



# Association of leisure-time physical activity with perceived general health status among hypertensive people: an analysis of NHANES 2015–18

Gulam Muhammed Al Kibria<sup>1</sup> · Rajat Das Gupta<sup>2</sup> · Reese Crispen<sup>1</sup>

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## Abstract

Although leisure-time physical activity (LTPA) improves general health, little is known about its impacts on the health of hypertensive people within the United States. We investigated the general health of hypertensive people and the relationship between LTPA and general health within this population. This cross-sectional study analyzed National Health and Nutrition Examination Survey 2015–18 data. None, some, and high LTPA were defined as ‘0’, ‘>0 but <150’, and ‘≥150’ minutes of LTPA in each week, respectively. Hypertension was defined as the systolic/diastolic blood pressure ≥130/80 mmHg or taking BP-lowering drugs. General health status was dichotomized as whether participants reported ‘very good to excellent’ health status or not. After descriptive analysis, logistic regression was performed. Among 8504 participants (48.6% male and mean age: 48.2 years), about 47.9%, 41.4%, and 39.5% of people had hypertension, ‘very good to excellent’ health, and high LTPA, respectively. The odds of ‘very good to excellent’ health was lower among hypertensives than those without hypertension (adjusted odds ratio [AOR]: 0.7, 95% confidence interval [CI]: 0.6–0.8,  $p < 0.001$ ). Among hypertensive individuals, about one-third reported ‘very good to excellent’ health (33.1%) and high LTPA (32.0%). Lastly, compared to people with no LTPA, those with some (AOR: 1.5, 95% CI: 1.0–2.0,  $p < 0.05$ ) and high (AOR: 2.3, 95% CI: 1.7–3.0,  $p < 0.001$ ) LTPA had greater odds of ‘very good to excellent’ health. We found positive relationships between LTPA and ‘very good to excellent’ health of hypertensive people. Therefore, improving general health could be an added advantage of LTPA for hypertensive people.

## Introduction

Uncontrolled hypertension is a leading risk factor for cardiovascular disease, stroke, and chronic kidney disease [1–3]. It is also one of the leading causes of health care visits, morbidities, and premature deaths among US adults [3–5]. According to the latest 2017 American College of Cardiology/American Heart Association (ACC/AHA)

guideline’s prevalence estimate by Muntner et al., an estimated 46% of the US adults are hypertensive [6]. Several other studies had similar findings [7–9]. Lowering the systolic/diastolic blood pressure (SBP/DBP) cutoff from ≥140/90 mmHg to ≥130/80 mmHg in the new guideline could newly label about 14% people as hypertensive who would have been diagnosed as prehypertensive (i.e., SBP and DBP as 120–139 and 80–89, respectively) as per the previous cutoff [2, 6]. Physical activity (PA) is a universally recommended measure for preventing and controlling hypertension [2, 10]. In addition, adequate PA helps to prevent or reduce the complications of nearly all other major chronic conditions that are also leading causes of disabilities and deaths, including other cardiac diseases, diabetes, obesity, dyslipidemia, and cancer [10, 11]. Many of these conditions are also associated with hypertension [2]. The latest PA guideline for Americans recommends at least 150 min of moderate-intensity, 75 min of vigorous-intensity, or an equivalent combination of PA in each week

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✉ Gulam Muhammed Al Kibria  
gkibria1@outlook.com

<sup>1</sup> University of Maryland School of Medicine, Baltimore, MD, USA

<sup>2</sup> Arnold School of Public Health, University of South Carolina, Columbia, SC, USA

[12]. This guideline explicitly mentioned that having even some level of PA is better than no PA. However, according to several estimates, the typical level of PA is substantially lower. Specifically, only about half of the US adults meet the minimum requirement [13].

Perceived health status is a self-rated measure commonly used in observational and experimental studies to understand the impacts of disease or its treatment on patients. It asks ‘how’ an individual thinks about his/her health [14]. The overall correlates have been identified as age, gender, race/ethnicity, behavioral factors, and presence of any disease, including hypertension [14–16]. Several studies examined the perceived health status of hypertensive patients. As expected, these studies found an inverse association with hypertension such that patients with hypertension had a lower perceived health status compared to people without it [17–19]. Having complications of hypertension itself, measures required to control it, and presence of other comorbidities could lead to poor health [17]. However, the health status of people with hypertension as per the new 2017 ACC/AHA guideline is not known. Furthermore, although studies found a positive association of leisure-time PA (LTPA) with health status among general people [12, 17, 20, 21], there has been limited investigation about how LTPA can impact general health of hypertensive people, especially among people with hypertension as per the new 2017 ACC/AHA guideline, who are newly labeled and have not been considered as hypertensive in previous estimates [2]. This study aims to fill these gaps in the literature by investigating the association of hypertension with health status and how LTPA can impact this relationship. Based on previous literature, we hypothesize that hypertensive people have a lower health status compared to people who are not hypertensive. Moreover, hypertensive people with a higher LTPA have higher health status compared to hypertensive people with lower or no LTPA.

## Methods

This cross-sectional study analyzed National Health and Nutrition Examination Survey (NHANES) 2015–18 data. NHANES aims to obtain a nationally representative sample of the non-institutionalized US population. Data are released in every 2 years. Four recent survey years were combined to obtain a larger sample size. Datasets are available according to modules. The datasets were downloaded and merged by a unique identification number for each survey participant [22]. The National Center for Health Statistics’ Ethics Review Board approved the survey protocols [23].

## Study Variables

### Hypertension

In mobile examination centers (MEC), participants’ BP levels were measured by factory-calibrated ‘Baumanometer® mercury true gravity wall model sphygmomanometers’. At first, participants rested in a seated position for 5 min. Then, trained physicians measured BP four times in the same position with appropriate cuff sizes [22]. We used the average of the first three available BP measurements to calculate BP levels. When an individual had only one BP measure, we used that measure [8]. As previously stated, as per the 2017 ACC/AHA guideline, individuals with at least 130/80 mmHg of SBP/DBP were considered hypertensive. In addition, participants who reported that they were taking at least one BP-lowering drug were also considered hypertensive [2].

### Leisure-time physical activity

In NHANES, participants reported the amount of moderate and vigorous PA they perform during their leisure time in a week. The total minutes of vigorous LTPA were multiplied with two and added to moderate LTPA. It was categorized as none (i.e., 0 min per week), some (i.e., more than 0 but less than 150 min per week), and high (i.e., 150 or more minutes per week) [10, 8, 12].

### Outcome variable

Participants were asked about their general health condition (i.e., “Would you say your health in general is...”), and asked to rate it as ‘excellent’, ‘very good’, ‘good’, ‘fair’, or ‘poor’. We merged ‘excellent’ and ‘very good’ as one category (i.e., coded as 1). The other three ratings were merged as ‘not very good to excellent’ health (i.e., coded as 0) [24].

### Other variables

Participants reported their age (i.e., categorized as 20–39, 40–59, and  $\geq 60$  years), gender, race/ethnicity (i.e., grouped as non-Hispanic whites, non-Hispanic blacks, Hispanics, and other races/ethnicities), education levels (i.e., categorized as ‘below high school’, ‘high school’, and ‘college graduate or above’), health insurance coverage (i.e., ‘yes’ or ‘no’), and family income. Based on the number of family members and the federal poverty threshold, income was reported as family income to poverty ratio in NHANES, and categorized as low, middle, and high-income. Body mass index (BMI) was grouped as low/normal (i.e.,  $\text{BMI} < 25 \text{ Kg/m}^2$ ), overweight (i.e.,  $\text{BMI} 25\text{--}29.9 \text{ Kg/m}^2$ ), and obese (i.e.,  $\text{BMI} \geq 30 \text{ Kg/m}^2$ )

[25, 26]. In addition, participants were asked about the presence of comorbidities. Based on the literature search, a participant was classified as having other diseases if he or she had at least one of the following conditions: cancer, diabetes, chronic bronchitis, coronary heart disease, emphysema, and cholesterol [17].

### Statistical analysis

First, descriptive analyses were conducted and participants were compared by hypertension status (Table 1), LTPA (Supplementary Table 1), and general health status (Table 2). After that, we examined the association of hypertension with general health status (Table 2). Then, among those who were hypertensive, participants were compared by LTPA (Table 3) and general health status (Table 4). At last, we examined the association of LTPA and general health among hypertensive people (Table 4).

Mean and standard error (SE) were used to report continuous variables and weighted percentage (%) and unweighted frequencies ( $n$ ) were used to report categorical variables. Continuous variables were tested by  $t$ -tests/analysis of variance and categorical variables were tested by chi-square tests. The associations of hypertension with 'general health' and 'LTPA' were assessed by unadjusted and multivariable logistic regression analysis. Variables that were significantly associated with outcome and exposure variables (i.e.,  $p < 0.05$ ) in bivariate analyses were adjusted into multivariable analysis. Crude odds ratio (COR) and adjusted odds ratio (AOR) were reported along with 95% confidence intervals (CI). Variance inflation factors were used to assess multicollinearity. Observations with missing data were excluded from the analysis, as the overall proportion of missing data was low (i.e.,  $< 10\%$ ). Thus, complete case analysis approach was not expected to cause substantial bias. The mobile examination center's weight was adjusted. Stata 14.0 (College Station, Texas, USA) was used to analyze data.

## Results

Table 1 compares the study sample by hypertension status. A total of 8504 participants were included in the analysis. About 47.9% people had hypertension ( $n = 4578$ ). The mean age of the participants was 48.2 (SE: 0.5) years. Hypertensive people had a significantly older mean age than people who were not hypertensive, 55.9 (SE: 0.5) and 41.1 (SE: 0.6) years, respectively. About half of the participants were males (48.6%) and two-third of the participants were non-Hispanic whites (65.9%);

however, the proportion of males and non-Hispanic blacks were substantially higher among hypertensive people. In addition, compared to those without hypertension, hypertensive people had a higher proportion with high school or below education level (72.9% vs 63.5%), health insurance coverage (90.1% vs 84.5%), other diseases (60.9% vs 30.6%), obesity (52.3% vs 32.8%), 'not very good to excellent' health (66.9% vs 50.9%), and no LTPA (52.1% vs 38.0%).

Table 2 shows the distribution of people by general health along with the results of logistic regression analysis. The overall age and gender distribution were similar by health status ( $p > 0.05$ ). Among people without 'very good to excellent' health, the proportion of non-Hispanic black race/ethnicity (12.1% vs 8.3%), Hispanic race/ethnicity (18.0% vs 8.8%), high school (61.8% vs 48.6%) and below (16.5% vs 4.8%) education level, low- (27.9% vs 13.0%) and middle-income (32.6% vs 25.5%), no health insurance (16.1% vs 8.2%), comorbidity (50.8% vs 37.1%), obesity (52.0% vs 28.1%), no LTPA (54.5% vs 31.0%), and hypertension (54.7% vs 38.3%) was higher compared to people with 'very good to excellent' health status. The multivariable model was adjusted by variables that had significant associations with both exposure and outcome variables, as well as gender. After adjusting for all these variables, the odds of 'very good to excellent' health status was about 30% lower among people with hypertension compared to people without hypertension (AOR: 0.7, 95% CI: 0.6–0.8,  $p < 0.001$ ). In unadjusted analysis, most variables were found to be associated with general health (Supplementary Table 1).

Per the results in Table 3, among hypertensive people, all investigated variables had significant relationships with LTPA. Overall, people with high LTPA had a higher proportion of people with younger than 60 years of age, male gender, non-Hispanic white race/ethnicity, college graduate or above education level, high-income, and insurance coverage ( $p < 0.05$ ); however, they have a lower proportion of people with any comorbidity and obesity than the other two LTPA levels ( $p < 0.05$ ).

Table 4 compares the general health of hypertensive people and shows the results of simple and multivariable logistic regression analysis. Similar to previous tables, most of the studied variables had significant association with health status, including age, race/ethnicity, education level, family income, health insurance coverage, other diseases, obesity, and LTPA. In the multivariable model, most factors also had significant association. People with some (AOR: 1.5, 95% CI: 1.0–2.0,  $p < 0.05$ ) and high (AOR: 2.3, 95% CI: 1.7–3.0,  $p < 0.001$ ) LTPA significantly higher odds of very good to excellent health status compared to people with no LTPA.

**Table 1** Comparison of the study sample by hypertension status ( $N = 8504$ ).

Variables	Overall ( $N = 8504$ )	Hypertension ( $n = 4578$ )	No hypertension ( $n = 3926$ )	<i>p</i> values
Age (in year)				
Mean (SE)	48.2 (0.5)	55.9 (0.5)	41.1 (0.6)	<0.001
20–39	35.6 (2703)	17.0 (642)	52.6 (2061)	<0.001
40–59	35.9 (2770)	39.5 (1549)	32.6 (1221)	
≥60	28.5 (3031)	43.5 (2387)	14.8 (644)	
Gender				
Male	48.6 (4166)	52.3 (2400)	45.2 (1766)	<0.001
Female	51.4 (4338)	47.7 (2178)	54.8 (2160)	
Race/ethnicity				
Non-Hispanic white	65.9 (3110)	67.0 (1674)	65.0 (1436)	<0.001
Non-Hispanic black	10.6 (1830)	12.5 (1164)	8.8 (666)	
Hispanic	14.2 (2184)	11.7 (1064)	16.6 (1120)	
Other races/ethnicities	9.3 (1380)	8.8 (676)	9.7 (704)	
Education level				
Below high school	11.6 (1705)	12.8 (1016)	10.6 (689)	<0.001
High school	56.3 (4687)	60.1 (2557)	52.9 (2130)	
College graduate or above	32.0 (2112)	27.1 (1005)	36.6 (1107)	
Family income to poverty ratio				
Low-income	21.7 (2773)	21.0 (1505)	22.3 (1268)	0.41
Middle-income	29.6 (2857)	30.6 (1579)	28.8 (1278)	
High-income	48.6 (2874)	48.4 (1494)	48.9 (1380)	
Covered by health insurance				
No	12.8 (1329)	9.9 (548)	15.5 (781)	<0.001
Yes	87.2 (7175)	90.1 (4030)	84.5 (3145)	
Other Disease				
No	54.9 (4418)	39.1 (1712)	69.4 (2706)	<0.001
Yes	45.1 (4086)	60.9 (2866)	30.6 (1220)	
Body mass index (kg/m <sup>2</sup> )				
<25	26.9 (2243)	17.5 (882)	35.6 (1361)	<0.001
25–29	31.0 (2693)	30.3 (1439)	31.7 (1254)	
≥30	42.1 (3568)	52.3 (2257)	32.8 (1311)	
General health				
Not very good–excellent	58.6 (5682)	66.9 (3366)	50.9 (2316)	<0.001
Very good–excellent	41.4 (2822)	33.1 (1212)	49.1 (1610)	
Leisure-time physical activity (in minutes)				
No (0)	44.8 (4416)	52.1 (2649)	38.0 (1767)	<0.001
Some (>0 to <150)	15.8 (1175)	15.9 (666)	15.7 (509)	
High (≥150)	39.5 (2913)	32.0 (1263)	46.3 (1650)	

## Discussion

In this study, we investigated the general health status of hypertensive people within the US and how LTPA could be associated with it. As we hypothesized, the overall perceived general health of people (i.e., the proportion of people with ‘very good to excellent’ health) with

hypertension was lower compared to people without hypertension. In addition, among people with hypertension, people with high LTPA had more than two times odds of having ‘very good to excellent’ health status.

One major aspect of our study is that we defined hypertension using a new cutoff. All previous studies that investigated the relationship of perceived health status and

**Table 2** Comparison of health status by study variables and results of logistic regression analysis ( $N = 8504$ ).

Variables	Very good–excellent health			Odds ratio of ‘very good–excellent’ health status	
	No ( $n = 5682$ )	Yes ( $n = 2822$ )	$p$ value	COR (95% CI)	AOR (95% CI)
Age (in year)					
Mean (SE)	48.5 (0.5)	47.7 (0.5)	0.25	–	–
20–39	34.1 (1635)	37.6 (1068)	0.14	Ref.	Ref.
40–59	37.0 (1914)	34.3 (856)		0.8* (0.7, 1.0)	1.1 (0.9, 1.2)
≥60	28.9 (2,133)	28.0 (898)		0.9 (0.7, 1.1)	1.6** (1.2, 2.0)
Gender					
Male	50.1 (2767)	46.5 (1399)	0.053	Ref.	Ref.
Female	49.9 (2915)	53.5 (1423)		1.2 (1.0, 1.3)	1.2 (1.0, 1.4)
Race/Ethnicity					
Non-Hispanic white	60.2 (1855)	74.0 (1255)	<0.001	Ref.	Ref.
Non-Hispanic Black	12.1 (1274)	8.3 (556)		0.6*** (0.5, 0.7)	0.8*** (0.7, 0.9)
Hispanic	18.0 (1703)	8.8 (481)		0.4*** (0.3, 0.5)	0.6*** (0.5, 0.7)
Other races/ethnicities	9.6 (850)	8.8 (530)		0.8** (0.6, 0.9)	0.7*** (0.5, 0.8)
Education level					
Below high school	16.5 (1452)	4.8 (253)	<0.001	Ref.	Ref.
High school	61.8 (3231)	48.6 (1456)		2.7*** (2.1, 3.4)	1.9*** (1.4, 2.6)
College graduate or above	21.7 (999)	46.6 (1113)		7.3*** (5.9, 9.1)	3.5*** (2.6, 4.7)
Family income to poverty ratio					
Low-income	27.9 (2188)	13.0 (585)	<0.001	Ref.	Ref.
Middle-income	32.6 (1967)	25.5 (890)		1.7*** (1.4, 2.0)	1.4** (1.2, 1.7)
High-income	39.5 (1527)	61.5 (1347)		3.4*** (2.8, 4.0)	2.0*** (1.6, 2.5)
Covered by health insurance					
No	16.1 (1027)	8.2 (302)	<0.001	0.5*** (0.4, 0.6)	0.7* (0.6, 0.9)
Yes	83.9 (4655)	91.8 (2520)		Ref.	Ref.
Other Disease					
No	49.2 (2640)	62.9 (1778)	<0.001	Ref.	Ref.
Yes	50.8 (3042)	37.1 (1044)		0.6*** (0.5, 0.6)	0.5*** (0.5, 0.6)
Body mass index (kg/m <sup>2</sup> )					
<25	19.8 (1195)	36.9 (1048)	<0.001	Ref.	Ref.
25–29	28.2 (1698)	35.0 (995)		0.7*** (0.6, 0.8)	0.7** (0.6, 0.9)
≥30	52.0 (2789)	28.1 (779)		0.3*** (0.2, 0.3)	0.4*** (0.3, 0.4)
Leisure time physical activity (in minutes)					
No (0)	54.5 (3374)	31.0 (1042)	<0.001	Ref.	Ref.
Some (>0 to <150)	16.4 (784)	15.0 (391)		1.6*** (1.3, 1.9)	1.1 (0.9, 1.4)
High (≥150)	29.1 (1524)	54.1 (1389)		3.3*** (2.9, 3.7)	2.2*** (1.9, 2.5)
Hypertension					
No	45.3 (2316)	61.7 (1610)	<0.001	Ref.	Ref.
Yes	54.7 (3366)	38.3 (1212)		0.5*** (0.4, 0.6)	0.7*** (0.6, 0.8)

hypertension used a higher cutoff (i.e., 140/90 mmHg or more) or used self-reports of hypertension [17, 20]. The investigated association between perceived general health and LTPA can be explained in multiple ways. Studies have shown PA could lead to weight, blood sugar, and lipid reduction, and improve cardiovascular health (e.g., reduce

peripheral arterial resistance and increase lumen diameter), which ultimately improves overall physical and mental well-being [12, 20]. In addition, several neurotransmitters (e.g., serotonin, dopamine, and norepinephrine) could be released during exercise that could improve mental well-being, including reduction of stress, anxiety, and depression

**Table 3** Comparison of people by aerobic leisure time physical activity level among those who were hypertensive ( $N = 4578$ ).

Variables	Overall ( $N = 4578$ )	Comparison by leisure-time physical activity level			
		No ( $n = 2649$ )	Some ( $n = 666$ )	High ( $n = 1263$ )	$p$ values
Age (in year)					
Mean (SE)	55.9 (0.5)	57.8 (0.6)	56.1 (0.5)	52.7 (0.7)	<0.001
20–39	17.0 (642)	13.8 (281)	14.0 (83)	23.7 (278)	<0.001
40–59	39.5 (1549)	38.2 (851)	43.5 (258)	39.6 (440)	
≥60	43.5 (2387)	48.0 (1517)	42.5 (325)	36.7 (545)	
Gender					
Male	52.3 (2400)	47.5 (1287)	48.3 (321)	62.2 (792)	<0.001
Female	47.7 (2178)	52.5 (1362)	51.7 (345)	37.8 (471)	
Race/ethnicity					
Non-Hispanic white	67.0 (1674)	65.5 (982)	67.0 (242)	69.4 (450)	0.019
Non-Hispanic black	12.5 (1164)	12.6 (639)	12.9 ((182)	12.2 (343)	
Hispanic	11.7 (1064)	13.4 (688)	9.2 (126)	10.1 (250)	
Other races/ethnicities	8.8 (676)	8.5 (340)	10.9 (116)	8.3 (220)	
Education level					
Below high school	12.8 (1016)	18.2 (746)	7.3 (98)	6.6 (172)	<0.001
High school	60.1 (2557)	65.5 (1533)	58.4 (379)	52.2 (645)	
College or above	27.1 (1005)	16.3 (370)	34.3 (189)	41.2 (446)	
Family income to poverty ratio					
Low-income	21.0 (1505)	26.7 (1018)	18.6 (199)	13.0 (288)	0.003
Middle-income	30.6 (1579)	35.6 (978)	26.0 (203)	24.6 (398)	
High-income	48.4 (1494)	37.6 (653)	55.4 (264)	62.5 (577)	
Covered by health insurance					
No	9.9 (548)	12.1 (355)	8.1 (70)	7.3 (123)	<0.001
Yes	90.1 (4030)	87.9 (2294)	91.9 (596)	92.7 (1,140)	
Other Disease					
No	39.1 (1712)	35.9 (928)	36.6 (232)	45.6 (552)	0.001
Yes	60.9 (2866)	64.1 (1721)	63.4 (434)	54.4 (711)	
Body mass index ( $\text{kg}/\text{m}^2$ )					
<25	17.5 (882)	16.8 (491)	15.6 (119)	19.5 (272)	<0.001
25–29.9	30.3 (1439)	26.6 (795)	30.7 (206)	36.1 (438)	
≥30	52.3 (2257)	56.6 (1363)	53.7 (341)	44.4 (553)	
General health					
Not very good–excellent	66.9 (3366)	76.9 (2126)	65.2 (470)	51.6% (770)	<0.001
Very good–excellent	33.1 (1212)	23.1 (523)	34.8 (196)	48.4% (493)	

[12]. Inadequate PA is also a well-known risk factor for several other comorbidities that may also cause poor physical health, including premature deaths [11].

The findings of this study also have public health significance [21]. As we discussed, the significance of LTPA for the reduction of BP or improving LTPA is already known. We observed a dose–response relationship between LTPA and general health such that people with higher levels of LTPA had greater odds of having ‘very good to excellent’ health status [12, 21]. Currently, for patients with stage 1 hypertension (i.e., SBP/DBP with 130–139/80–89 mmHg) without having any other comorbidities, PA, weight reduction, and balanced diets are recommended with a goal to reduce SBP and DBP below 130 mmHg and 80 mmHg, respectively [2]. However, improving general health could be an added benefit of LTPA among those who are hypertensive. Even a small amount of LTPA (i.e., more than 0 but less than 150 min per week) is helpful compared to no LTPA

(i.e., 0 min in each week) [12]. Considering the higher prevalence of hypertension within the US, our results may benefit about half of the adults within this country. In addition, while the proportion of people with high LTPA was only about 40%, this was substantially lower among those who were hypertensive compared to people who were not hypertensive, 32% and 46%, respectively (Table 1). Insufficient knowledge regarding the recommended level of PA was reported previously [27], therefore, interventions have to be directed for people who may have lower LTPA [28, 29], higher risk of future diseases [12, 30], and also lack of knowledge about PA [27]. As part of our analyses, we investigated the unadjusted relationships of LTPA with the study variables among overall study people (Supplemental Table 1) and people with hypertension (Table 3); most of these variables also had association with general health.

Although we have found a relationship between LTPA and perceived health status among those with hypertension,

**Table 4** Comparison of health status by study variables and results of logistic regression analysis among people with hypertension ( $N = 4578$ ).

Variables	Very good–excellent health			Odds ratio of ‘very good–excellent’ health status	
	No ( $n = 3366$ )	Yes ( $n = 1212$ )	$p$ value	COR (95% CI)	AOR (95% CI)
<b>Age (in year)</b>					
Mean (SE)	55.2 (0.5)	57.4 (0.7)	0.003	–	–
20–39	17.8 (466)	15.4 (176)	0.021	Ref.	Ref.
40–59	40.9 (1168)	36.8 (381)		1.0 (0.8, 1.3)	1.1 (0.9, 1.4)
≥60	41.4 (1732)	47.8 (655)		1.3* (1.0, 1.7)	1.9*** (1.3, 2.6)
<b>Gender</b>					
Male	52.2 (1720)	52.6 (680)	0.89	Ref.	Ref.
Female	47.8 (1646)	47.4 (532)		1.0 (0.8, 1.2)	1.1 (0.8, 1.4)
<b>Race/ethnicity</b>					
Non-Hispanic white	62.3 (1111)	76.4 (563)	<0.001	Ref.	Ref.
Non-Hispanic black	14.2 (892)	9.1 (272)		0.5*** (0.4, 0.7)	0.7*** (0.6, 0.8)
Hispanic	14.3 (891)	6.5 (173)		0.4*** (0.3, 0.5)	0.6** (0.5, 0.8)
Other races/ethnicities	9.2 (472)	8.0 (204)		0.7** (0.6, 0.9)	0.6*** (0.5, 0.8)
<b>Education level</b>					
Below high school	16.1 (877)	6.0 (139)	<0.001	Ref.	Ref.
High school	63.5 (1896)	53.1 (661)		2.2*** (1.6, 3.2)	1.6* (1.0, 2.4)
College or above	20.4 (593)	40.8 (412)		5.4*** (3.9, 7.5)	2.5*** (1.7, 3.7)
<b>Family income to poverty ratio</b>					
Low-income	26.4 (1272)	10.2 (233)	<0.001	Ref.	Ref.
Middle-income	33.4 (1187)	24.9 (392)		1.9*** (1.5, 2.5)	1.5** (1.2, 2.0)
High-income	40.2 (907)	64.9 (587)		4.2*** (3.3, 5.3)	2.6*** (2.0, 3.3)
<b>Covered by health insurance</b>					
No	12.0 (456)	5.7 (92)	<0.001	0.4*** (0.3, 0.7)	0.7 (0.4, 1.2)
Yes	88.0 (2910)	94.3 (1120)		Ref.	Ref.
<b>Other disease</b>					
No	35.6 (1151)	46.1 (561)	<0.001	Ref.	Ref.
Yes	64.4 (2215)	53.9 (651)		0.6*** (0.5, 0.8)	0.5*** (0.4, 0.6)
<b>Body mass index (kg/m<sup>2</sup>)</b>					
<25	14.1 (556)	24.3 (326)	<0.001	Ref.	Ref.
25–29.9	26.8 (981)	37.3 (458)		0.8 (0.6, 1.0)	0.7* (0.6, 1.0)
≥30	59.1 (1829)	38.3 (428)		0.4*** (0.3, 0.5)	0.4*** (0.3, 0.5)
<b>Leisure-time physical activity (in minutes)</b>					
No (0)	59.9 (2126)	36.4 (523)	<0.001	Ref.	Ref.
Some (>0 to <150)	15.5 (470)	16.7 (196)		1.8*** (1.3, 2.4)	1.5* (1.0, 2.0)
High (≥150)	24.7 (770)	46.8 (493)		3.1*** (2.5, 3.9)	2.3*** (1.7, 3.0)

it is important to consider our findings in the context of limitations of this study. This is a cross-sectional study, therefore, we are not certain about the temporal association between exposure and outcomes [31]. On the other hand, in experimental studies, implementing and objectively measuring an intervention like LTPA could be difficult as it would be very hard to mask an investigator or study participants about LTPA. During an intervention like group walking or running, participants’ quality of life can be improved through social support networks and other group activities [20]. LTPA and general health are two variables

that can serve both as predictors and consequences of one another. A person with poorer health can perform lower LTPA because of the inability to do moderate to vigorous LTPA. These two variables could be common outcomes of several other variables like older age and presence of comorbidities [12, 28, 29]. However, we have adjusted for several sociodemographic and clinical variables that have increased the credibility of our findings. In addition, several other criteria for causality including strength of association, consistency, dose–response relationship, biological plausibility, coherence, and analogy could support our findings

[31]. Data on general health status and LTPA were based on self-reports, not based on objective measurements, and estimates of hypertension were obtained based on a single day's measures. Lastly, because NHANES collects data from non-institutionalized people, we may underestimate the prevalence. We also did not consider other types of activities people perform to do daily routine work.

The strengths of the study include using a nationally representative large sample of a survey that uses standardized validated protocols. We adjusted for sample weights and used appropriate statistical analytical procedures. We also controlled for multiple potential confounders in the association between LTPA and health status.

## Conclusion

In conclusion, this study found positive associations between LTPA and general health among hypertensive people such that improving general health could be an added advantage of higher LTPA among these people. Considering the lower proportion of hypertensive people with high LTPA, future interventions are also required to improve the levels of LTPA among all people.

## Summary

### What is already known

- About half of the adults in the United States have hypertension.
- Leisure-time physical activity (LTPA) improves general health of overall population; however, little is known about the proportion of hypertensive people who perform recommended level of LTPA or how LTPA impacts the general health of hypertensive people.

### What this study adds

- This study found that leisure-time physical activity could positively impact health of hypertensive people.
- These results suggest that improving general health could be an added advantage of leisure time physical activity among hypertensive people.

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## Compliance with ethical standards

**Conflict of interest** The authors declare no competing interests.

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