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

J. Brooks Jackson MD MBA¹, Linder Wendt MS² and Patrick Ten Eyck MS PhD²

¹Department of Pathology, Carver College of Medicine, University of Iowa, Iowa City, Iowa, USA.
²Institute for Clinical and Translational Science, University of Iowa, Iowa City, Iowa, USA.

Correspondence:
Brooks Jackson MD MBA, Professor of Pathology, Carver College of Medicine, University of Iowa, CMAB 312, 451 Newton Road, Iowa City, Iowa 52242, Tel: 319-335-8064, Fax: 319-335-8478.

Received: 13 July 2021; Accepted: 28 August 2021

Citation: J. Brooks Jackson, Linder Wendt, Patrick Ten Eyck. Association of Body Mass Index with Hypertension in Patients with Healthy Weight. Clin Rev Cases. 2021; 3(2): 1-3.

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, 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, sex, and race. 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      |

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.

Sponsorship: Funding for this project was from the Carver College of Medicine internal funds and the University of Iowa Institute for Clinical and Translational Science which is granted with Clinical and Translational Science Award funds from the National Institutes of Health (UL1TR002537).

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.