34,5.06]	0.85 [0.67,1.08]	0.47*** [0.38,0.58]
Alcohol consumption						
Moderate consumption	1.62*** [1.39,1.89]	1.43** [1.15,1.78]			1.27* [1.04,1.55]	1.40*** [1.18,1.67]
Excessive consumption	2.37*** [1.98,2.85]	4.08*** [3.31,5.02]			1.12 [0.89,1.39]	1.38*** [1.14,1.67]
Physical activity						
PA < 150 min	1.13 [0.94,1.37]	0.87 [0.68,1.11]	1.29* [1.06]	1.14 [0.91,1.42]		
PA ≥ 150 min	1.01 [0.86,1.18]	0.47*** [0.37,0.58]	1.40*** [1.57]	1.36** [1.12,1.65]		

[a] Base groups: Non-smokers, No alcohol consumption, and No physical activity.
[b] Adjusted for sex, age, ethnicity, education, income, BMI, diabetes, heart disease, health insurance, self-rated health status, and NHANES wave.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

found no differences in physical activity. A previous study has shown that less than one-quarter of the patients with hypertension have been advised to exercise, and among those only 62% followed health professional's advice (Valderrama et al., 2010). Although efforts among health professionals have been made to increase advice to engage in physical activity among individuals with hypertension, cardiovascular

Table 3
Relative risk ratio (RR) of each independent variable, including age at diagnosis and duration of hypertension, on smoking, alcohol consumption and physical activity among adults aged 20–80 years participating in the National Health and Nutrition Examination Surveys (2007–2012)[a,b].

	Smoking			
	Past-smoker		Current-smoker	
	RR	*P*-value	RR	*P*-value
Age at hypertension diagnosis	1.03*** [1.02,1.04]	< 0.001	1.01*** [1.00,1.02]	< 0.001
Duration of hypertension	1.01** [1.00,1.02]	0.004	1.01[1.00,1.01]	0.069
Prescribed medication for hypertension	0.86[0.63,1.18]	0.34	0.95[0.79,1.15]	0.614
Physical activity	1.09[0.90,1.31]	0.363	1.02[0.88,1.19]	0.761

	Alcohol consumption			
	Moderate consumption		Excessive consumption	
	RR	*P*-value	RR	*P*-value
Age at hypertension diagnosis	1.00[0.99,1.01]	0.693	0.96*** [0.95,0.97]	< 0.001
Duration of hypertension	0.99[0.98,1.01]	0.225	1.00*** [0.94,0.96]	< 0.001
Prescribed medication for hypertension	0.94[0.64,1.39]	0.753	0.94[0.69,1.28]	0.691
Smoking status	0.92[0.67,1.27]	0.595	2.09*** [1.54,2.83]	< 0.001
Physical activity	1.20[0.88,1.64]	0.246	1.18[0.88,1.58]	0.273

	Physical activity (PA)			
	PA < 150 minutes		PA ≥ 150 minutes	
	RR	*P*-value	RR	*P*-value
Age at hypertension diagnosis	0.98*** [0.97,0.99]	< 0.001	1.00[0.99,1.00]	0.572
Duration of hypertension	0.98*** [0.96,0.99]	< 0.001	1.00[0.99,1.00]	0.48
Prescribed medication for hypertension	0.98[0.71,1.36]	0.892	0.99[0.88,1.12]	0.899
Smoking status	0.88[0.65,1.18]	0.375	0.98[0.89,1.09]	0.758

*$P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
[a] Base groups: Non-smokers, No alcohol consumption, and No physical activity.
[b] Adjusted for sex, age, ethnicity, education, income, BMI, diabetes, heart disease, health insurance, self-rated health status, and NHANES wave.

disease, and older adults, the proportions receiving it remain small (Valderrama et al., 2010; Barnes and Schoenborn, 2012). In fact, this study found high rates of sedentary behavior among adults with hypertension, regardless of their diagnosis status. Study findings corroborate with previous studies which indicated that a large number of adults do not meet the national recommendations for physical activity or do not engage in any type of physical activity in spite of public health efforts to improve lifestyle behaviors (Valderrama et al., 2010; Kohl et al., 2012; Bauman et al., 2012).

Among individuals with hypertension, rates of unhealthy behavior, such as smoking, excessive alcohol consumption and no physical activity, were high. In addition, lifestyle behaviors were associated with each other. For instance, individuals who consumed alcohol in moderate and/or excessive levels were more likely to also smoke. On the other hand, adults with hypertension who exercise regularly were less likely to be current-smokers, even though they were more likely to report drinking excessively. These positive associations of non-smoking status and regular physical activity for the management of cardiovascular diseases among individuals with hypertension were also found in previous studies (Ford et al., 2010; Malekzadeh et al., 2013; Mahmud et al., 2015). Individuals with hypertension who followed the national recommendation of physical activity were more likely to be male, and to have higher socioeconomic status. However, older people and those with high BMI were less likely to exercise regularly.

Because of the nature of the NHANES data, this cross-sectional study was observational and thus precluded causal inferences, and the self-reported data in NHANES were possibly subject to bias due to measurement error and under-reporting. Future studies can benefit from the use of longitudinal data for hypertensive individuals. Rather than relying on reports of when a patient was diagnosed with hypertension, one would be able to follow individuals with hypertension after they are diagnosed, and observe how they change their health behaviors over time and whether their lifestyle behaviors improve or decline through hypertension diagnostic status. The availability of these data would also enable causal estimates because individual-level unobserved heterogeneity could be more easily isolated.

5. Conclusions

There is some indication that individuals with hypertension tended to quit smoking, yet there were no differences in alcohol consumption and physical activity. Barriers to engaging in physical activity could include time constraint, lack of interest, and lack of knowledge of recommended behaviors. Increasing physical activity is one of the main objectives of the Healthy People 2020 initiative, which seeks to encourage more effective physician counseling and educational programs for exercising (U.S. Department of Health and Human Services, 2012). Regular physical activity has been reported to increase life expectancy by 0.68 years (Lee et al., 2012). Therefore, given that most individuals with hypertension, regardless of their diagnostic status, did not engage in physical activity, increasing physical activity should improve health outcomes in this population. In addition, promoting regular visits to doctors, providing information about recommended lifestyle behaviors, and better monitoring can improve health outcomes by better tracking blood pressure levels, increasing awareness of the importance of hypertension control, and promotion of healthy behavioral modifications (Fan et al., 2010; McManus et al., 2010).

Statement of potential conflict of interest

The authors declare that there are no conflicts of interest.

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