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Research Article

# Development of a Binary Logistic Regression Model for Predicting Hypertension Risk Using Anthropometric and Lifestyle Variables

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## Abstract

The purpose of the present study was to develop a binary logistic regression model for predicting hypertension risk using selected anthropometric and lifestyle variables among adults. The dependent variable of the study was hypertension status, categorized as hypertensive and non-hypertensive individuals. The independent variables selected for the study included anthropometric variables such as Body Mass Index (BMI), waist circumference, hip circumference, waist-hip ratio, and body fat percentage, along with lifestyle variables including physical activity level, smoking habit, alcohol consumption, and sleep duration. A total of 200 adults aged between 30 and 60 years were selected as participants for the study using purposive sampling technique. Anthropometric measurements were obtained using standardized procedures, while lifestyle-related information was collected through structured questionnaires. Blood pressure measurements were recorded to classify participants into hypertensive and non-hypertensive groups according to standard clinical guidelines. The collected data were analysed using descriptive statistics and binary logistic regression analysis. Odds ratios and confidence intervals were calculated to identify significant predictors of hypertension risk. The findings of the study revealed that BMI, waist circumference, body fat percentage, smoking habit, alcohol consumption, and reduced physical activity level were significant predictors of hypertension. The developed logistic regression model effectively predicted hypertension risk among adults. The study concluded that both anthropometric and lifestyle variables play an important role in the prediction of hypertension risk and that binary logistic regression modeling can be effectively used as a statistical approach for identifying individuals at greater risk of hypertension.

## Keywords

Hypertension, Binary Logistic Regression, Anthropometric Variables, Lifestyle Variables, Body Mass Index, Waist Circumference, Hypertension Risk

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# 1. Introduction

Hypertension is a common health issue affecting adults all over the world. It is a risk factor for heart diseases, stroke and kidney problems [11-13, 27, 42, 43]. The increasing number of people with hypertension is a concern for public health. This is because of urbanization people not exercising enough eating unhealthy food, stress, smoking, drinking alcohol and being overweight.

Hypertension develops progressively across the lifespan, and the residual lifetime risk of developing hypertension remains high among adults, emphasizing the need for early identification of risk factors [26].

Essential hypertension accounts for the majority of hypertension cases and results from the interaction of genetic, environmental, and lifestyle factors [28].

Anthropometric characteristics such as Body Mass Index (BMI), waist circumference, waist-hip ratio, and body fat percentage have been identified as important indicators of hypertension risk [21-25]. Lifestyle factors including physical inactivity, smoking, alcohol consumption, and inadequate sleep are strongly associated with the development of hypertension [16-20, 30-36].

Identifying people at risk of hypertension early is crucial for preventing and managing the condition. Recently statistical models have become important in research for finding out what factors contribute to the risk of disease. Binary logistic regression is an used technique, for predicting outcomes like whether someone has hypertension or not.

Binary logistic regression calculates the likelihood of an event happening based on one or more factors. It helps Figure out how each factor contributes and estimates the chances of developing hypertension based on characteristics and lifestyle factors [1-10].

It estimates the probability of occurrence of an event based on one or more variables.

It helps determine the contribution of each predictor variable and estimates the odds of developing hypertension based on lifestyle characteristics. the logistic regression model used in the present study may be represented as:

$$log\left(\frac{p}{1-p}\right) = \beta_0+\beta_1\ (BMI)+\beta_2\ (Waist\ Circumference)+\beta_3\ (Body\ Fat\ Percentage)+\beta_4\ (Physical\ Activity)+\beta_5\ (Smoking)+\beta_6\ (Alcohol\ Consumption)+\beta_7\ (Sleep\ Duration)$$

Where:

1) represents the probability of hypertension,
2) $\beta_0$ is the intercept,
3) $\beta_1$ to $\beta_7$ represent regression coefficients of predictor variables.

Although several studies have examined individual risk factors associated with hypertension, limited studies have attempted to develop predictive models combining both anthropometric and lifestyle variables. Therefore, the present study aimed to develop a binary logistic regression model for predicting hypertension risk using selected anthropometric and lifestyle variables among adults.

# 2. Methods

## 2.1. Participants

A total of 200 adults aged between 30 and 60 years were selected as participants for the study. The subjects were selected using purposive sampling technique from urban and semi-urban areas. Both hypertensive and non-hypertensive individuals participated in the study.

## 2.2. Variables

Dependent Variable

*Hypertension Status*

1) Hypertensive = 1
2) Non-Hypertensive = 0

Independent Variables

Anthropometric Variables

1) Body Mass Index (BMI)
2) Waist Circumference
3) Hip Circumference
4) Waist-Hip Ratio
5) Body Fat Percentage

Lifestyle Variables

1) Physical Activity Level
2) Smoking Habit
3) Alcohol Consumption
4) Sleep Duration

## 2.3. Tools Used for the Study

The following tools and instruments were used for the collection of data related to anthropometric and lifestyle variables in the study titled Development of a Binary Logistic Regression Model for Predicting Hypertension Risk Using Anthropometric and Lifestyle Variables.

1). Stadiometer

A standard stadiometer was used to measure the height of the participants in centimeters. The subjects were instructed to stand barefoot in an erect posture while the measurement was recorded.

2). Digital Weighing Scale

A calibrated digital weighing scale was used to measure body weight in kilograms. The participants were measured wearing light clothing and without footwear.

3). Body Mass Index (BMI) Calculator

Body Mass Index was calculated using the standard formula:

$$BMI = \frac{Weight\ (kg)}{Height\ (m)^2}$$

The BMI values were expressed in kg/m$^2$.

4). Measuring Tape

A non-elastic anthropometric measuring tape was used to measure waist circumference and hip circumference in centimetres.

Waist circumference was measured at the midpoint between the lower rib and iliac crest.

Hip circumference was measured at the widest portion of the buttocks.

5). Waist–Hip Ratio (WHR) Calculation

Waist–Hip Ratio was calculated using the formula:

$$WHR = \frac{Waist\ Circumference}{Hip\ Circumference}$$

6). Body Fat Analyzer

A bioelectrical impedance analysis (BIA) device was used to estimate body fat percentage of the participants.

7). Physical Activity Questionnaire

A standardized physical activity questionnaire was administered to assess the habitual physical activity level of the participants.

8). Lifestyle Assessment Questionnaire

A structured questionnaire was used to collect information related to smoking habits, alcohol consumption, and sleep duration.

9). Sphygmomanometer

A standard digital sphygmomanometer was used to measure blood pressure for identifying hypertensive and non-hypertensive participants.

## 2.4. Data Collection

Anthropometric measurements were obtained using standardized instruments and procedures. Height and weight were measured to calculate BMI. Waist circumference and hip circumference were measured using measuring tape, and waist-hip ratio was subsequently calculated. Body fat percentage was assessed using body composition analysis.

Lifestyle variables such as physical activity level, smoking habit, alcohol consumption, and sleep duration were collected using structured questionnaires and interview schedules.

Blood pressure was measured using a standard sphygmomanometer. Participants with systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg were classified as hypertensive.

## 2.5. Statistical Analysis

The collected data were analysed using descriptive statistics such as mean and standard deviation. Binary logistic regression analysis was employed to identify significant predictors of hypertension risk. Odds ratios with 95% confidence intervals were calculated to determine the likelihood of hypertension associated with each predictor variable. The analytical procedures followed established statistical recommendations for regression modelling and logistic regression analysis [1-10].

# 3. Results

***Table 1.*** *Descriptive Statistics of Anthropometric and Lifestyle Variables.*

| Variable | Mean | SD |
|---|---|---|
| BMI (kg/m$^2$) | 26.84 | 3.92 |
| Waist Circumference (cm) | 92.46 | 8.15 |
| Hip Circumference (cm) | 101.72 | 7.94 |
| Waist-Hip Ratio | 0.91 | 0.07 |
| Body Fat Percentage | 28.53 | 5.64 |
| Physical Activity Level | 2.84 | 0.76 |
| Sleep Duration (hours) | 6.38 | 1.21 |

Table 1 presents the descriptive statistics of selected anthropometric and lifestyle variables of the participants. The mean Body Mass Index (BMI) was 26.84 kg/m$^2$ with a standard deviation of 3.92. The mean waist circumference was 92.46 cm (SD = 8.15), while the mean hip circumference was 101.72 cm (SD = 7.94). The mean waist-hip ratio recorded was 0.91 with a standard deviation of 0.07. The mean body fat percentage was 28.53 (SD = 5.64). The participants recorded a mean physical activity level of 2.84 with a standard deviation of 0.76. The mean sleep duration was 6.38 hours with a standard deviation of 1.21.

***Table 2.*** *Binary Logistic Regression Analysis for Predicting Hypertension Risk.*

| Variable | B | S. E. | Wald | Sig. | Odds Ratio |
|---|---|---|---|---|---|
| BMI | 0.182 | 0.061 | 8.91 | 0.003 | 1.2 |
| Waist Circumference | 0.094 | 0.032 | 8.63 | 0.003 | 1.1 |
| Body Fat Percentage | 0.127 | 0.049 | 6.71 | 0.01 | 1.14 |

| Variable | B | S. E. | Wald | Sig. | Odds Ratio |
|---|---|---|---|---|---|
| Physical Activity Level | -0.563 | 0.212 | 7.05 | 0.008 | 0.57 |
| Smoking Habit | 0.847 | 0.338 | 6.28 | 0.012 | 2.33 |
| Alcohol Consumption | 0.692 | 0.291 | 5.65 | 0.017 | 1.99 |
| Sleep Duration | -0.248 | 0.109 | 5.18 | 0.023 | 0.78 |

Table 2 presents the results of the binary logistic regression analysis conducted to predict hypertension risk using selected anthropometric and lifestyle variables. The analysis revealed that Body Mass Index (BMI) significantly predicted hypertension risk, *B* = 0.182, SE = 0.061, Wald = 8.91, $p$ = .003, with an odds ratio of 1.20. This indicates that an increase in BMI was associated with increased likelihood of hypertension. Waist circumference also emerged as a significant predictor, *B* = 0.094, SE = 0.032, Wald = 8.63, $p$ = .003, OR = 1.10. Similarly, body fat percentage significantly predicted hypertension risk, *B* = 0.127, SE = 0.049, Wald = 6.71, $p$ = .010, OR = 1.14.

Physical activity level showed a significant negative association with hypertension risk, *B* = -0.563, SE = 0.212, Wald = 7.05, $p$ = .008, OR = 0.57, indicating that higher physical activity levels were associated with lower odds of hypertension. Smoking habit significantly increased the likelihood of hypertension, *B* = 0.847, SE = 0.338, Wald = 6.28, $p$ = .012, OR = 2.33. Alcohol consumption was also found to be a significant predictor of hypertension risk, *B* = 0.692, SE = 0.291, Wald = 5.65, $p$ = .017, OR = 1.99.

Sleep duration demonstrated a significant negative association with hypertension risk, *B* = -0.248, SE = 0.109, Wald = 5.18, $p$ = .023, OR = 0.78, indicating that increased sleep duration was associated with reduced odds of hypertension. Overall, the binary logistic regression analysis identified both anthropometric and lifestyle variables as significant predictors of hypertension risk.

The binary logistic regression model equation for predicting hypertension risk using anthropometric and lifestyle variables is presented as follows:

$$log\left(\frac{p}{1-p}\right) = \beta_0 + 0.182\ (\text{BMI}) + 0.094\ (\text{Waist Circumference}) + 0.127\ (\text{Body Fat Percentage}) - 0.563\ (\text{Physical Activity Level}) + 0.847\ (\text{Smoking Habit}) + 0.692\ (\text{Alcohol Consumption}) - 0.248\ (\text{Sleep Duration})$$

Where:

1) $p$= probability of hypertension risk
2) $\frac{p}{1-p}$= odds of hypertension
3) $log\ log\ \left(\frac{p}{1-p}\right)$ = logit transformation
4) $\beta_0$= constant/intercept of the model

The positive coefficients for BMI, waist circumference, body fat percentage, smoking habit, and alcohol consumption indicate increased hypertension risk, whereas the negative coefficients for physical activity level and sleep duration indicate reduced hypertension risk.

## 4. Discussion

The main goal of this study was to create a model that can predict the risk of hypertension using physical and lifestyle characteristics in adults. The study found that both physical and lifestyle characteristics play a role in predicting hypertension risk. The results showed that Body Mass Index, waist circumference, body fat percentage, smoking and alcohol consumption increase the risk of hypertension while activity and sleep duration decrease the risk of hypertension.

The study found that a higher Body Mass Index is linked to a risk of hypertension in adults. When people are overweight, it puts strain on their heart and blood vessels, which can lead to high blood pressure. Being overweight can also cause problems with insulin and inflammation which can increase blood pressure. This is what other researchers like Hall and the World Health Organization have found in the past [14, 15, 23-25, 37].

Waist circumference is also a factor in predicting hypertension risk. When people have fat around their waist it can cause problems with their metabolism and heart health. This type of fat can also affect the balance of hormones in the body, which can increase blood pressure. Other researchers like Janssen and Després have also found that waist circumference is an indicator of heart health and hypertension risk [21, 22].

The study also found that body fat percentage is a predictor of hypertension risk. When people have more body fat it can cause problems with their blood vessels. Increase their blood pressure. Extra body fat can also make it harder for the body to use insulin. Can cause problems with the health of the blood vessels. This is what other researchers have found in the past.

The study also found that physical activity is very important for reducing the risk of hypertension. People who are more active are less likely to get hypertension. Exercise can help improve the health of the heart and blood vessels. It can also help people maintain a healthy weight. Exercise can also help improve the balance of the system and the health of the blood vessels. This is what other researchers like Warburton and Hu have found in the past [16-20].

The study found that smoking is a risk factor for hypertension. Smoking can cause problems with the blood vessels. Increase blood pressure. Nicotine can also increase heart rate. Make the blood vessels stiffer, which can put extra strain on the heart. This is what other researchers like Primatesta have found in the past [31].

The study also found that drinking much alcohol can increase the risk of hypertension. Much alcohol can cause problems with the heart and blood vessels and it can also affect the balance of hormones in the body. This can increase blood pressure. Cause other health problems. This is what other researchers like Briasoulis and Fuchs have found in the past [32, 33].

The study found that sleep duration is also a factor in predicting hypertension risk. People who get sleep are less likely to get hypertension. Not getting sleep can cause problems with stress hormones and the nervous system, which can increase blood pressure. Getting sleep is important for the health of the heart and blood vessels. This is what other researchers like Gangwisch and Cappuccio have found in the past [34-36].

The model developed in this study can help identify people who're at high risk of hypertension. The study found that hypertension is linked to a combination of lifestyle characteristics. The results of the study can be useful for doctors, researchers and public health professionals who want to help prevent hypertension and other heart health problems.

Overall the study found that using a model to predict hypertension risk is a good idea. The results of the study can help identify people who're at high risk of hypertension and can help prevent hypertension and other heart health problems. The study found that Body Mass Index, waist circumference, body fat percentage, physical activity, smoking, alcohol consumption and sleep duration are all factors in predicting hypertension risk. Hypertension is a health problem that can be prevented by maintaining a healthy lifestyle and getting regular check-ups. Hypertension can be managed by making lifestyle changes, such as eating a healthy diet getting regular exercise and not smoking.

The study highlights the importance of hypertension prevention and the need for people to make lifestyle choices to reduce their risk of hypertension. Hypertension is a risk factor for heart disease and stroke and it can be prevented by maintaining a healthy lifestyle. The study found that hypertension prevention is critical for reducing the risk of heart disease and stroke and it can be achieved by making lifestyle choices, such as eating a healthy diet getting regular exercise and not smoking.

The results of the study can be used to develop health programs that promote healthy lifestyle choices and reduce the risk of hypertension. The study found that public health programs can play a role in reducing the risk of hypertension and promoting healthy lifestyle choices. The results of the study can be used to develop programs that promote activity, healthy eating and stress management and that provide people with the tools and resources they need to make healthy lifestyle choices.

The study highlights the importance of hypertension prevention and the need for people to make lifestyle choices to reduce their risk of hypertension. The study found that hypertension prevention is critical for reducing the risk of heart disease and stroke and it can be achieved by making lifestyle choices, such, as eating a healthy diet getting regular exercise and not smoking. The results of the study can be used to develop health programs that promote healthy lifestyle choices and reduce the risk of hypertension. Hypertension is a health problem that can be prevented by maintaining a healthy lifestyle and getting regular check-ups.

The clinical management of hypertension requires accurate assessment of modifiable risk factors such as obesity, physical inactivity, smoking, alcohol consumption, and inadequate sleep, all of which contribute to elevated blood pressure [29].

## 5. Conclusion

Hypertension remains one of the leading contributors to cardiovascular morbidity and mortality worldwide [38-40, 43]. Early identification of individuals at risk is essential because elevated blood pressure significantly increases the likelihood of cardiovascular events and premature death [45-48]. Current clinical guidelines emphasize lifestyle modification, risk-factor management, and regular monitoring as primary strategies for hypertension prevention and control [41, 44, 49, 50].

Based on the findings of the study, the following conclusions were drawn:

1) Anthropometric variables such as BMI, waist circumference, and body fat percentage significantly predicted hypertension risk among adults.
2) Lifestyle variables including smoking habit and alcohol consumption significantly increased hypertension risk.
3) Higher physical activity level and adequate sleep duration reduced the likelihood of hypertension.
4) Binary logistic regression modelling was effective in predicting hypertension risk using anthropometric and lifestyle variables.
5) The developed model may be useful for early identification and prevention of hypertension among adults.

## Abbreviations

BLR Binary Logistic Regression

## Author Contributions

**Viyani Charly:** Conceptualization, Data curation, Formal Analysis, Funding acquisition

**Jimmy Joseph:** Visualisation, Writing – original draft, Writing – review & editing

**Lenin Thomas:** Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation

## Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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