

Association of Body Mass Index with Hypertension in Patients with Healthy Weight

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ABSTRACT

Objective: To determine the association between body mass index (BMI) and hypertension in the healthy weight group (BMI: ≥ 18.5 - <25.0) stratified by age, sex, and race.

Methods: Patient age, sex, race, BMI, and a diagnosis of hypertension for 51,435 adult patients (≥ 18 years old) seen since 2015 at either the family medicine clinic or general internal medicine clinics were obtained from the electronic health record using ICD-10 codes for hypertension. This analysis was implemented on the 14,443 of these patients whose BMI values were between 18.5 and <25 . Logistic regression was used to assess the relationship between BMI and hypertension with and without adjusting for the impact of age, race, and sex. Odds ratios were calculated for both the adjusted and unadjusted models.

Results: Hypertension rates for healthy weight individuals steadily increased with BMI and age, which were independently associated with hypertension. The percentage of patients with hypertension by race was 20.9%, 18.1%, 13.1%, 11.7%, and 9.5% for Black, White, Asian, Other, and Hispanic/Latino, respectively. Fewer women had hypertension compared with men (15.5% vs 20.4%). Tests of odds ratios (both adjusted and unadjusted) indicated that individuals with greater BMI measurements in the healthy weight group are at significantly greater risk for hypertension.

Conclusions: Patients in the healthy weight group with higher BMI within that group are at greater risk for hypertension. Patients who are male, Black, or older are also at greater risk of hypertension relative to the rest of the patient population.

Keywords

Body mass index, Healthy weight, Hypertension.

Introduction

Epidemiological studies report increasing prevalence of hypertension and obesity in the United States [1,2]. Seventy to 75% of adult Americans are now overweight or obese, with the nation's adult population in 2017-2018 having an obesity rate of 42.5% [2].

Likewise, the prevalence of hypertension in the U.S. adult population has increased from 41.7% in 2013-2014 to 45.4% in 2017-2018 [3], and has been strongly associated with body mass index (BMI) in the overweight and obesity categories [1,4-6]. Chronic hypertension has been strongly associated with stroke, cardiovascular disease, and lower life expectancy [7]. The objective of this study was to determine whether increasing body mass index (BMI) in a "healthy weight" group (BMI: ≥ 18.5 - <25.0) was associated with increasing prevalence of hypertension. Institutional Review Board approval obtained for this study.

Methods

In order to determine the association between body mass index (BMI) and hypertension in a healthy weight group (BMI: ≥ 18.5 - <25.0) stratified by age, sex, and race, patient demographic and clinical data were pulled from the electronic medical record for over 50,000 adult patients who had been seen in the last 5 years in a patient population of the family medicine and general internal medicine clinics in our large academic medical center.

Patient age, sex, race, and BMI was recorded for 51,428 adult patients (≥ 18 years old) seen in the last 5 years since 2015 at either the family medicine or general internal medicine clinic were obtained from the EPIC electronic health record using ICD-10 codes for hypertension. This analysis was implemented on the 14,443 of these patients whose BMI values were between ≥ 18.5 and <25.0 . Hypertension rates stratified by BMI, age, sex, and race are reported as counts and percentages. Logistic regression models were fit using BMI to predict hypertension status with and without adjusting for the impact of age, race, and sex. Odds ratio point estimates and confidence intervals were calculated for predictors in both the adjusted and unadjusted models, along with test p-values. All comparisons were made at $\alpha=0.05$, and analyses were conducted in R [8,9].

Results

The percentage of patients with a BMI in the healthy weight range, overweight range, and obesity categories was 28.1% (n= 14,443), 30.8% (n= 15,830), and 39.6% (n= 20,355), respectively. Table 1 shows that the percentage of patients with hypertension in the healthy weight group steadily increased with higher BMI from a low of 13.9% to a high of 21.2%.

Table 1: Percent of Patients with Hypertension in each BMI Sub-category.

BMI Range	Sample Size	Percent with Hypertension
≥ 18.5 - <20	N = 1456	13.9%
≥ 20 - <21	N = 1707	14.8%
≥ 21 - <22	N = 2250	15.3%
≥ 22 - <23	N = 2775	17.1%
≥ 23 - <24	N = 3007	17.9%
≥ 24 - <25	N = 3248	21.2%

Likewise, the percentage of patients with hypertension in the healthy weight group steadily increased with age from a low of 1.0% in the 18-25 age group up to 56.6% in the ≥ 73 -year-old age group (Table 2). BMI and age were independently associated with hypertension.

Table 2: Percent with Hypertension and Median BMI by Age Group.

Age Group	Sample Size	Percent with Hypertension	Median BMI
18 - 25	N = 1856	1.0%	22.26
26 - 31	N = 2166	2.0%	22.52
32 - 36	N = 1440	3.0%	22.76
37 - 41	N = 1299	5.5%	22.74
42 - 48	N = 1305	9.3%	22.73
49 - 54	N = 1032	16.6%	22.86
55 - 60	N = 1274	24.6%	22.76
61 - 66	N = 1209	27.9%	22.78
67 - 72	N = 1200	36.8%	22.75
≥ 73	N = 1662	56.6%	22.77

Of 1,456 patients with BMI values between 18.5 and 20, which comprises 2.9% of 50,628 non-underweight patients and 10.1% of 14,443 healthy weight patients, 0.4% had hypertension in the 18-25 age group versus 50.8% in the >73 -year-old age group. Conversely, of 3,248 patients with BMI values between 24 and 25, which comprises 6.4% of 50,628 non-underweight patients and 22.5% of 14,443 healthy weight patients, 1.0% had hypertension in the 18-25 age group versus 64.1% in the >73 -year-old age group.

The percentage of patients with hypertension by race in the healthy weight group was 20.9%, 18.1%, 13.1%, 11.7%, and 9.5% for Black, White, Asian, Other and Hispanic/Latino, respectively. Fewer women had hypertension compared with men (15.5% vs 20.4%).

The odds ratios (both adjusted and unadjusted) indicated that individuals with greater BMI measurements in the healthy weight group are at significantly greater risk for hypertension (see Table 3).

Table 3: Odds Ratios for Predictors of Hypertension.

Characteristic	OR ¹	95% CI ¹	p-value
BMI	1.093	1.059, 1.127	<0.001
Sex			
F	—	—	
M	1.508	1.357, 1.675	<0.001
Racial Category			
African American/Black	—	—	
Asian	0.408	0.313, 0.530	<0.001
Hispanic/Latino of any race	0.365	0.233, 0.561	<0.001
Other	0.388	0.270, 0.553	<0.001
White	0.345	0.280, 0.425	<0.001
Age (yrs)	1.084	1.080, 1.087	<0.001

¹OR = Odds Ratio, CI = Confidence Interval

Conclusions

We found that patients with higher BMI within the healthy weight group are at greater risk for hypertension, reaching as high as 57% in the ≥ 73 old group. Patients who are male, Black, or older are also at greater risk of hypertension relative to the rest of the patient population in the healthy weight group and were independently associated. Those patients with the lowest BMI, younger, or Hispanic/Latino were at least risk for hypertension in the healthy weight group.

These results indicate that a lower BMI in the healthy weight group is associated with a decreased risk of hypertension, and being of a healthy weight is not sufficient to prevent hypertension especially as one ages. Other epidemiological studies provide strong evidence that above a BMI of 20-21 a strong and linear association exists between BMI and the risk of hypertension, diabetes type 2 and other chronic diseases in both men and women [6]. Our findings are consistent with these reports. The health risks associated with being overweight and obese have been well documented and include hypertension, diabetes and its complications, liver disease, heart disease, sleep disturbance, some forms of cancer, and chronic joint disease [5,7].

Data from 1960 show that 13.4% of adult Americans were obese compared to 42.5% today [2]. The mean weight gain between

1960 and 2016 for adult men and women in the United States has been 32 pounds and 30 pounds, respectively [10,11]. A recent study projects that by 2030, nearly 1 in 2 adults will have obesity and nearly 1 in 4 adults will have severe obesity in the United States [12]. This increasing trend portends increasing prevalence of hypertension and its detrimental sequelae in what is considered a healthy weight group.

Given the uniform increase in hypertension rates that we observed as BMI increased among patients in the weight group, we conclude that patients with lower BMI values are at decreased risk of hypertension within the healthy weight group.

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References

1. Shihab HM, Meoni LA, Chu AY, et al. Body Mass Index and Risk of Incident Hypertension Over the Life Course. The John Hopkins Precursors Study. *Circulation*. 2012; 126: 2983-2989.
2. Fryar CD, Carroll MD, Afful J. Prevalence of overweight, obesity, and severe obesity among adults aged 20 and over: United States, 1960-1962 through 2017-2018. National Center for Health Statistics.
3. Ostchega Y, Fryar CD, Nwankwo T, et al. Hypertension prevalence among adults aged 18 and over: United States, 2017-2018. NCHS Brief, no 364. Hyattsville MD National Center for Health Statistics, 2020.
4. Franco OH, Peeters A, Bonneux L, et al. Blood Pressure in Adulthood and Life Expectancy With Cardiovascular Disease in Men and Women. *Life Course Analysis. Hypertension*. 2005; 46: 280-286.
5. Fontana L, Hu FB. Optimal body weight for health and longevity: bridging basic, clinical, and population research. *Aging Cell*. 2014; 13: 391-400.
6. Willett WC, Dietz WH, Colditz GA. Guidelines for healthy weight. *N. Engl. J. Med*. 1999; 341: 427-434.
7. Billington CJ, Epstein LH, Goodwin NJ, et al. Overweight, obesity, and health risk. *Arch Internal Med*. 2000; 160: 898-904.
8. <https://www.R-project.org/>.
9. <https://CRAN.R-project.org/package=gtsummary>.
10. https://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.pdf.
11. Hales CM, Fryar CD, Carroll MD, et al. Trends in obesity and severe obesity prevalence in US youth and adults by sex and age, 2007-2008 to 2015-2016. *JAMA*. 2018; 319: 1723-1725.
12. Ward ZJ, Bleich SN, Cradock AL, et al. Projected U.S. state-level prevalence of adult obesity and severe obesity. *N Engl J Med*. 2019; 381: 2440-2450.