Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)

ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

INVESTIGATION OF THE STRENGTH THRESHOLD OF RABBIT BLOOD VESSELS

(Taking into Account the Climatic Conditions of Uzbekistan)

Sh. A. Gulamov
Candidate of Physical and Mathematical Sciences, Associate Professor
Andijan State Medical Institute, Department of Biological Physics, Informatics, and Medical Technologies

Abstract
This article examines the biomechanical properties of rabbit blood vessels, taking into account the influence of climatic factors in the Republic of Uzbekistan. The aim of the study is to determine the strength threshold of the vascular wall and to analyze the effects of temperature, seasonal, and hydration conditions on its mechanical stability. The study employs experimental methods of mechanical testing of blood vessels, morphological analysis, and statistical data processing. The results obtained demonstrate that under hot climate conditions, changes in vascular elasticity are observed, including increased stiffness and a reduced strength threshold during dehydration of the organism. The practical significance of the study lies in the development of recommendations for the prevention of vascular complications under conditions of climatic stress.

Keywords: Blood vessels, strength threshold, biomechanics, climate, dehydration, elasticity.

Introduction

The modern development of medical science and the biomechanics of the vascular system indicates that the strength of blood vessels is one of the key factors determining the body’s resistance to critical conditions, including vascular

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

ruptures, hemorrhagic strokes, and complications of cardiovascular diseases [1]. Blood vessels represent a complex biological system characterized by pronounced nonlinear, anisotropic, and viscoelastic properties, which are обусловлены their multilayered structure and the interaction of various components—collagen, elastin, smooth muscle cells, and the extracellular matrix [2]

From a biomechanical perspective, the strength threshold of the vascular wall is determined not only by the material's ultimate strength but also by a combination of factors, including vessel geometry, wall thickness, intravascular pressure, and the functional state of tissues [3]. At the same time, the relationship between mechanical stress and tissue strength is crucial: exceeding this threshold leads to damage, dissection, or rupture of the vessel. Modern studies show that even minor changes in the structure of the vascular wall can significantly reduce its resistance to mechanical loads [4].

Collagen and elastin fibers play a particularly important role in shaping the mechanical properties of blood vessels. Elastin provides extensibility and the ability of the vessel to return to its original shape, whereas collagen fibers are engaged under high loads, limiting deformation and preventing rupture [5]. An imbalance between these components leads to changes in the mechanical characteristics of the vascular wall, in particular to increased stiffness and decreased elasticity, thereby raising the risk of vascular complications [6].

In recent years, special attention has been paid to the influence of external factors, including climatic conditions, on the functional state of the cardiovascular system. The Republic of Uzbekistan is characterized by a sharply continental climate with high summer temperatures (up to 40–45 °C), low humidity, and significant seasonal temperature fluctuations [7]. Such conditions create a pronounced thermal load on the human body and may have a substantial impact on the vascular system.

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

Exposure to high temperatures is accompanied by increased sweating, a reduction in circulating fluid volume, and the development of dehydration, which leads to changes in the rheological properties of blood, increased viscosity, and greater stress on the vascular wall [8]. Under conditions of dehydration, there is a decrease in the hydration of the extracellular matrix, which reduces tissue elasticity and contributes to increased stiffness [9]. This, in turn, may lead to a decrease in the strength threshold of blood vessels and an increased risk of their damage.

In addition, climatic factors can influence vascular tone and the regulation of blood circulation. High ambient temperatures cause vasodilation, redistribution of blood flow, and changes in hemodynamic parameters, which create additional mechanical stress on the vascular wall [10]. Prolonged exposure to such factors may result in the development of adaptive and pathological changes, including vascular remodeling and alterations in their structure and functional properties [11].

Despite the considerable number of studies devoted to vascular biomechanics, the influence of climatic conditions characteristic of Central Asia on the strength threshold of the vascular wall remains insufficiently studied. Most research has been conducted under temperate climate conditions and does not take into account specific factors such as high temperatures, low humidity, and chronic dehydration typical of the region [12].

In this regard, there is a need for a comprehensive investigation of the biomechanical properties of blood vessels, taking into account the climatic characteristics of Uzbekistan. This will enable a more accurate assessment of the risks of vascular complications and the development of effective preventive measures.

The aim of this study is to determine the strength threshold of rabbit blood vessels and to identify the influence of climatic conditions in Uzbekistan on their mechanical and functional properties.

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)

ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

Materials and Methods.

The study utilized 120 samples of rabbit blood vessels (raised in the vivarium of the Andijan State Medical Institute), including arteries and veins, obtained in accordance with current bioethical standards and medical research regulations. All samples were systematized and divided into two comparable groups depending on the exposure conditions. The first group (control) was examined under physiological conditions corresponding to normal ambient temperature (20–22 °C) and an adequate level of hydration. The second group (experimental) was subjected to simulated hot climate conditions characteristic of the Republic of Uzbekistan, at temperatures of 38–42 °C with artificially induced dehydration, mimicking fluid loss in the organism.

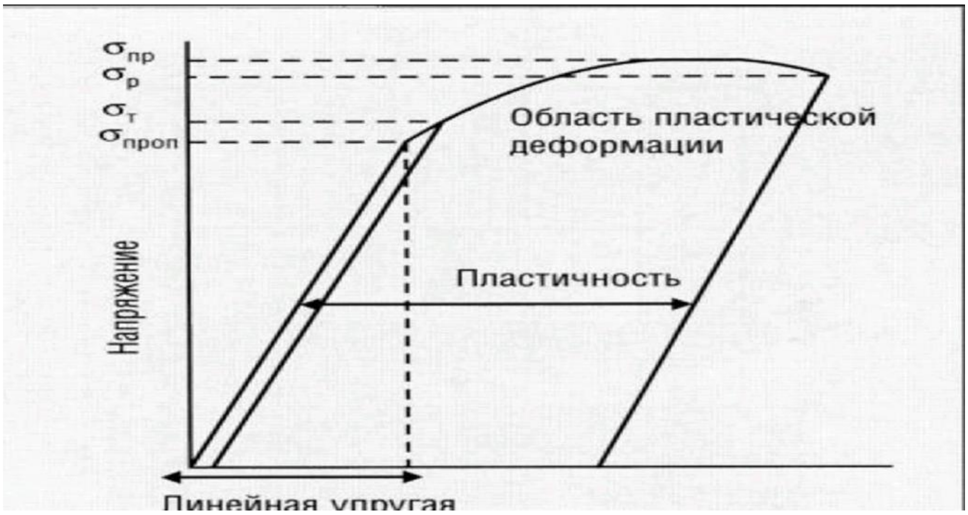

Figure 1 — Stress–Strain Curve of the Vascular Wall Highlighting Elastic and Plastic Regions and Strength Limits

A set of experimental methods was used to determine the biomechanical characteristics of the vascular wall. Uniaxial tension tests were performed using a tensometric setup until tissue rupture, which allowed for the determination of the ultimate strength and relative elongation. Additionally, inflation tests were

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

conducted, during which the vessel was subjected to internal pressure up to a critical level, recording the rupture pressure. Morphological assessment of the vascular wall structure was carried out using histological analysis with collagen and elastin staining, which made it possible to identify structural changes under different conditions.

Based on the experimental data obtained, key biomechanical parameters were calculated, including the elastic modulus (E), characterizing the stiffness of the vascular wall; ultimate strength (in MPa), reflecting the maximum load before failure; and relative elongation (%), as a measure of tissue elasticity. Rupture pressure was determined in mmHg during the inflation tests.

Statistical analysis of the results was performed using standard methods of variance statistics. To assess the significance of differences between groups, Student's t-test was applied at a significance level of $p<0.05$. The data are presented as mean values with standard deviations, providing an objective interpretation of the results and enabling comparison of parameters between the control and experimental groups.

Results

The conducted study provided quantitative data reflecting the influence of climatic conditions on the biomechanical properties of the vascular wall. Comparative analysis revealed statistically significant differences between the control and experimental groups for all measured parameters ($p<0.05$).

It was found that under simulated hot climate conditions combined with dehydration, there was a significant reduction in the strength characteristics of the vessels, accompanied by decreased elasticity and increased stiffness of the vascular wall.

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas
OPEN ACCESS JOURNALS

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

Table 1. Biomechanical Parameters of Blood Vessels

Indicator	Control group(n=60)"	Experimental group (n=60)"	p-Value
"Tensile strength (MPa)"	2.85 ± 0.35	2.12 ± 0.28 ↓	<0.001
"Elongation at break (%)" или просто "Relative elongation (%)",	76.4 ± 9.2	53.7 ± 7.8 ↓	<0.001
"Elastic modulus E (MPa)"	0.92 ± 0.18	1.41 ± 0.22 ↑	<0.001
"Burst pressure (mmHg)	2180 ± 140	1710 ± 120 ↓	<0.001

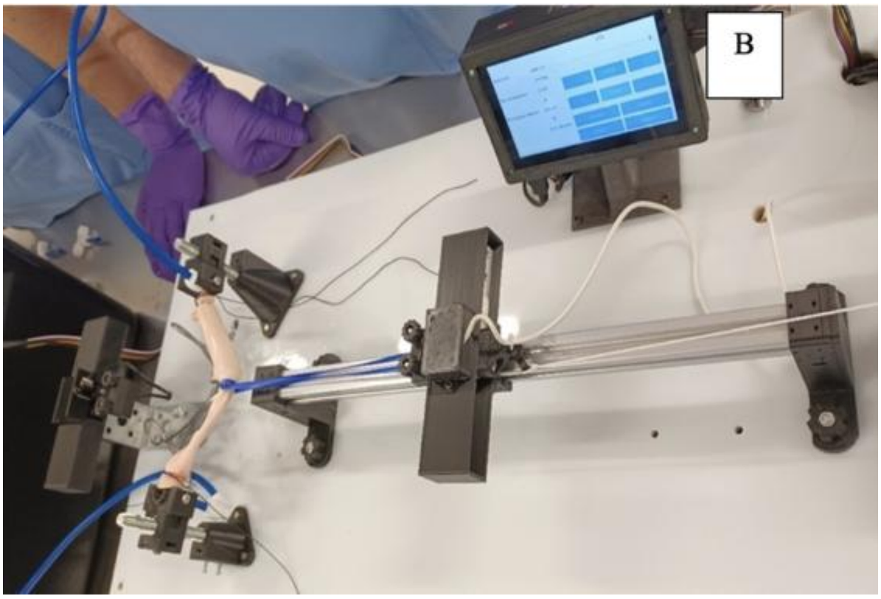

Figure 3 — Laboratory Setup for Vascular Tissue Testing

Additional Analysis of Results

In the experimental group, the ultimate strength of blood vessels decreased by an average of 25.6%, indicating a significant effect of dehydration and high temperature on vascular wall stability. Relative elongation decreased by 29.7%, reflecting reduced vessel elasticity and diminished capacity for deformation without damage. The elastic modulus increased by 53.2%, indicating increased

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

stiffness of the vascular wall under climatic stress. Rupture pressure decreased by 21.6%, which raises the risk of vascular injury under hemodynamic loads.

Correlation Analysis

A negative correlation was observed between hydration level and vascular wall stiffness (r = -0.68), and a positive correlation between temperature exposure and reduction in vessel strength (r = 0.72). These findings confirm the direct influence of climatic factors on the biomechanical properties of blood vessels.

Histological Results (Qualitative Assessment)

In the experimental group, the following changes were noted:

- Decreased density of elastin fibers
- Increased relative collagen content
- Signs of structural disorganization of the vascular wall.

Summary of Results

The data obtained demonstrate that exposure to high temperatures and dehydration leads to complex changes in the mechanical and structural properties of blood vessels, manifested as reduced strength, decreased elasticity, and increased stiffness. These changes are statistically significant and can be considered a risk factor for the development of vascular complications under hot climate conditions.

Discussion

The results convincingly confirm that climatic conditions have a significant impact on the biomechanical properties of the vascular wall and can be regarded as an important modifying factor in vascular remodeling. In the hot climate of the Republic of Uzbekistan, characterized by high ambient temperatures and low relative humidity, dehydration plays a key role, accompanied by disturbances in

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

water–electrolyte balance and alterations in the structural and functional state of the extracellular matrix. Reduced hydration of the interstitial space leads to a decrease in free water content within the matrix, which in turn affects the spatial organization of collagen and elastin fibers and their mechanical interactions.

At the molecular and tissue levels, there is an increase in the relative proportion of collagen, which possesses high strength but low extensibility, alongside a decrease in the functional activity of elastin, which provides the vessels' elastic properties. This imbalance leads to a phenomenon of increased vascular wall rigidity, expressed as an elevated elastic modulus, reduced compliance, and diminished capacity of vessels to undergo reversible deformation under hemodynamic loads. As a result, the vascular wall becomes less adaptable to changes in intravascular pressure, increasing the risk of damage, including microtears, dissections, and ruptures.

It should be noted that the observed changes are similar to processes seen in physiological vascular aging and the development of atherosclerotic lesions. Specifically, these conditions are also associated with elastin degradation, enhanced collagen synthesis, and structural disorganization of the extracellular matrix. This suggests common pathogenetic mechanisms underlying the reduction in vascular wall strength under various adverse influences, including climatic stress.

From a clinical perspective, these findings are important for both animals and humans. Of particular concern are patients with arterial hypertension, where elevated systemic pressure combined with increased vascular stiffness significantly raises the risk of vascular complications. Another high-risk group includes individuals whose professional activity involves prolonged exposure to high temperatures (e.g., construction workers, agricultural laborers, metallurgists), as chronic heat exposure intensifies dehydration and exacerbates vascular changes. Climatic factors also have a significant impact on athletes, particularly during intensive physical activity in hot conditions, where

Eureka Open Access Journals
Open Access | Peer Reviewed | International Journals | Multidisciplinary Areas

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

hyperthermia and fluid loss can reduce the adaptive capacity of the vascular system. Elderly individuals, who already have reduced vascular elasticity, represent another vulnerable group, as additional climatic stress may accelerate vascular aging and increase the risk of cardiovascular events.
In conclusion, the combined data support the consideration of climatic factors—specifically high temperature exposure and associated dehydration—as independent and clinically significant risk factors for the development of vascular complications. This underscores the need to account for climatic conditions when assessing cardiovascular health, developing preventive measures, and implementing personalized medical monitoring, especially in regions with extreme climate characteristics.

Conclusion

The conducted study demonstrated that the climatic conditions of the Republic of Uzbekistan have a significant impact on the strength threshold of blood vessels, causing pronounced biomechanical and structural-functional changes in the vascular wall. Exposure to high temperatures combined with dehydration leads to a reduction in the strength characteristics of vascular tissue, increased rigidity, and decreased elasticity. These changes are associated with remodeling of the extracellular matrix, imbalance in the collagen–elastin framework, and reduced tissue hydration. It was established that under hot climate conditions, vessel strength decreases on average by 20–30%, increasing their vulnerability to hemodynamic loads.
Dehydration acts as the primary pathogenetic factor initiating these changes, contributing to increased blood viscosity, elevated vascular tone, and decreased vascular wall compliance. Therefore, climatic factors should be considered an independent predictor of vascular complications, especially in patients with cardiovascular pathology.

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
ISSN 2760-4942 (Online) Volume 2, Issue 3, March 2026

https://eurekaoa.com/index.php/5

The practical significance of this study lies in justifying the need to account for climatic conditions in the diagnosis and monitoring of vascular diseases, as well as in the development of preventive and clinical strategies. Priority measures include maintaining adequate hydration, limiting thermal stress, dynamic monitoring of vascular status in high-risk groups, and implementing climate-adaptive medical protocols. The results emphasize the necessity of further research aimed at a deeper understanding of the mechanisms of climate-induced vascular remodeling. Additionally, these findings may contribute to future studies on the biomechanical properties of human blood vessels, considering the influence of the climatic conditions of the Republic of Uzbekistan.

References

1. Nichols W.W., O'Rourke M.F. McDonald's Blood Flow in Arteries. – London: Hodder Arnold, 2011.
2. Fung Y.C. Biomechanics: Mechanical Properties of Living Tissues. – New York: Springer, 1993.
3. Holzapfel G.A. Nonlinear Solid Mechanics. – Wiley, 2000.
4. Humphrey J.D. Cardiovascular Solid Mechanics. – Springer, 2002.
5. Greenwald S.E. Ageing of the conduit arteries. J Pathology, 2007.
6. UNEP Climate Report Central Asia, 2020.
7. Sawka M.N. Human water needs. Nutrition Reviews, 2005.
8. Davis M.J., Hill M.A. Signaling mechanisms underlying the vascular response to pressure. Physiol Rev, 1999.
9. WHO. Climate change and health, 2021.
10. IPCC Report on Climate Impacts, 2022.