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НОВЫЙ ДЕНЬ В МЕДИЦИНЕ  
NEW DAY IN MEDICINE**

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## PATHOPHYSIOLOGICAL ASPECTS OF CARDIOMYOPATHY PROGRESSION IN TYPE 2 DIABETES UNDER HOT CLIMATE EXPOSURE

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### ✓ Resume

**Abstract** The purpose of the research: This study aims to assess the clinical and functional characteristics of diabetic cardiomyopathy (DCM) in patients with type 2 diabetes mellitus (T2DM) who reside in regions with hot climates and to identify strategies for optimizing metabolic therapy under these conditions.

**Research methods:** A cohort of 180 patients with T2DM was observed in a regional cardiology center. Clinical, echocardiographic, electrocardiographic, and laboratory evaluations were performed. Patients were divided into two groups depending on the presence or absence of DCM. Statistical analysis was conducted using SPSS v25.0.

**Research results:** Patients with DCM showed significantly more complaints of dyspnea (74%), fatigue (68%), and edema (61%). Diastolic dysfunction ( $E/A < 1.0$ ) was identified in 71% of DCM patients, while  $GLS < -17\%$  was observed in 64%. HRV was reduced ( $SDNN 91 \pm 11$  ms), and arrhythmias occurred in 38% of cases. HbA1c and NT-proBNP levels were elevated. Electrolyte imbalances were observed in 62% of DCM patients.

**Practical application:** The results support the necessity of climate-adapted therapy for T2DM patients, including adjusted hydration strategies, greater use of cardioprotective antidiabetics, and enhanced patient education on heat stress prevention.

**Keywords:** Type 2 diabetes mellitus, diabetic cardiomyopathy, hot climate, echocardiography, arrhythmia, metabolic therapy, cardiac function

## ПАТОФИЗИОЛОГИЧЕСКИЕ АСПЕКТЫ ПРОГРЕССИРОВАНИЯ КАРДИОМИОПАТИИ ПРИ САХАРНОМ ДИАБЕТЕ 2 ТИПА В УСЛОВИЯХ ВОЗДЕЙСТВИЯ ЖАРКОГО КЛИМАТА

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### ✓ Резюме

**Аннотация** Цель исследования: Цель данного исследования - оценить клинические и функциональные характеристики диабетической кардиомиопатии (ДКМП) у пациентов с сахарным диабетом 2 типа (СД2), проживающих в регионах с жарким климатом, и определить стратегии оптимизации метаболической терапии в этих условиях.

**Методы исследования:** В региональном кардиологическом центре наблюдалась группа из 180 пациентов с СД2. Были проведены клинические, эхокардиографические, электрокардиографические и лабораторные исследования. Пациенты были разделены на две группы в зависимости от наличия или отсутствия СД2. Статистический анализ проводился с использованием SPSS версии 25.0.

**Результаты исследования:** Пациенты с ДКМП значительно чаще жаловались на одышку (74%), утомляемость (68%) и отеки (61%). Диастолическая дисфункция ( $E/A < 1,0$ ) была выявлена у 71% пациентов с ДКМП, в то время как  $GLS < -17\%$  наблюдалась у 64%. ВРС была снижена ( $SDNN 91 \pm 11$  мс), а аритмии наблюдались в 38% случаев. Уровни HbA1c и

NT-proBNP были повышены. Электролитный дисбаланс наблюдался у 62% пациентов с ДКМП.

**Практическое применение:** Результаты подтверждают необходимость адаптированной к климату терапии для пациентов с СД2, включая скорректированные стратегии гидратации, более широкое использование кардиопротекторных противодиабетических средств и повышение уровня информированности пациентов о профилактике теплового стресса.

**Ключевые слова:** сахарный диабет 2 типа, диабетическая кардиомиопатия, жаркий климат, эхокардиография, аритмия, метаболическая терапия, сердечная функция

## ISSIQ IQLIM TA'SIRIDA 2-TOIFA DIABETDA KARDIYOMIYOPATIYA RIVOJLANISHINING PATOFIZIOLOGIK JIHATLARI

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### ✓ Rezyume

**Xulosa tadqiqotning maqsadi:** ushbu tadqiqot issiq iqlimi bo'lgan hududlarda yashovchi 2-toifa diabet mellitus (T2DM) bilan og'rigan bemorlarda diabetik kardiomyopatiyaning (DCM) klinik va funktsional xususiyatlarini baholashga va ushbu sharoitlarda metabolik terapiyani optimallashtirish strategiyasini aniqlashga qaratilgan.

**Tadqiqot usullari:** mintaqaviy kardiologiya markazida T180DM bilan kasallangan 2 bemorning kohortasi kuzatildi. Klinik, ekokardiyografik, elektrokardiyografik va laboratoriya tekshiruvlari o'tkazildi. Bemorlar DCM mavjudligi yoki yo'qligiga qarab ikki guruhga bo'lingan. Statistik tahlil SPSS V25. 0 yordamida o'tkazildi.

**Tadqiqot natijalari:** DCM bilan og'rigan bemorlarda nafas qisilishi (74%), charchoq (68%) va shish (61%) shikoyatlari sezilarli darajada oshdi. Diastolik disfunktsiya ( $e/a < 1.0$ ) DCM bemorlarining 71% da aniqlangan, GLS esa  $-17\%$  64% da kuzatilgan. HRV kamaydi (SDNN 91 va 11 ms) va aritmiya 38% hollarda sodir bo'lgan. HbA1c va NT-proBNP darajalari ko'tarildi. DCM bemorlarining 62 foizida elektrolitlar muvozanati kuzatildi.

**Amaliy qo'llanma:** natijalar t2dm bemorlari uchun iqlimga moslashtirilgan terapiya zarurligini, shu jumladan tuzatilgan hidratsiya strategiyasini, kardioprotektiv antidiyabetikadan ko'proq foydalanishni va issiqlik stressining oldini olish bo'yicha bemorlarga kengaytirilgan ta'limni qo'llab-quvvatlaydi.

**Kalit so'zlar:** 2-toifa qandli diabet, diabetik kardiomyopatiya, issiq iqlim, ekokardiyografiya, aritmiya, metabolik terapiya, yurak faoliyati

### Relevance

Type 2 diabetes mellitus (T2DM) is one of the most widespread chronic diseases worldwide, and its socio-economic burden continues to grow. Current epidemiological data indicate a significant increase in T2DM incidence in regions with hot climates, particularly in the Middle East, Central Asia, Southern Europe, and North Africa. These climatic conditions exacerbate the course and complications of T2DM[1,2,3].

Among the complications, diabetic cardiomyopathy (DCM) plays a significant role. This condition is characterized by structural and functional changes in the myocardium, developing in the absence of coronary artery disease, hypertension, or valvular defects. DCM significantly increases the risk of heart failure, sudden cardiac death, and reduces life expectancy [5,7,9].

Hot climates impose additional stress on the cardiovascular system of patients with T2DM. High temperatures contribute to dehydration, electrolyte imbalance, increased blood viscosity, and activation of the sympathoadrenal system, all of which can aggravate cardiomyopathy and increase the risk of decompensation [4,11,12]. Despite numerous studies on DCM pathogenesis and treatment, the impact

of climatic factors, particularly extreme heat, remains underexplored. It is especially important to consider how to adapt therapeutic approaches under high ambient temperatures [6,10].

To identify the clinical and functional features of diabetic cardiomyopathy in patients with T2DM living in hot climates, and to determine the directions for therapy adaptation under such conditions.

### Materials and methods

The study was conducted at a regional cardiology center located in a southern climatic zone. A total of 180 patients with T2DM living in hot climates for at least 5 years were included. All patients provided informed consent.

Inclusion criteria: age 45–70 years, T2DM duration over 5 years, no significant hypertension, coronary artery disease, or structural heart defects.

The patients were divided into two groups: Group A (n=90) – patients with signs of DCM confirmed via echocardiography and lab tests; Group B (n=90) – patients without DCM signs.

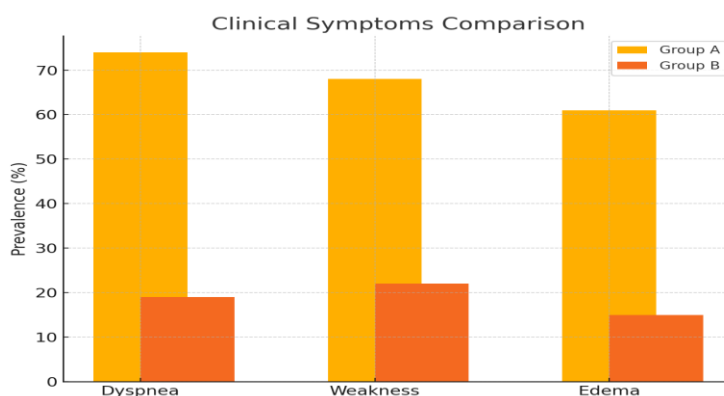
Study methods included:

- Clinical and anamnestic evaluation (complaints, NYHA class, BMI);
- Echocardiography (EF, diastolic function, GLS);
- 24-hour ECG monitoring (HRV, arrhythmias);
- Lab tests (HbA1c, NT-proBNP, electrolytes, inflammation markers);
- Treatment scheme assessment and compliance.

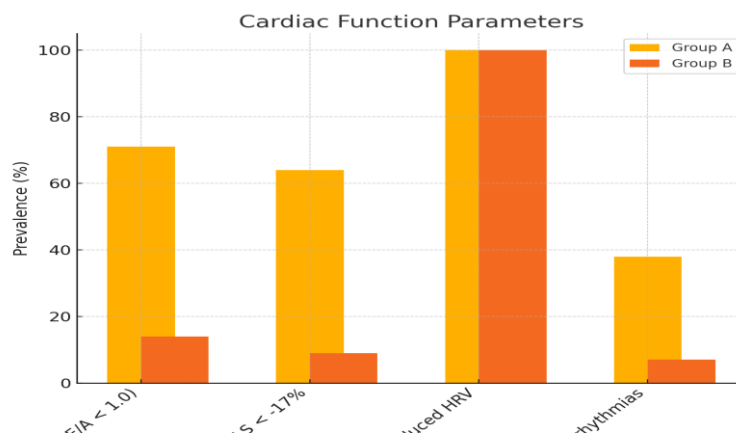
### Results and discussions

The study revealed the following patterns:

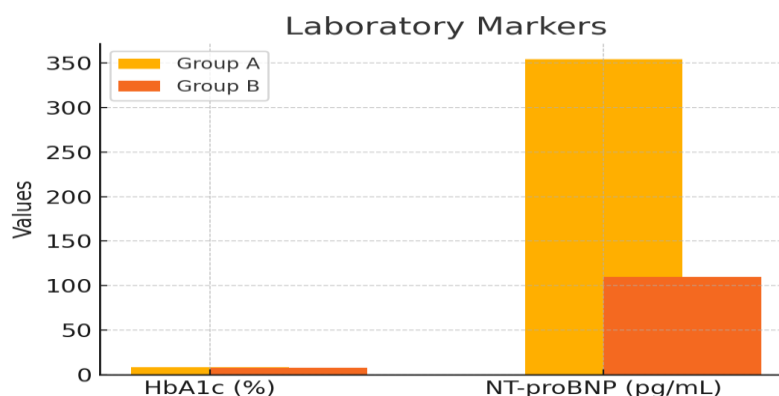
**Figure 1. Comparison of clinical symptoms between groups**



**Figure 2 Cardiac function parameters in patients with DCM**



**Figure 3. Laboratory markers in Group A and Group B**



Patients in Group A more frequently reported symptoms such as dyspnea (74%), weakness (68%), and edema (61%) compared to Group B (19%, 22%, and 15%, respectively). Resting heart rate was significantly higher in Group A ( $84.2 \pm 8.5$  bpm vs.  $75.1 \pm 6.9$  bpm,  $p < 0.01$ ).

Diastolic dysfunction ( $E/A < 1.0$ ) was detected in 71% of Group A vs. 14% of Group B ( $p < 0.001$ ). GLS  $< -17\%$  was present in 64% of Group A vs. 9% of Group B. Holter monitoring showed reduced HRV (SDNN  $91 \pm 11$  ms in Group A vs.  $112 \pm 13$  ms,  $p < 0.001$ ). Arrhythmias, including ventricular extrasystoles and AF paroxysms, were seen in 38% of DCM patients vs. 7%.

HbA1c and NT-proBNP levels were higher in Group A:  $8.6 \pm 1.1\%$  and  $354 \pm 78$  pg/mL, respectively, compared to  $7.8 \pm 0.9\%$  and  $110 \pm 47$  pg/mL ( $p < 0.05$ ). Electrolyte imbalances, including hypokalemia and hypomagnesemia, were noted in 62% of Group A.

### Conclusion

Patients with T2DM living in hot climates experience a more severe course of diabetic cardiomyopathy. Major aggravating factors include dehydration, reduced circulating blood volume, electrolyte imbalance, elevated body temperature, and sympathoadrenal activation.

Our results support therapy adaptation: increased use of SGLT2 inhibitors, dose adjustments of diuretics, regular monitoring of electrolytes and hydration. Patient education on hydration and self-monitoring is especially important during hot seasons.

Future studies should focus on multicenter validation, including gender and age analysis, comorbidities, and evaluation of personalized prevention programs for complications in this patient population.

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