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Body Roundness Index as a Predictor of Hypertension: A Logistic Regression Analysis Using NHANES Data

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Abstract. Hypertension remains a serious public health issue worldwide because of its strong association with cardiovascular disease and premature mortality. Although body mass index (BMI) and waist circumference (WC) are commonly used indicators of obesity, they do not always capture differences in fat distribution. This study examined whether Body Roundness Index (BRI), a newer measure of body shape, is associated with hypertension among U.S. adults. The analysis used data from the 2017–2020 National Health and Nutrition Examination Survey (NHANES). After excluding participants with incomplete demographic, anthropometric, or blood pressure data, 5,729 individuals were included. Multivariable logistic regression was applied to evaluate the association between BRI and hypertension while controlling for demographic, socioeconomic, and lifestyle characteristics. The results showed that individuals in the highest BRI quartile were more likely to have hypertension than those in the lowest quartile, even after adjustment for potential confounders. Overall, the findings indicate that BRI may be a useful marker for identifying hypertension risk in population-based research.

Keywords: Body Roundness Index (BRI), Hypertension, Obesity, NHANES, Logistic Regression

1. Introduction

Hypertension is a common chronic health conditions in the world and is closely related to cardiovascular disease and premature death [1]. For this reason, finding simple and dependable ways to identify people at risk is important for prevention and early intervention. Traditional measures such as BMI and WC are often used to assess obesity, but they may not fully capture differences in body fat distribution. BRI, a newer measure based on height and WC, has been proposed as a potentially better way to reflect body shape and visceral fat accumulation [2].

As obesity and hypertension continue to affect a growing number of adults in the United States, the possible role of BRI in hypertension risk deserves more attention. In this study, we analyzed NHANES data from 2017 to 2020, which provide nationally representative information on the U.S. population. The study examined whether BRI was associated with hypertension in U.S. adults. Hypertension was identified using measured blood pressure and self-reported diagnosis, and BRI was calculated from anthropometric measures. Multivariable logistic regression was then used to account for demographic and socioeconomic differences. This analysis adds to existing research on

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newer anthropometric indicators and may offer useful implications for hypertension screening in both public health and clinical settings [3,4].

2. Data and measures

2.1. Data source

This study analyzed data from the 2017–2020 waves of the NHANES. NHANES is designed to provide nationally representative information on the civilian, noninstitutionalized U.S. population [5]. The survey collects information through household interviews, physical examinations, and laboratory assessments. For this study, demographic characteristics, anthropometric measures, blood pressure readings, and self-reported hypertension information were linked across datasets using participant identification numbers (SEQN). Adults were included in the final sample if they had complete data on WC, standing height, systolic and diastolic blood pressure, and hypertension-related questionnaire items.

2.2. Definition of key variables

The BRI was derived using the published formula based on measurements of standing height and WC:

$$BRI = 364.2 - 365.5 \times \sqrt{1 - \frac{(waist/(2\pi))^2}{(0.5 \times height)^2}} \quad (1)$$

Higher BRI values reflect a more rounded body shape and increased central fat accumulation. Hypertension status was determined using both measured blood pressure values and self-reported information. Up to four repeated measurements were used to calculate the mean systolic blood pressure (SBP) and diastolic blood pressure (DBP). Participants were classified as hypertensive if they fulfill any of the following criteria: (a) mean SBP ≥ 140 mmHg, (b) mean DBP ≥ 90 mmHg, or (c) a prior diagnosis of hypertension was reported [6]. This definition is commonly used in epidemiological studies based on NHANES data. Demographic variables considered in the analysis included age, sex, and race/ethnicity, with categories defined according to NHANES criteria.

Behavioral and health-related variables were derived from NHANES questionnaire data. Participants were grouped as current, former, or never smokers according to their responses to smoking-related survey questions. This classification was based on participants' responses to smoking-related survey items. Alcohol use was defined as if the participant reported consuming alcohol in the past 12 months (yes/no). Physical activity was defined as engagement in any moderate or vigorous activity (yes/no) based on multiple activity-related items. Sedentary behavior was measured as total daily sedentary time (minutes per day).

All variables were cleaned prior to analysis. Special NHANES codes (e.g., 7, 9, 77, 99, 777, and 999), which indicate missing or non-response categories, were recoded as missing values (NA). Although several lifestyle variables were constructed, they were mainly used for descriptive analysis and were not included in the final regression models.

3. Descriptive characteristics of the sample

Participants were divided into three smoking groups: current smokers, former smokers, and never smokers. Age and BRI, as continuous indicators, were summarized with means and standard

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deviations. Variables measured categorically, such as sex and smoking group, were described using numbers and proportions. Group comparisons between hypertensive and non-hypertensive participants were conducted with independent-samples t tests for continuous variables and chi-square analyses for categorical variables.

Table 1 summarizes the sample characteristics according to hypertension status. Compared with participants without hypertension, those with hypertension were older and had higher average BRI values, with both differences reaching statistical significance ($p < 0.001$).

Table 1. Baseline characteristics of the study population by hypertension status

Variable	No Hypertension(n = 3566)	Hypertension(n = 2163)	p test
Age (years), mean (SD)	41.46 (18.55)	60.72 (14.81)	<0.001
Body Roundness Index, mean (SD)	5.04 (2.35)	6.58 (2.41)	<0.001

4. Statistical analysis

4.1. Logistic regression models

Logistic regression was performed to determine whether BRI was associated with hypertension. Odds ratios and 95% confidence intervals were used to summarize the estimated effects. The analysis began with a crude model containing only BRI, followed by an adjusted model that accounted for demographic and socioeconomic characteristics, specifically age, sex, race/ethnicity, and income status. Other relevant covariates, such as smoking, alcohol use, exercise participation, diabetes, and sedentary behavior, were incorporated as part of the analytical adjustment process. According to the results in Table 2, BRI showed a statistically significant positive association with hypertension in the unadjusted model (OR = 1.30, 95% CI: 1.27–1.33, $p < 0.001$). This positive association remained after covariate adjustment in the second model (OR = 1.24, 95% CI: 1.21–1.28, $p < 0.001$). Taken together, the findings suggest that BRI is not only related to hypertension risk but may also provide predictive information beyond basic demographic differences.

Table 2. Logistic regression results for the association between BRI and hypertension

Model	Variable	OR (95% CI)	p-value
Model 1: Crude	Body Roundness Index	1.30 (1.27–1.33)	<0.001
Model 2: Adjusted	Body Roundness Index	1.24 (1.21–1.28)	<0.001
	Age (years)	1.06 (1.05–1.07)	<0.001
	Race: Other Hispanic	1.42 (1.03–1.96)	0.031
	Race: NH White	1.60 (1.26–2.05)	<0.001
	Race: NH Black	2.95 (2.29–3.82)	<0.001
	Race: Other	1.85 (1.41–2.43)	<0.001
	Income ratio	1.00 (0.96–1.05)	0.882

4.2. Quartile-based trend analysis

To evaluate potential non-linear patterns and better illustrate how hypertension risk changes across different levels of body roundness, BRI was further categorized as quartiles. The first quartile was used as the reference category. Odds ratios for hypertension were then calculated for the remaining

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groups, including Quartile 2, Quartile 3, and Quartile 4. Calculate p-value for trend across ordered quartiles to assess whether hypertension risk increased monotonically with higher BRI.

Table 3 presents the adjusted odds ratios for hypertension across BRI quartiles. Compared to the lowest quartile (Q1), participants in higher quartiles had progressively higher odds of hypertension. Specifically, the odds ratios increased from 2.20 in Q2 to 3.52 in Q3 and 5.55 in Q4 (all $p < 0.001$), indicating a clear monotonic increasing trend. These findings indicate a clear gradient in hypertension risk across increasing levels of BRI.

Table 3. Adjusted odds ratios for hypertension across BRI quartiles

Variable	OR (95% CI)	p-value
Q1 (Reference)	1.00(Ref)	-
Q2	2.20 (1.75–2.79)	<0.001
Q3	3.52 (2.80–4.46)	<0.001
Q4	5.55 (4.41–7.02)	<0.001
Age (RIDAGEYR)	1.06 (1.05–1.06)	<0.001
Other Hispanic	1.41 (1.03–1.95)	0.034
Non-Hispanic White	1.73 (1.36–2.21)	<0.001
Non-Hispanic Black	3.17 (2.46–4.11)	<0.001
Other race	1.99 (1.52–2.62)	<0.001
PIR (INDFMPIR)	1.00 (0.96–1.05)	0.983

5. Visualization of risk pattern

5.1. Adjusted odds ratios by BRI category

To facilitate interpretation of the trend across BRI categories, the adjusted odds ratios and their 95% confidence intervals were visualized in Figure 1. The plotted values correspond to the multivariable-adjusted model, with the lowest quartile treated as the reference level (OR = 1.0). The y-axis is plotted on a logarithmic scale to emphasize relative risk differences between quartiles. Visualizing the results in this format helps highlight how hypertension risk escalates with increasing body roundness.

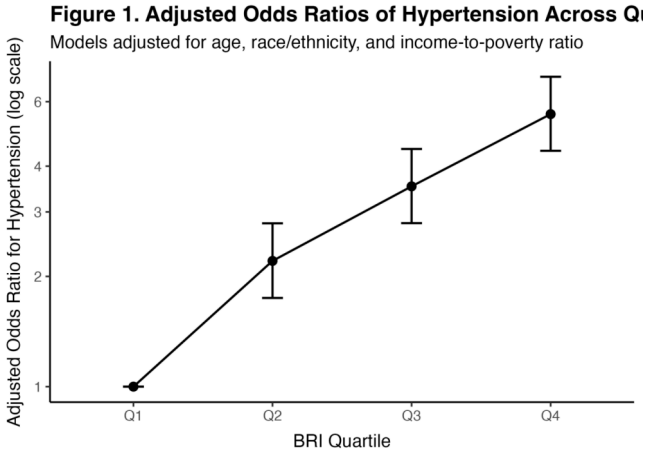


Figure 1. Adjusted odds ratios of hypertension across quartiles of BRI

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5.2. Interpretation of the pattern

It can be observed that hypertension risk does not increase randomly but follows an approximately monotonic pattern across BRI categories. The consistent elevation of odds ratios in higher quartiles suggests that central adiposity captured by BRI is meaningfully linked to blood pressure burden. These findings suggest that BRI could be useful as a screening measure for hypertension in both clinical practice and public health applications. It may also provide additional value beyond commonly used anthropometric measures, including BMI and WC.

6. Conclusion

Using NHANES data collected from 2017 to 2020, this study examined whether BRI was related to hypertension in U.S. adults. The results showed that higher BRI was linked to a greater likelihood of hypertension. This association remained statistically significant after accounting for demographic and socioeconomic characteristics. In addition, the risk of hypertension increased across BRI quartiles, indicating that individuals with higher body roundness may be more vulnerable to hypertension.

Overall, this study contributes to the growing evidence that BRI, a simple index derived from height and WC, may serve as an accessible and cost-effective screening tool for identifying populations at risk of hypertension. However, this research has certain limitations, such as not including longitudinal data or additional health behaviors like diet and physical activity. Future studies could expand on these findings by exploring BRI's predictive ability over time, applying it across diverse ethnic groups, and integrating lifestyle variables to develop more comprehensive models for hypertension prevention.

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