

Article

Not peer-reviewed version

Predictors of Raised Blood Pressure and NCDs Among Adult Saudi Population in Buraidah, Saudi Arabia

[Mohammed Awad Alanazi](#)*, [Fatmah Alribdi](#), [Abdullah Alqwaee](#), [Annalyn Velasquez Camba](#), [Abdulsalam Alfawzan](#), [Albandary Freeh Alanazi](#), Query Ann Dulnuan Rimando, [Khuzama Alkhalaf](#)

Posted Date: 13 October 2025

doi: 10.20944/preprints202510.0898.v1

Keywords: hypertension; non-communicable diseases; weight management; aging; gender differences; Saudi Arabia; cross-sectional study; public health



Preprints.org is a free multidisciplinary platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This open access article is published under a Creative Commons CC BY 4.0 license, which permit the free download, distribution, and reuse, provided that the author and preprint are cited in any reuse.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Article

Predictors of Raised Blood Pressure and NCDs Among Adult Saudi Population in Buraidah, Saudi Arabia

Mohammed Awad Alanazi ^{1,*}, Fatmah Alribdi ¹, Abdullah Alqwaee ², Annalyn Velasquez Camba ¹, Abdulsalam Alfawzan ¹, Albandary Freeh Alanazi ¹, Query Ann Dulnuan Rimando ¹ and Khuzama Alkhalaf ¹

¹ Saudi Model of Care – Qassim Health Cluster, Buraidah, Saudi Arabia

² Health Care Delivery – Qassim Health Cluster, Buraidah, Saudi Arabia

* Correspondence: malsumairy@gmail.com

Abstract

Background: Hypertension is a major global risk factor for cardiovascular and non-communicable diseases (NCDs), with obesity and aging playing significant roles. While extensive national research has been conducted across Saudi Arabia, targeted studies specifically addressing urban centers like Buraidah remain scarce, necessitating region-specific evidence. **Objective:** To examine the impact of body mass index (BMI), age, Sex, and physical activity on blood pressure (BP) levels among adults in Buraidah. **Methods:** This cross-sectional study analyzed electronic medical records (EMRs) of 25,589 Saudi adults aged 18–65 years, collected between January and April 2024 from two urgent care centers. Participants with pre-existing hypertension, diabetes, cardiovascular disease, or dyslipidemia were excluded. The data included demographics, BMI, blood pressure (BP), and physical activity levels. We conducted statistical analyses including descriptive statistics, Pearson correlations, multiple linear regression, and subgroup analyses stratified by BMI category. **Results:** BMI and age were significantly associated with both systolic (SBP) and diastolic blood pressure (DBP). Notably, the impact of BMI on SBP was more pronounced among males. While physical activity showed a modest inverse relationship with DBP, it also had a smaller yet statistically significant association with SBP. **Conclusion:** Our study, the first of its kind in Buraidah, identified obesity and aging as key drivers of hypertension. These findings underscore the urgent need for targeted public health initiatives particularly in weight management, early screening, and gender-specific care, to support the Saudi Vision 2030's healthcare objectives. Limitations include the cross-sectional design, which precludes causal inferences.

Keywords: hypertension; non-communicable diseases; weight management; aging; gender differences; Saudi Arabia; cross-sectional study; public health

Introduction

Hypertension remains one of the leading global health concerns, significantly contributing to cardiovascular diseases (CVDs) and other non-communicable diseases (NCDs). Currently, more than 1.4 billion people worldwide suffer from hypertension, and this number is projected to rise due to increasing obesity rates, sedentary lifestyles, and aging populations [1]. Among the well-documented risk factors, body mass index (BMI) stands out as a primary contributor, with excess adiposity leading to metabolic imbalances, insulin resistance, and arterial stiffness, all of which elevate blood pressure [2,3]. Additionally, age-related vascular changes and gender-specific hormonal differences further influence hypertension risk [4].

Saudi Arabia has experienced a notable rise in hypertension prevalence, with recent WHO estimates indicating that 39% of adults aged 30–79 years are affected. This increase is largely driven

by urbanization, shifts in dietary habits, and an escalating obesity crisis, which affects over 41% of adults [5]. Studies in Saudi populations underscore a concerning trend, with hypertension rates reaching 34% among adults in certain regions [6]. In Alkharj, for instance, a subpopulation study reported prehypertension rates at 28.5% and hypertension at 26.2%, emphasizing the need for targeted interventions [7]. However, a significant challenge remains nearly 60% of hypertensive individuals undiagnosed, and only 19% achieve effective blood pressure control [5,8].

BMI continues to be one of the strongest predictors of hypertension, with 69.9% of Saudi adults classified as overweight or obese [9]. A 2023 UK systematic review reinforced the global link between BMI and hypertension, suggesting that obesity accounts for 20–30% of hypertension cases across various populations [10].

Despite the growing body of research on hypertension risk factors in major Saudi cities like Riyadh and Jeddah, smaller urban centers, such as Buraidah, remain understudied [6]. Given its distinct sociodemographic characteristics, lifestyle patterns, and dietary habits, Buraidah may exhibit unique hypertension trends, necessitating localized research. To the best of our knowledge, no prior studies have examined predictors of hypertension specifically among adults in Buraidah. This study aims to bridge this gap by investigating BMI, age, gender, and physical activity as predictors of hypertension in Buraidah [5,7]. The findings will support the development of evidence-based health policies in alignment with Saudi Vision 2030, which prioritizes reducing NCD burdens and advancing preventive healthcare initiatives [5].

Methods

Study Design and Population

This cross-sectional study, conducted between January and April 2024, aimed to identify key predictors of elevated blood pressure and non-communicable diseases (NCDs) among adults residing in Buraidah, Saudi Arabia. Data were systematically extracted from electronic medical records (EMRs) collected from two regional urgent care centers, ensuring a comprehensive and representative dataset. The study included adults aged 18 to 65 years who were Saudi nationals with complete medical records, particularly those with available body mass index (BMI), blood pressure (BP), physical activity, and demographic data. Participants with missing or incomplete records for these key variables were excluded. Ultimately, a total of 25,589 individuals met the eligibility criteria and were incorporated into the final analysis, allowing for a robust investigation into the factors influencing blood pressure variations and related health risks in the targeted population.

Ethical Considerations

This study was conducted in accordance with institutional ethical guidelines and was approved by the relevant ethics committee under IRB number 607-46-9075. All data were de-identified to maintain confidentiality, and no personally identifiable information was accessed. Ethical approval ensured compliance with national and international standards for human research ethics.

Data Collection

Data was collected using a standardized extraction protocol from electronic medical records (EMRs), ensuring consistency and accuracy. The extracted variables included demographics (age in years and gender), anthropometric measures (height in meters, weight in kilograms, and body mass index [BMI] calculated as kg/m^2), and clinical measures (systolic and diastolic blood pressure readings recorded using calibrated automatic sphygmomanometers following standard clinical protocols). Lifestyle factors were assessed through self-reported physical activity levels, categorized as sufficient or insufficient based on World Health Organization (WHO) guidelines. Chronic disease status, including diagnoses of hypertension, diabetes, cardiovascular diseases, and dyslipidemia, was

collected solely for screening purposes to ensure that only participants without these pre-existing conditions were included in the final analysis.

To ensure data reliability, several quality control procedures were implemented. Outlier detection was performed to identify implausible BMI values (defined as <15 kg/m² or >50 kg/m²). Blood pressure readings were verified against clinical standards to confirm measurement accuracy. Completeness checks were conducted to ensure that no key variables were missing from the dataset. These steps collectively enhanced the validity and robustness of the data used for analysis.

Statistical Analysis

All statistical analyses were conducted using Python (version 3.11), utilizing libraries such as pandas, statsmodels, and scipy. Descriptive statistics were used to summarize continuous variables, including means, standard deviations (SD), medians, and interquartile ranges (IQRs). Categorical variables were presented as percentages and frequencies.

Bivariate analyses were performed to explore relationships between variables. Pearson correlation was used to assess associations among continuous variables, including BMI, age, systolic blood pressure (SBP), and diastolic blood pressure (DBP). Independent t-tests and analysis of variance (ANOVA) were employed to compare blood pressure levels across gender and physical activity groups.

Multiple linear regression models were developed to evaluate the effects of BMI, age, gender, and physical activity on systolic and diastolic blood pressure. Interaction terms were included to examine whether gender moderated the associations between BMI, age, and blood pressure outcomes. Subgroup analyses were conducted by stratifying participants according to BMI categories: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obese (≥30 kg/m²). Separate models were also run for male and female participants to investigate gender-specific associations.

Model diagnostics and sensitivity analyses were undertaken to ensure the robustness of the findings. Variance Inflation Factor (VIF) values were calculated to assess multicollinearity among predictors. Residual analysis and normality checks were performed to validate model assumptions. Additionally, sensitivity analyses were conducted by excluding extreme BMI values to test the stability of the results.

A p-value of less than 0.05 was considered statistically significant for all analyses. This comprehensive analytical approach strengthened the validity of the findings and enabled a robust evaluation of hypertension and non-communicable disease (NCD) risk factors within the Buraidah population.

Results

Descriptive Statistics

This study analyzed data from 25,589 Saudi adults, with a mean age of 40.18 ± 12.30 years and a mean BMI of 27.55 ± 4.76 kg/m². The sample consisted of 56.73% males and 43.27% females, and 49.02% of participants reported insufficient physical activity.

BMI varied significantly across age groups, with higher BMI levels observed in older adults (aged 45–65 years) compared to younger individuals. The mean systolic blood pressure (SBP) was 123.80 mmHg (SD = 12.67), and the mean diastolic blood pressure (DBP) was 75.22 mmHg (SD = 8.44). The distribution of these key variables is presented in (Table 1). The distribution of BMI among the study population is visualized in (shown in Figure 1), highlighting a peak around the overweight category and reflecting the high prevalence of elevated BMI values.

Figure 1. Histogram showing the distribution of Body Mass Index (BMI) among participants. The graph highlights a peak around the overweight range, indicating a high prevalence of elevated BMI in the study population.

The distribution of gender and physical activity status among participants is presented in (Table 2), particularly among those classified as overweight or obese. Furthermore, individuals with insufficient physical activity tended to have higher blood pressure readings compared to those who met WHO-recommended activity levels.

Table 1. Demographic and Clinical Characteristics of Participants (N=25,589).

Table 2. Distribution of Gender and Physical Activity (N=25,589).

Bivariate Analysis

To explore the associations between BMI, age, blood pressure, and other factors, Pearson correlation analysis was conducted. The results indicate a moderate positive correlation between BMI and SBP ($r = 0.31$, $p < 0.001$) and between BMI and DBP ($r = 0.22$, $p < 0.001$). Age exhibited an even stronger correlation with blood pressure, with SBP showing an r -value of 0.40 ($p < 0.001$) and DBP at $r = 0.35$ ($p < 0.001$). These findings suggest that both BMI and aging significantly contribute to increased blood pressure (shown in Figures 2 and 3). These relationships are further visualized in the correlation heatmap (Figure 4), which highlights the positive associations between age, BMI, and blood pressure measurements.

Figure 2. Scatter plot of BMI and Systolic Blood Pressure (SBP). A moderate positive trend is observed, suggesting that higher BMI is associated with elevated SBP levels.

Figure 3. Scatter plot of BMI and Diastolic Blood Pressure (DBP). A weak positive correlation appears, indicating a less pronounced association between BMI and DBP compared to SBP.

Figure 4. Correlation heatmap of key study variables, including BMI, age, systolic and diastolic blood pressure. Stronger associations are observed between age and SBP, and between BMI and SBP.

Regression Analysis

A multiple regression model was employed to examine the impact of BMI, age, gender, and physical activity on systolic blood pressure (SBP). The model explained 15% of the variance in SBP ($R^2 = 0.150$, $p < 0.001$). Both BMI ($\beta = 0.44$, 95% CI: $0.41\text{--}0.47$, $p < 0.001$) and age ($\beta = 0.27$, 95% CI: $0.26\text{--}0.28$, $p < 0.001$) were significant predictors of higher SBP levels. Gender differences were also noted, with males exhibiting significantly higher SBP than females ($\beta = -6.06$, $p < 0.001$). However, Physical activity demonstrated a small but statistically significant association with SBP. (Table 3).

The diastolic BP regression model explained 2.1% of the variance ($R^2 = 0.021$, $p < 0.001$). While BMI and age remained significant predictors, their effect sizes were notably smaller than those observed for SBP. Specifically, BMI ($\beta = 0.15$, 95% CI: $0.13\text{--}0.17$, $p < 0.001$) and age ($\beta = 0.05$, 95% CI: $0.04\text{--}0.06$, $p < 0.001$) were both positively associated with DBP. Unlike in the SBP model, physical activity demonstrated a small but significant inverse association with DBP ($\beta = -0.11$, 95% CI: $-0.21\text{--}0.005$, $p = 0.041$), indicating that individuals engaging in regular activity had slightly lower DBP levels (Table 4).

Table 3. Multiple Regression Analysis for Systolic Blood Pressure (SBP).

Table 4. Multiple Regression Analysis for Diastolic Blood Pressure (DBP).

Subgroup Analysis of Blood Pressure by BMI Categories

To better understand the relationship between BMI and blood pressure, regression analyses were conducted across four BMI categories: underweight, normal weight, overweight, and obese. The results indicate that BMI plays a significant role in predicting systolic blood pressure (Table 5) (shown in Figure 5).

In the obese category, BMI remained the strongest predictor of systolic BP ($\beta = 0.3139$, $p < 0.001$), and the model explained 5.16% of the variance ($R^2 = 0.0516$) (Table 5). For overweight individuals, BMI was also a strong predictor ($\beta = 0.2576$, $p < 0.001$), with age remaining a key factor ($\beta = 0.0574$, $p < 0.001$). Among normal-weight individuals, BMI's effect on BP was lower than in overweight and obese groups ($\beta = 0.3116$, $p < 0.001$), but still statistically significant. Interestingly, in the underweight category, age did not significantly contribute to BP variation ($p = 0.747$). However, physical activity emerged as the only significant factor ($\beta = 1.38$, $p = 0.026$). This suggests that, in underweight individuals, non-metabolic factors may play a greater role in BP regulation (shown in Figure 5).

A similar regression analysis was performed for diastolic blood pressure (DBP) across BMI categories (Table 6) (shown in Figure 6), revealing a comparable trend where BMI and age were significant predictors across all groups. The strongest association between BMI and DBP was observed in the obese category ($\beta = 0.2786$, $p < 0.001$), followed by overweight individuals ($\beta = 0.2028$, $p < 0.001$). Unlike SBP, the relationship between physical activity and DBP showed weak significance in the obese group ($\beta = -0.4882$, $p = 0.0145$), suggesting minimal but present effects of activity on DBP regulation.

Table 5. Multiple Regression Results for SBP by BMI Category.

Table 6. Multiple Regression Results for DBP by BMI Category Table 7. Variance Inflation Factor (VIF) Results.

The variation in systolic and diastolic blood pressure across BMI categories is further visualized through boxplots (shown in Figures 7 and 8).

Figure 5. Scatter plot of BMI and Systolic Blood Pressure stratified by BMI category. The relationship is more evident among obese individuals, suggesting that BMI has a stronger effect in higher BMI groups.

Figure 6. Scatter plot of BMI and Diastolic Blood Pressure stratified by BMI category. A weaker association is observed across all categories compared to systolic pressure.

Figure 7. Boxplot showing the distribution of Systolic Blood Pressure across BMI categories. Higher median SBP levels are observed among overweight and obese individuals.

Figure 8. Boxplot showing the distribution of Diastolic Blood Pressure across BMI categories. Although less pronounced, obese individuals exhibit slightly higher DBP medians than other groups.

Diagnostics and Multicollinearity Results

To ensure the validity of the regression models, multicollinearity was assessed using the Variance Inflation Factor (VIF). All predictor variables had VIF values below 2, indicating no significant collinearity concerns (Table 7).

Additionally, independent t-tests were conducted to compare blood pressure differences by gender and physical activity levels. The results confirmed significant differences in systolic and diastolic BP between males and females, while physical activity was only associated with lower diastolic BP (Table 8).

These diagnostic tests confirm the robustness of the regression models and highlight the significant influence of gender on blood pressure outcomes.

Table 8. Independent T-Test Results by Gender and Physical Activity.

Discussion

1. Summary of Main Findings

This study delved into the factors that contribute to high blood pressure among adults in Buraidah, Saudi Arabia, focusing on body mass index (BMI), age, gender, and physical activity. The

results showed that BMI and age were the strongest predictors of both systolic and diastolic blood pressure. This highlights the significant role that obesity and aging play in the development of hypertension. Additionally, gender played a key role in how BMI affects blood pressure, with men showing a stronger link between BMI and systolic blood pressure compared to women. Physical activity, while beneficial, demonstrated a modest inverse association with diastolic blood pressure and a weaker yet statistically significant association with systolic blood pressure. These findings suggest that while physical activity plays a role, obesity and aging remain the more dominant predictors of hypertension risk.

2. Comparison with Previous Studies

Our findings align with national studies such as Al-Qahtani (2019), who found that BMI is a primary factor in determining hypertension among Saudi adults, which mirrors our conclusion that higher BMI is significantly linked to increased blood pressure. Similarly, Linderman et al. (2018) documented a dose-response relationship between BMI and hypertension in a large Chinese population, further supporting the idea that obesity is a key modifiable risk factor for high blood pressure. Globally, similar patterns are observed; for instance, Gutema et al. [19] identified BMI as the strongest predictor of hypertension in Southern Ethiopian adults, aligning with our findings in Buraidah.

Gender differences in hypertension risk have also been noted in earlier studies. Koskinas et al. [11] pointed out that men tend to have a higher prevalence of hypertension due to factors like greater visceral fat, metabolic differences, and lower rates of seeking healthcare. El-Ashker et al. [12] corroborate these findings, demonstrating that young Saudi males exhibit elevated cardio-metabolic risks, including hypertension, linked to sedentary lifestyles and poor dietary habits. Our study supports this, showing a stronger relationship between BMI and systolic blood pressure in men compared to women. On the other hand, Leggio et al. (2017) found that postmenopausal women face an increased risk of hypertension due to hormonal changes affecting vascular function, which may explain why BMI has a weaker effect on blood pressure in premenopausal women.

The impact of physical activity on blood pressure in our study was less significant than expected, aligning with previous research in Saudi Arabia. Studies indicate that while physical inactivity contributes to hypertension, its effect is often overshadowed by obesity and poor dietary habits, which have a stronger metabolic impact on blood pressure regulation [9,14]. Additionally, national studies have shown that hypertension prevalence is more closely linked to BMI and dietary patterns than to physical activity levels [15]. These findings suggest that although physical activity is beneficial for overall cardiovascular health, obesity and aging remain the dominant predictors of hypertension in Saudi populations.

3. Interpretation of Findings

Our study reinforces the critical role that obesity and aging play in the development of hypertension. Increased BMI contributes to elevated blood pressure through mechanisms such as heightened activation of the sympathetic nervous system, insulin resistance, and arterial stiffness [2]. The expanding waistline and visceral adiposity, as highlighted by Jia et al. [16], exacerbate insulin resistance and arterial stiffness, further explaining the strong BMI-blood pressure association observed in our study. Aging further exacerbates hypertension due to vascular changes, endothelial dysfunction, and arterial calcification [6]. Esfandiari et al. [17] recently emphasized that fluctuations in BMI significantly predict cardiovascular outcomes, underscoring the importance of sustained weight management for hypertension prevention.

The gender-specific findings highlight important biological and behavioral factors. The stronger impact of BMI on systolic blood pressure in men can be attributed to higher visceral fat accumulation, which is known to cause greater metabolic dysfunction and arterial stiffness [11]. In contrast, women, especially those who are premenopausal, may benefit from estrogen's protective effects on the cardiovascular system, which can reduce the impact of BMI on blood pressure [13].

The weaker association between physical activity and blood pressure in our study suggests that other factors, such as diet, genetic predisposition, and stress, may have a larger influence on hypertension risk in the Saudi population. The World Health Organization [5] emphasizes that sodium intake and processed food consumption are major drivers of hypertension – factors that were not accounted for in our study but should be considered in future research.

Limitations and Future Directions

This study has several strengths, including a large sample size of 25,589 participants, the use of electronic medical records (EMRs), and robust statistical analysis methods like ordinary least squares (OLS) and logistic regression. These factors increase the reliability and generalizability of our findings.

However, there are some limitations to consider:

1. Cross-Sectional Design: Our study cannot establish causality between BMI, age, and hypertension. As demonstrated by Shihab et al. [18] in their life-course analysis, longitudinal designs are critical to unraveling causal pathways between BMI and hypertension, which our cross-sectional study could not address.
2. Self-Reported Physical Activity Bias: The assessment of physical activity in this study relied on self-reported measures, which are subject to recall bias and social desirability effects. Previous Saudi-based research has highlighted that self-reported physical activity levels tend to be overestimated, with inconsistencies between reported and objectively measured activity levels [15]. Given these limitations, future studies should incorporate objective measurement tools (e.g., wearable fitness trackers, accelerometers) to improve the accuracy of physical activity assessments in hypertension research.
3. Lack of Dietary Data: Sodium intake and processed food consumption are major contributors to hypertension [5]. Future studies should integrate dietary assessments to better understand hypertension risks.
4. Potential Unmeasured Confounders: Other factors such as genetic predisposition, socioeconomic status, and stress levels were not analyzed but may influence blood pressure outcomes.

To address these limitations and inform future research directions, we propose the following recommendations:

- Use longitudinal designs to track BMI and blood pressure over time.
- Include dietary and metabolic factors such as sodium intake, sugar consumption, and lipid profiles.
- Investigate gender differences further by exploring hormonal, behavioral, and lifestyle factors.
- Assess social determinants of health, including income, education, and healthcare access.

Conclusion

This study highlights the strong influence of BMI and aging on hypertension risk in Saudi adults, reinforcing the importance of weight management and early intervention strategies. Gender differences in blood pressure regulation emphasize the need for personalized approaches to hypertension prevention. Despite the minimal impact of physical activity on SBP, it remains a valuable component of cardiovascular health. Given the increasing burden of obesity-related hypertension in Saudi Arabia, public health initiatives must prioritize obesity prevention, early screening, and region-specific interventions aligned with Saudi Vision 2030. Future research should employ longitudinal designs and comprehensive dietary assessments to strengthen our understanding of hypertension determinants and improve prevention strategies.

Author Contributions: Author 1: Conceptualization, Software, Writing – original draft, Project administration. Author 2: Formal analysis, Visualization. Author 3: Investigation, Methodology. Author 4: Validation, Writing – review & editing.

Author 5: Data curation, Data handling. Author 6: Coordination, Review support.

Author 7: Data collection. Author 8: Writing – review & editing.

Funding Sources: This study received no external funding.

Statement of Ethics: Ethical approval was obtained from the relevant institutional review board (IRB: 607-46-9075). Data were anonymized, and informed consent was waived due to the retrospective nature of the study.

Data Availability Statement: The data that support the findings of this study are not publicly available due to privacy and ethical restrictions but are available from the corresponding author upon reasonable request and subject to approval by the relevant institutional review board.

Conflict of Interest Statement: The authors declare no conflict of interest.

List of Abbreviations

Abbreviation	Term
BMI	Body Mass Index
BP	Blood Pressure
CVDs	Cardiovascular Diseases
DBP	Diastolic Blood Pressure
EMRs	Electronic Medical Records
IQR	Interquartile Range
NCDs	Non-Communicable Diseases
OLS	Ordinary Least Squares
R ²	Coefficient of Determination
SBP	Systolic Blood Pressure
SD	Standard Deviation

Abbreviation	Term
VIF	Variance Inflation Factor
WHO	World Health Organization

References

1. NCD Risk Factor Collaboration. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019. *Lancet*. 2021;398(10304):957–80. [https://doi.org/10.1016/S0140-6736\(21\)01330-1](https://doi.org/10.1016/S0140-6736(21)01330-1).
2. Linderman GC, Lu J, Lu Y, et al. Association of body mass index with blood pressure among 1.7 million Chinese adults. *JAMA Netw Open*. 2018;1(4):e181271. <https://doi.org/10.1001/jamanetworkopen.2018.1271>.
3. Itoh H, Kaneko H, Yoshida M, et al. Effect of body weight change on blood pressure in a Japanese general population with a body mass index. *Int Heart J*. 2019;60(6):1381–6. <https://doi.org/10.1536/ihj.19-314>.
4. Heianza Y, Kodama S, Arase Y, et al. Role of body mass index history in predicting risk of the development of hypertension in Japanese individuals. *Hypertension*. 2014;64(2):247–52. <https://doi.org/10.1161/HYPERTENSIONAHA.113.02918>.
5. World Health Organization (WHO). Hypertension profiles: Saudi Arabia. *Global Health Estimates* [Internet]. 2023. Available from: <https://www.who.int/publications/m/item/hypertension-sau-2023-country-profile>.
6. Mumena WA, Hammouda SA, Aljohani RM, et al. Prevalence and determinants of undiagnosed hypertension in the Western region of Saudi Arabia. *PLOS ONE*. 2023;18(3):e0280844. <https://doi.org/10.1371/journal.pone.0280844>.
7. Aldiab A, Shubair MM, Al-Zahrani JM, et al. Prevalence of hypertension and prehypertension and its associated cardioembolic risk factors: a cross-sectional study in Alkharj. *BMC Public Health*. 2018;18:1327. <https://doi.org/10.1186/s12889-018-6216-9>.
8. Al-Nozha MM, Abdullah M, Arafah MR, et al. Hypertension in Saudi Arabia. *Saudi Med J*. 2007;28(1):77–84.
9. Al-Qahtani AM. Prevalence and predictors of obesity and overweight among adults visiting primary care settings in the Southwestern region, Saudi Arabia. *Biomed Res Int*. 2019;2019:8073057. <https://doi.org/10.1155/2019/8073057>.
10. Innocent DC, Vasavada A, Kumar R, et al. Correlative study on body mass index and blood pressure in the United Kingdom: a systematic review of current evidence. *medRxiv* [Internet]. 2023. Available from: <https://doi.org/10.1101/2023.10.13.23297003>.
11. Koskinas KC, Van Craenenbroeck EM, Antoniades C, et al. Obesity and cardiovascular disease: an ESC clinical consensus statement. *Eur Heart J*. 2024;45(38):4063–98. <https://doi.org/10.1093/eurheartj/ehae508>.
12. El-Ashker S, Pednekar MS, Narake SS, et al. Blood pressure and cardio-metabolic risk profile in young Saudi males in a university setting. *Medicina (Kaunas)*. 2021;57(8):755. <https://doi.org/10.3390/medicina57080755>.
13. Leggio M, Lombardi M, Caldarone E, et al. The relationship between obesity and hypertension: an updated comprehensive overview. *Hypertens Res*. 2017;40(12):947–63. <https://doi.org/10.1038/hr.2017.75>.
14. Almajwal AM, Al-Baghli NA, Batterham MJ, et al. Performance of body mass index in predicting diabetes and hypertension in the Eastern Province of Saudi Arabia. *Ann Saudi Med*. 2009;29(6):437–45. <https://doi.org/10.4103/0256-4947.57165>.
15. Saeed AA, Al-Hamdan NA. Anthropometric risk factors and predictors of hypertension among Saudi adult population – a national survey. *J Epidemiol Glob Health*. 2013;3(4):197–204. <https://doi.org/10.1016/j.jegh.2013.08.004>.

16. Jia G, Sowers JR, Whaley-Connell AT. Obesity in hypertension: the role of the expanding waistline and insights into the future. *Hypertension*. 2024;81(4):687–90. <https://doi.org/10.1161/HYPERTENSIONAHA.123.21719>.
17. Esfandiari MA, Kazemzadeh K, Saleh M, et al. Associations of variability in body mass index with cardiovascular outcomes: a systematic review. *JRSM Cardiovasc Dis*. 2024;13:20480040241234149. <https://doi.org/10.1177/20480040241234149>.
18. Shihab HM, Liang M, Shafi T, et al. Body mass index and risk of incident hypertension over the life course: the Johns Hopkins precursors study. *Circulation*. 2012;126(25):2983–9. <https://doi.org/10.1161/CIRCULATIONAHA.112.117333>.
19. Gutema BT, Chuka A, Ayele G, et al. Predictive capacity of obesity indices for high blood pressure among Southern Ethiopian adults: a WHO STEPS survey. *BMC Cardiovasc Disord*. 2020;20(1):421. <https://doi.org/10.1186/s12872-020-01686-9>.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.