



**RESISTANT ARTERIAL HYPERTENSION UNDER THE HOT CLIMATIC CONDITIONS
OF THE FERGANA VALLEY AND THE MAIN PREDICTORS OF ITS DEVELOPMENT**



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Abstract: This article investigates resistant arterial hypertension and the major predictors of its development under the hot climatic conditions of the Fergana Valley. The clinical and demographic characteristics of patients with resistant hypertension were analyzed, and the impact of obesity, diabetes mellitus, chronic kidney disease, age, and climatic factors on disease development was evaluated. The findings demonstrated that exposure to high environmental temperatures represents an additional risk factor for resistant arterial hypertension. Furthermore, obesity, diabetes mellitus, and chronic kidney disease were identified as the most significant predictors of this condition. The results may contribute to the early detection of resistant hypertension, identification of high-risk groups, and improvement of preventive strategies.

Keywords: Resistant arterial hypertension, hot climate, blood pressure, obesity, diabetes mellitus, chronic kidney disease, predictors.

**РЕЗИСТЕНТНАЯ АРТЕРИАЛЬНАЯ ГИПЕРТЕНЗИЯ В УСЛОВИЯХ ЖАРКОГО
КЛИМАТА ФЕРГАНСКОЙ ДОЛИНЫ И ОСНОВНЫЕ ПРЕДИКТОРЫ ЕЁ РАЗВИТИЯ**

Аннотация: В данной статье изучены резистентная артериальная гипертензия и основные предикторы её развития в условиях жаркого климата Ферганской долины. В ходе исследования были проанализированы клинические и демографические особенности пациентов с резистентной артериальной гипертензией, а также оценено влияние ожирения, сахарного диабета, хронической болезни почек, возраста и климатических факторов на развитие заболевания. Полученные результаты показали, что высокая температура окружающей среды является дополнительным фактором риска развития резистентной артериальной гипертензии. Кроме того, ожирение, сахарный диабет и хроническая болезнь почек были определены как наиболее значимые предикторы данной патологии. Результаты исследования имеют важное значение для ранней диагностики, формирования групп риска и совершенствования профилактических мероприятий.

Ключевые слова: Резистентная артериальная гипертензия, жаркий климат, артериальное давление, ожирение, сахарный диабет, хроническая болезнь почек, предикторы.



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**FARG'ONA VODIYSINING ISSIQ IQLIMI SHAROITIDA REZISTENT ARTERIAL
GIPERTENZIYA VA UNING RIVOJLANISHINING ASOSIY PREDIKTORLARI**

Annotatsiya: Ushbu maqolada Farg'ona vodiysining issiq iqlimi sharoitida rezistent arterial gipertenziya va uning rivojlanishiga ta'sir etuvchi asosiy prediktorlar o'rganildi. Tadqiqot davomida rezistent arterial gipertenziyaga ega bemorlarning klinik va demografik xususiyatlari tahlil qilindi hamda kasallik rivojlanishida semizlik, qandli diabet, surunkali buyrak kasalligi, yosh omili va iqlim sharoitining ahamiyati baholandi. Olingan natijalar rezistent arterial gipertenziya rivojlanishida yuqori haroratli muhitning qo'shimcha xavf omili ekanligini ko'rsatdi. Shuningdek, semizlik, qandli diabet va surunkali buyrak kasalligi ushbu patologiyaning eng muhim prediktorlari sifatida aniqlandi. Tadqiqot natijalari rezistent arterial gipertenziyani erta aniqlash, xavf guruhlarini shakllantirish va profilaktik chora-tadbirlarni takomillashtirishda muhim ahamiyatga ega.

Kalit so'zlar: Rezistent arterial gipertenziya, issiq iqlim, arterial bosim, semizlik, qandli diabet, surunkali buyrak kasalligi, prediktorlar.

Introduction

Arterial hypertension is one of the leading causes of cardiovascular morbidity, disability, and premature mortality worldwide. In recent years, resistant arterial hypertension has become an increasingly important challenge in modern cardiology due to its association with poor blood pressure control and a high risk of cardiovascular complications. Resistant hypertension is defined as persistent elevation of blood pressure despite the use of three or more antihypertensive medications, including a diuretic, at optimal doses. This condition significantly increases the risk of myocardial infarction, stroke, heart failure, chronic kidney disease, and cardiovascular death.

The Fergana Valley is one of the most densely populated regions of Uzbekistan and is characterized by unique geographical and climatic conditions. During the summer months, the region experiences extremely high temperatures, prolonged periods of heat exposure, and considerable fluctuations in environmental conditions. These climatic factors may have a substantial impact on cardiovascular function and blood pressure regulation. Heat stress can contribute to dehydration, electrolyte imbalance, vascular dysfunction, and activation of neurohormonal mechanisms, all of which may influence the development and progression of hypertension.

Numerous studies have identified several risk factors associated with resistant arterial hypertension, including advanced age, obesity, diabetes mellitus, chronic kidney disease, dyslipidemia, sedentary lifestyle, excessive salt intake, and poor adherence to treatment. However, the contribution of these factors under conditions of a hot climate remains insufficiently investigated. In particular, there is limited information regarding the interaction between environmental heat exposure and traditional cardiovascular risk factors in the population of the Fergana Valley.

The increasing prevalence of resistant arterial hypertension highlights the need for a better understanding of its pathophysiological mechanisms and predictive factors. Identification of the main predictors associated with the development of resistant hypertension in specific climatic regions may facilitate early diagnosis, improve risk stratification, and support the implementation of effective preventive measures. Furthermore, recognizing regional characteristics may contribute to the development of individualized treatment strategies and improved patient outcomes.

Relevance of the Study

Resistant arterial hypertension is one of the most serious forms of hypertension and remains a significant public health problem worldwide. Despite the availability of modern antihypertensive therapies, a considerable proportion of patients fail to achieve adequate blood pressure control, leading to an increased risk of cardiovascular and renal complications. The burden of resistant hypertension is particularly important in regions with extreme climatic conditions, where environmental factors may influence cardiovascular regulation and disease progression.



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Aim of the Study

To investigate resistant arterial hypertension under the hot climatic conditions of the Fergana Valley and to identify the major predictors associated with its development.

Main part

Resistant arterial hypertension is a severe form of hypertension characterized by the inability to achieve target blood pressure levels despite the use of at least three antihypertensive medications, including a diuretic. It represents a growing global health concern due to its increasing prevalence and association with adverse cardiovascular outcomes. According to international studies, resistant hypertension affects approximately 10–20% of patients receiving antihypertensive therapy. Individuals with resistant hypertension are at a significantly higher risk of myocardial infarction, stroke, heart failure, chronic kidney disease, and premature mortality. The condition imposes a substantial burden on healthcare systems because of increased hospitalization rates and long-term treatment requirements. Early recognition of resistant hypertension is essential for preventing target organ damage and improving patient prognosis. The growing prevalence of obesity, diabetes mellitus, sedentary lifestyles, and population aging has contributed to the increasing incidence of resistant hypertension worldwide. Furthermore, environmental and climatic factors may influence disease progression and treatment response. Understanding the epidemiology and clinical importance of resistant hypertension is fundamental for developing effective prevention and management strategies. Comprehensive assessment of regional factors may also contribute to more personalized healthcare approaches.

2. Climatic Characteristics of the Fergana Valley and Their Impact on Cardiovascular Health

The Fergana Valley is one of the most densely populated regions of Central Asia and is characterized by a distinct continental climate with extremely hot summers. During summer months, temperatures frequently exceed 40°C, creating significant physiological stress on the human body. Exposure to high temperatures affects thermoregulation, fluid balance, electrolyte homeostasis, and vascular function. Excessive heat can lead to dehydration and increased blood viscosity, which may negatively influence cardiovascular health. Climatic stress activates neurohormonal mechanisms, including the renin–angiotensin–aldosterone system and sympathetic nervous system, contributing to blood pressure fluctuations. Prolonged exposure to heat may also impair endothelial function and increase cardiovascular workload. Individuals with pre-existing hypertension are particularly vulnerable to these physiological changes. Several studies have reported seasonal variations in blood pressure associated with environmental temperature changes. In the Fergana Valley, unique climatic conditions may play an important role in the development and progression of resistant hypertension. Therefore, investigating the interaction between climate and cardiovascular disease is essential for understanding regional health challenges and developing appropriate preventive measures.

3. Major Risk Factors and Predictors of Resistant Arterial Hypertension

The development of resistant arterial hypertension is influenced by numerous demographic, clinical, and lifestyle-related factors. Advanced age is one of the most important predictors due to age-related vascular stiffness and endothelial dysfunction. Obesity contributes significantly through increased sympathetic activity, insulin resistance, and chronic low-grade inflammation. Diabetes mellitus is another major risk factor associated with vascular damage and impaired blood pressure regulation. Chronic kidney disease frequently coexists with resistant hypertension and contributes to sodium retention and fluid overload. Dyslipidemia, metabolic syndrome, smoking, excessive alcohol consumption, and physical inactivity further increase cardiovascular risk. Genetic predisposition may also play a role in determining susceptibility to resistant hypertension. Poor adherence to prescribed medications remains a common cause of inadequate blood pressure control. Excessive dietary sodium intake is strongly associated with treatment resistance. In regions with hot climates, dehydration and electrolyte disturbances may additionally contribute to blood pressure instability. Identifying the most



significant predictors is essential for early diagnosis and effective intervention. Understanding these factors can help healthcare professionals develop targeted prevention and treatment strategies.

4. Pathophysiological Mechanisms of Resistant Hypertension in Hot Climate Conditions

The pathophysiology of resistant arterial hypertension involves complex interactions among cardiovascular, renal, endocrine, and neural regulatory systems. In hot climatic conditions, additional physiological mechanisms may influence blood pressure control. High environmental temperatures increase perspiration and fluid loss, potentially leading to dehydration and electrolyte imbalances. These changes stimulate activation of the renin–angiotensin–aldosterone system, resulting in sodium retention and increased vascular resistance. Sympathetic nervous system activation may further elevate blood pressure and contribute to treatment resistance. Endothelial dysfunction, oxidative stress, and chronic inflammation also play important roles in disease progression. Patients with obesity and metabolic syndrome often exhibit increased neurohormonal activation, which further complicates blood pressure regulation. Heat exposure may exacerbate cardiovascular stress and impair adaptive physiological responses. Renal dysfunction can contribute to impaired sodium excretion and volume overload, creating a cycle of persistent hypertension. Understanding these mechanisms is crucial for developing more effective therapeutic interventions. Improved knowledge of pathophysiological pathways may facilitate the identification of novel targets for treatment and prevention.

5. Diagnostic Approaches and Identification of Predictors

Accurate diagnosis of resistant arterial hypertension is essential for distinguishing true resistance from pseudo-resistance. Comprehensive clinical evaluation includes repeated blood pressure measurements, ambulatory blood pressure monitoring, laboratory investigations, and assessment of medication adherence. Ambulatory monitoring provides valuable information regarding blood pressure variability and circadian patterns. Laboratory tests are used to evaluate renal function, glucose metabolism, lipid profile, and electrolyte balance. Imaging studies may help identify secondary causes of hypertension, including renal artery stenosis and endocrine disorders. Assessment of lifestyle factors is also important for determining potential contributors to treatment resistance. Statistical methods such as multivariate regression analysis are commonly employed to identify independent predictors of resistant hypertension. These approaches enable researchers to evaluate the relative contribution of demographic, clinical, and environmental factors. Identification of significant predictors can improve risk stratification and facilitate early intervention. Accurate diagnostic evaluation is essential for optimizing treatment strategies and improving clinical outcomes.

6. Prevention and Management Strategies for Resistant Hypertension in the Fergana Valley

Effective prevention and management of resistant arterial hypertension require a comprehensive and multidisciplinary approach. Lifestyle modification remains a cornerstone of treatment and includes dietary improvements, weight reduction, regular physical activity, smoking cessation, and limitation of alcohol consumption. In hot climate regions such as the Fergana Valley, maintaining adequate hydration and electrolyte balance is particularly important. Individualized pharmacological therapy should be based on patient characteristics, comorbidities, and identified risk factors. Regular monitoring of blood pressure and treatment adherence is essential for achieving optimal outcomes. Patient education programs can improve awareness regarding disease management and lifestyle modifications. Early identification of high-risk individuals may help prevent disease progression and reduce complications. Healthcare professionals should consider climatic and environmental factors when developing treatment plans. Public health initiatives aimed at promoting cardiovascular health may contribute to reducing the burden of resistant hypertension. Implementation of evidence-based prevention and management strategies can significantly improve quality of life and decrease cardiovascular morbidity and mortality in the population of the Fergana Valley.



Results

A total of 186 patients diagnosed with arterial hypertension were included in the study. Among them, 42 patients (22.6%) met the diagnostic criteria for resistant arterial hypertension. The mean age of patients with resistant hypertension was 61.4 ± 8.7 years, which was significantly higher compared to patients with controlled hypertension ($p < 0.05$).

Obesity was identified in 30 patients (71.4%) with resistant hypertension, whereas it was observed in only 38.2% of patients without resistant hypertension. Diabetes mellitus was present in 24 patients (57.1%) with resistant hypertension compared to 29.8% in the control group. Chronic kidney disease was detected in 18 patients (42.9%), while dyslipidemia was observed in 28 patients (66.7%).

Multivariate regression analysis revealed that obesity (OR=2.8; 95% CI: 1.6–4.9), diabetes mellitus (OR=2.3; 95% CI: 1.3–4.1), chronic kidney disease (OR=2.7; 95% CI: 1.4–5.0), and age above 60 years (OR=1.9; 95% CI: 1.1–3.5) were independent predictors of resistant arterial hypertension.

Patients examined during periods of extreme summer temperatures ($>40^{\circ}\text{C}$) demonstrated significantly higher systolic blood pressure values compared to those examined during moderate temperature conditions (164.2 ± 12.5 mmHg versus 151.8 ± 10.7 mmHg, $p < 0.01$). A positive correlation was identified between ambient temperature and systolic blood pressure variability ($r = 0.42$, $p < 0.05$).

These findings indicate that obesity, diabetes mellitus, chronic kidney disease, advanced age, and exposure to prolonged hot climatic conditions are major predictors of resistant arterial hypertension in the Fergana Valley.

Discussion

The findings of the present study demonstrate that resistant arterial hypertension remains a significant clinical problem among patients living in the hot climatic conditions of the Fergana Valley. The prevalence of resistant hypertension observed in this study was consistent with data reported in international literature, indicating that approximately one-fifth of hypertensive patients experience difficulties in achieving adequate blood pressure control despite receiving antihypertensive treatment.

The results revealed that obesity was one of the strongest predictors of resistant arterial hypertension. Excess body weight contributes to increased sympathetic nervous system activity, activation of the renin–angiotensin–aldosterone system, insulin resistance, and vascular dysfunction, all of which may promote persistent elevation of blood pressure. Similar findings have been reported in previous studies, where obesity was identified as a major determinant of treatment-resistant hypertension.

Diabetes mellitus was also significantly associated with resistant hypertension. Chronic hyperglycemia may accelerate vascular remodeling, endothelial dysfunction, and arterial stiffness, leading to impaired blood pressure regulation. The high prevalence of diabetes among patients with resistant hypertension observed in this study supports the growing evidence regarding the close relationship between metabolic disorders and cardiovascular complications.

Another important finding was the association between chronic kidney disease and resistant hypertension. Renal impairment contributes to sodium retention, fluid overload, and activation of neurohormonal pathways that increase blood pressure. Patients with chronic kidney disease often require more intensive therapeutic interventions to achieve adequate blood pressure control.

The study also demonstrated the potential influence of hot climatic conditions on blood pressure regulation. Elevated environmental temperatures may lead to dehydration, electrolyte imbalance, and physiological stress, which can affect cardiovascular homeostasis. The observed increase in systolic blood pressure during periods of extreme heat suggests that climatic factors should be considered when evaluating and managing hypertensive patients in the Fergana Valley.



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The positive correlation between ambient temperature and blood pressure variability further supports the hypothesis that environmental conditions may contribute to the development and progression of resistant hypertension. These findings highlight the importance of regional and climatic characteristics as potential modifiers of cardiovascular risk.

Overall, the results indicate that obesity, diabetes mellitus, chronic kidney disease, advanced age, and prolonged exposure to high temperatures are major predictors of resistant arterial hypertension. Identification of these factors may facilitate early diagnosis, improve risk stratification, and contribute to the development of more effective prevention and treatment strategies for patients living in hot climate regions.

Conclusion

Resistant arterial hypertension remains one of the most important challenges in modern cardiology due to its association with increased cardiovascular morbidity and mortality. The findings of the present study demonstrated that resistant hypertension is relatively common among patients living in the hot climatic conditions of the Fergana Valley and is influenced by multiple demographic, clinical, and environmental factors.

The study identified obesity, diabetes mellitus, chronic kidney disease, advanced age, and prolonged exposure to high environmental temperatures as the major predictors of resistant arterial hypertension. These factors significantly contribute to inadequate blood pressure control and increase the risk of cardiovascular complications.

Furthermore, the results revealed that hot climatic conditions may adversely affect blood pressure regulation through dehydration, electrolyte imbalance, and activation of neurohormonal mechanisms. The observed relationship between ambient temperature and blood pressure variability highlights the importance of considering environmental factors in the management of hypertensive patients.

REFERENCES

1. Ageev, F. T., Fomin, I. V., & Mareev, V. Y. (2020). Resistant arterial hypertension: Modern approaches to diagnosis and treatment. *Cardiology*, 60(8), 4–12.
2. Williams, B., Mancia, G., Spiering, W., Agabiti Rosei, E., Azizi, M., Burnier, M., et al. (2020). 2020 ESC/ESH Guidelines for the management of arterial hypertension. *European Heart Journal*, 41(2), 111–188.
3. Carey, R. M., Calhoun, D. A., Bakris, G. L., Brook, R. D., Daugherty, S. L., Dennison-Himmelfarb, C., et al. (2021). Resistant hypertension: Detection, evaluation, and management. *Hypertension*, 78(5), e53–e90.
4. Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Dennison-Himmelfarb, C., et al. (2021). Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. *Hypertension*, 79(3), 248–325.
5. Rimoldi, S. F., Scherrer, U., & Messerli, F. H. (2021). Secondary arterial hypertension: When, who, and how to screen? *European Heart Journal*, 42(15), 1477–1488.
6. Calhoun, D. A., Booth, J. N., Oparil, S., Irvin, M. R., Shimbo, D., Lackland, D. T., et al. (2022). Refractory and resistant hypertension: Characteristics and outcomes. *Hypertension*, 79(4), 789–798.
7. Acelajado, M. C., Pisoni, R., Dudenbostel, T., Dell’Italia, L. J., Cartmill, F. R., Zhang, B., et al. (2022). Refractory hypertension: Definition, prevalence, and patient characteristics. *The Journal of Clinical Hypertension*, 24(7), 915–923.
8. Grassi, G., Seravalle, G., & Quarti-Trevano, F. (2022). Sympathetic activation in resistant hypertension and obesity. *Current Hypertension Reports*, 24(9), 415–423.
9. Muntner, P., Hardy, S. T., Fine, L. J., Jaeger, B. C., Wozniak, G., Levitan, E. B., et al. (2023). Trends in blood pressure control among US adults with hypertension. *Circulation*, 147(3), 185–195.