

UDC 612.015.32 : 60.7 - 074/.078 (577.122)

TERRITORIAL PECULIARITIES OF VITAMIN D SUPPLY IN PERSONS WITH PREDIABETES AND TYPE 2 DM IN ANDIJAN REGION

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Abstract

The article deals with the prevalence of vitamin D, zinc and calcium deficiency among patients with carbohydrate metabolism disorders (IFG, IGT type 2 diabetes) in Andijan region. A comparative analysis of the level of these microelements in rural and urban residents was carried out. It was found that the level of vitamin D and calcium in patients with type 2 diabetes was significantly lower than in persons without carbohydrate metabolism disorders. A significant correlation was also found between reduced zinc levels and the presence of insulin resistance. These results emphasise the need for a comprehensive approach to the diagnosis and prevention of carbohydrate metabolism disorders, including monitoring and correction of vitamin D, zinc and calcium levels.

Keywords: vitamin D, zinc, calcium, carbohydrate metabolism disorder, prediabetes, type 2 diabetes mellitus.

Annotatsiya

Maqolada Andijon viloyatidagi uglevod almashinuvi buzilishi (NGB, GTB, 2-tur qandli diabet) bilan ogʻrigan bemorlarda D vitamini, rux va kalsiy tanqisligining tarqalishi oʻrganilgan. Qishloq va shahar aholisi orasida ushbu mikroelementlar darajasining qiyosiy tahlili oʻtkazildi. 2-tur qandli diabetga chalingan bemorlarda D vitamini va kalsiy miqdori uglevod almashinuvi buzilmagan shaxslarga nisbatan sezilarli darajada past ekanligi aniqlandi. Shuningdek, rux miqdorining pasayishi va insulin qarshiligining mavjudligi oʻrtasida muhim bogʻliqlik kuzatildi. Ushbu natijalar uglevod almashinuvi buzilishlarini tashxislash va oldini olishda kompleks yondashuvning, jumladan D vitamini, rux va kalsiy darajasini nazorat qilish va toʻgʻrilashning zarurligini koʻrsatadi.

Kalit soʻzlar: D vitamini, rux, kalsiy, uglevod almashinuvining buzilishi, prediabet, 2-tur qandli diabet.

Аннотация

В статье рассматривается распространенность витамина D, дефицита цинка и кальция среди пациентов с нарушениями углеводного обмена (НГН, НТГ, сахарный диабет 2 типа) в Андижанской области. Проведен сравнительный анализ уровня этих микроэлементов у сельских и городских жителей. Было обнаружено, что уровень витамина D и кальция у пациентов с сахарным диабетом 2 типа был значительно ниже, чем у лиц без нарушений углеводного обмена. Также была обнаружена значимая корреляция между сниженным уровнем цинка и наличием инсулинорезистентности. Эти результаты подчеркивают необходимость комплексного подхода к диагностике и профилактике нарушений углеводного обмена, включая мониторинг и коррекцию уровня витамина D, цинка и кальция.

Ключевые слова: витамин D, цинк, кальций, нарушение углеводного обмена, предсахарный диабет, сахарный диабет 2 типа.

Introduction. Prediabetes is an intermediate disorder of carbohydrate metabolism in which blood glucose levels exceed normal values but do not reach the threshold necessary for a diagnosis of type 2 diabetes mellitus. Often prediabetes is asymptomatic, but every year 5-10% of patients with this condition progress to DM2. At the prediabetes stage, complications characteristic of diabetes, particularly cardiovascular complications [1] may already appear.

The global prevalence of prediabetes remains extremely high and continues to rise. According to the latest data, in 2021, the prevalence of impaired glucose tolerance (IGT) in adults was about 9.1% (~464 million) and impaired fasting glycaemia (IFG) was 5.8% (~298 million) of the global population [1]. By 2045, these rates are projected to further increase to 10.0% (~638 million) and 6.5% (~414 million), respectively [14]. The prevalence of prediabetes is particularly high in industrialised countries, but the greatest relative increase is expected in low- and middle-income countries [14].

The increasing prevalence of prediabetes is closely related to the obesity epidemic and lifestyle changes. Urbanisation, ageing population, low physical activity level and increasing prevalence of overweight and obesity [2] are considered to be the key factors for the

increasing number of DM2 patients. As a result, there is a rapid increase in prediabetes in many regions today. For example, in South Asia, particularly in Nepal, prediabetes is detected in about 9.2% of adults [3], and in China in more than 50% of adults [4]. These trends reflect the global shift to sedentary lifestyles and high-calorie diets.

Given the increasing incidence of DM2 and the high prevalence of risk factors, early diagnosis of prediabetes is extremely important. Timely detection of carbohydrate metabolism disorders and preventive measures (lifestyle correction, screening of risk groups) can significantly reduce the risk of prediabetes progression to DM2 and long-term complications of the disease.

The study of the molecular basis of the role of vitamin D in the development of insulin resistance, type 1 and type 2 DM, gestational diabetes, metabolic syndrome and cardiovascular diseases has attracted the attention of many specialists and has been the subject of debate in recent years. Many epidemiological and observational studies have found an association between vitamin D insufficiency and the incidence of type 1 and type 2 DM [11-15]. In this sense, many studies have reported the existence of different mechanisms that can explain the potential role of vitamin D in glucose metabolism, such as the

preservation of β -cell function and the slow failure of residual β -cell function in patients with type 1 DM and latent autoimmune diabetes [12, 13]. The vitamin D receptor (VDR), involved in the systemic effects of vitamin D, is also expressed in tissues with high levels of insulin sensitivity (pancreas, adipose tissue and muscle) [10]. In the body, vitamin D is an epigenetic factor mediating the level of transcription and increasing insulin sensitivity.

of the study: To investigate the prevalence of vitamin D, zinc and calcium deficiency in patients with impaired fasting glycaemia (IFG), impaired glucose tolerance (IGT) and type 2 diabetes mellitus among rural and urban population of Andijan region.

Material and study design

In order to implement the tasks set in the dissertation work, a one-stage epidemiological study was conducted, covering men and women aged 30 to 75 years, living in rural and urban areas of Andijan region. The study surveyed 1800 people over 30 years of age living in Markhamat district and 1600 people over 40 years of age living in Andijan city. The study was conducted in three stages, including examination at the clinic of the Andijan State Medical Institute. At the 1st stage of the study, the population of 1800 people was screened using questionnaires (questionnaire-

questionnaire) to identify non-communicable diseases and their risk factors, as well as questionnaire-questionnaire - FINDRISC, to identify prediabetes and type 2 diabetes. At this stage, data obtained from the subjects themselves through questionnaires were used. At the 2nd stage of work, a sample of people with a high risk of prediabetes and type 2 diabetes mellitus was selected. In the formed group with a high risk of developing carbohydrate metabolism disorders, a number of analyses were carried out: glucose tolerance test, glycated haemoglobin.

At stage 3, the main risk factors for non-communicable diseases were identified and assessed according to WHO (2014) criteria. Thus, the levels of vitamin 25(OH)D₃, zinc, calcium, glycated haemoglobin, blood glucose and insulin, HOMA-IR index, body mass index (BMI), lipid spectrum, presence of AH and bad habits, degree of physical activity, low consumption of vegetables and fruits were determined in each examined person.

The reagents used were as follows: insulin - Vector Best (Russia), total cholesterol - Human (Germany), HDL - Human (Germany), LDL - Human (Germany), triglycerides - Cypress Diagnostics, Belgium, glycohaemoglobin - Human (Germany), calcium - Human (Germany), Zinc - firm "DAC-SpectroMed",

Vitamin D - Diagnostics Biochem Canada Inc". [25-hydroxyvitamin D or 25(OH)D].

The World Health Organisation (WHO) 1999 diagnostic criteria [8] were used to diagnose diabetes, IHD and NTDs.

Statistical processing of the study results was performed using Statistica 6.0 application software package. Spearman's rank correlation method was used to calculate correlation coefficients. To assess the significance of the difference between the shares, criterion χ^2 - Pearson's square will be used. Differences at the significance level of $p < 0.05$ are taken as reliable.

Results and their discussion:

Table 1 shows the prevalence of prediabetes (in the form of impaired fasting glycaemia (IGN), impaired glucose tolerance (IGT) and their combination) and type 2 diabetes mellitus (T2DM) among male and female population in rural areas (Markhamat district).

Among those with IGT ($n=19$), women were significantly more predominant than men, $68.4 \pm 11.0\%$ vs. $31.6 \pm 11.0\%$, respectively ($p < 0.05$). A similar trend was observed in the group with IGT ($n=30$), where the proportion of women was $73.3 \pm 8.2\%$ and men $26.7 \pm 8.2\%$ ($p < 0.001$). In the group with a combination of IFG and IGT ($n=53$), there was also a significant female predominance ($92.5 \pm 3.7\%$) compared to male predominance ($7.5 \pm 3.7\%$) ($p < 0.001$).

In the group with newly diagnosed type 2 diabetes mellitus ($n=52$), women also predominated ($61.5 \pm 6.8\%$) over men ($38.5 \pm 6.8\%$), and this difference was statistically significant ($p < 0.05$). In the control group without carbohydrate metabolism disorders ($n=30$), women ($83.3 \pm 6.9\%$) were similarly predominant compared to men ($16.7 \pm 6.9\%$) ($p < 0.001$).

Table 1

Prevalence of prediabetes and type 2 DM by sex (Markhamat)

Group	Husband.		Wife.		P
	abs.	%	abs.	%	
IFG, $n=19$	6	$31,6 \pm 11,0$	13	$68,4 \pm 11,0$	$<0,05$
IGT, $n=30$	8	$26,7 \pm 8,2$	22	$73,3 \pm 8,2$	$<0,001$
IFG+IGT, $n=53$	4	$7,5 \pm 3,7^{*^{\wedge}}$	49	$92,5 \pm 3,7^{*^{\wedge}}$	$<0,001$
DM, $n=52$	20	$38,5 \pm 6,8^{(&)} (&)$	32	$61,5 \pm 6,8^{&&}$	$<0,05$

No impairment, n=30	5	16,7±6,9 [#]	25	83,3±6,9 [#]	<0,001
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Note: *- reliable compared to the indicators of the IFG group (*-P<0.05)

^- significantly compared to the IGT group (^-P<0.05)

&- significantly compared to the IFG+IGT group (&-P<0.01)

#- significantly compared to the SD group (#-P<0.05)

Table 2. It can be seen that the prevalence of prediabetes in the NTD group (n=20) was also dominated by female sex over men 70.0±10.5% to 30.0±10.5% respectively (p<0.05). The same trend was observed in the group with IGT (n=30), where the percentage ratio of women to men was 76,7±7,9% and men - 23,3±7,9 p<0,001). In the group with a combination of IFG and IGT (n=53), there was also a significant female predominance (71.7±6.2%) compared to male predominance (28.3±6.2%) (p<0.001).

In the group with newly diagnosed type 2 diabetes mellitus (n=50), women

also predominated (78.0±5.9%) over men (22.0±5.9%), and this difference was statistically significant (p<0.001). In the control group without carbohydrate metabolism disorders (n=30), women (89.7±5.8%) were similarly predominant compared to men (10.3±5.8%) (p<0.001).

Thus, according to the survey data of rural and urban population of Andijan region, prediabetic conditions and type 2 DM were more often detected in women, which may indicate the need for gender-oriented preventive and diagnostic approaches

Table 2

Prevalence of prediabetes and type 2 DM by sex (urban)

Group	Husband.		Wife.		P
	abs.	%	abs.	%	
IFG, n=20	6	30,0±10,5	14	70,0±10,5	<0,05
IGT, n=30	7	23,3±7,9	23	76,7±7,9	<0,001
IFG+IGT, n=53	15	28,3±6,2	38	71,7±6,2	<0,001
DM, n=50	11	22,0±5,9	39	78,0±5,9	<0,001
No impairment, n=29	3	10,3±5,8 ^{&}	26	89,7±5,8 ^{&}	<0,001

Note: &- significantly compared to the IFG+IGT group (&-P<0.001)

- significantly compared to the indicators of the IFG group (-P<0.05)

The next stage we studied the average vit D, zinc and calcium levels in the studied groups (Table 3.). It follows from the data in Table 3. that vitamin D

and calcium levels in patients with IGT of Markhamat district and Andijan city were significantly reduced compared to those in the IFG group.

Table 3

Results of biochemical parameters by groups depending on the region

Group	Mean vitamin D level (ng/ml)		Average calcium level (mmol/l)		Mean zinc level (μmol/l)	
	Marhamat	City	Marhamat	City	Marhamat	City
IFG	12,8±1,0	13,2±0,77	0,98±0,020	1,03±0,020	11,4±0,76	16,8±0,94
IGT	16,1±1,0*	14,7±1,0	1,05±0,022*	1,04±0,018	12,7±0,78	15,5±0,83
IFG+IGT,	14,5±0,75 ^{^^}	12,5±0,5*	0,97±0,017**	1,07±0,015	11,6±0,55	13,6±0,48 ^{^^}
DM	11,8±0,87 ^(*) (^^&&&)	13,3±0,79	0,84±0,036 ^{***^^} &&&	0,93±0,030 ^{***^^} &&&	13,3±0,74	14,7±0,63 [*]
No offence,	28,7±0,9 ^{***^^} &&&	19,0±1,3 ^{***^} &##	1,09±0,018 ^{^&&#}	1,08±0,015 ^{##}	14,4±0,90 ^{*&}	18,1±0,81 ^{&}

Note: *- reliable compared to the indicators of the IFG group (*-P<0.05)

^- significantly compared to the IGT group values (^^-P<0.01; ^^^-P<0.001)

&- significantly compared to those of the IFG+IGT group (&&&-P<0.001)

#- significantly compared to the SD group (#-P<0.05)

The levels of zinc in residents of Markhamat district and Andijan city in patients with DM 2 were significantly reduced compared to the indicators of NDH+ IGT group. Levels of vitamin D and calcium in residents of Markhamat district and Andijan city were significantly lower in comparison with indicators of DM group.

According to Puri M, serum zinc concentration was significantly lower in patients with at least two microangiopathic complications ($p < 0.05$). The authors attributed this finding

to the side effects of high glucose concentration leading to decreased renal zinc reabsorption [143]. In our patients, the mean values of zinc levels were significantly lower than in the control group in patients with IFG (district, $p < 0.05$), IGT (district, $p < 0.05$), IFG+IGT (district/city, $p < 0.05$), with type 2 DM (district/city, $p < 0.05$).

Calcium homeostasis is impaired in type DM2 and contributes to cellular dysregulation in red blood cells, heart muscle, platelets and skeletal muscle. [141]. Studies have shown a complex

relationship between calcium levels and the pathogenesis of type 2 DM. Decreased β -cell function has been associated with abnormal calcium regulation [144]

Conclusions

The study revealed high prevalence of vitamin D, zinc and calcium deficiency among patients with carbohydrate metabolism disorders (CVD, NTD, type 2 DM) in Andijan region.

1. Mean vitamin D levels in patients with type 2 DM were significantly lower compared to the group without carbohydrate metabolism disorders, suggesting a potential role of hypovitaminosis D in the pathogenesis of diabetes.

2. Significant regional differences were found: vitamin D levels in rural residents were lower than in urban

residents, which is probably due to differences in diet, lifestyle and access to medical care.

3. The concentration of zinc was significantly reduced in patients with type 2 DM compared to the group without disorders, which confirms its important role in the regulation of carbohydrate metabolism and the development of insulin resistance.

4. Calcium deficiency was more frequent in patients with carbohydrate metabolism disorders, which is consistent with the available data on its effect on the functional activity of pancreatic β -cells.

5. The results emphasise the need for a comprehensive approach to the diagnosis and prevention of carbohydrate metabolism disorders, including monitoring and correction of vitamin D, zinc and calcium levels in the blood of patients.

Bibliography

1. Argano C, Mirarchi L, Amodeo S, Orlando V, Torres A, Corrao S. The Role of Vitamin D and Its Molecular Bases in Insulin Resistance, Diabetes, Metabolic Syndrome, and Cardiovascular Disease: State of the Art. *Int J Mol Sci.* 2023 Oct 23;24(20):15485. doi: 10.3390/ijms242015485.
2. Umar M, Sastry KS, Chouchane AI. Role of Vitamin D Beyond the Skeletal Function: A Review of the Molecular and Clinical Studies. *Int J Mol Sci.* 2018 May 30;19(6):1618. doi: 10.3390/ijms19061618.
3. Maddaloni E. et al. Vitamin D and diabetes mellitus //Vitamin D in Clinical Medicine. - 2018. - T. 50. - C. 161-176.
4. Mitri J, Muraru MD, Pittas AG. Vitamin D and type 2 diabetes: a systematic review. *Eur J Clin Nutr.* 2011 Sep;65(9):1005-15. doi: 10.1038/ejcn.2011.118.

5. Targher G. et al. Associations between serum 25-hydroxyvitamin D3 concentrations and liver histology in patients with non-alcoholic fatty liver disease //Nutrition, Metabolism and Cardiovascular Diseases. - 2007. - T. 17. - №. 7. - C. 517-524.
6. Chen X. et al. Association of serum total 25-hydroxy-vitamin D concentration and risk of all-cause, cardiovascular and malignancy-specific mortality in patients with hyperlipidaemia in the United States //Frontiers in Nutrition. - 2022. - VOL. 9. - P. 971720.
7. Wimalawansa S. J. Non-musculoskeletal benefits of vitamin D //The Journal of steroid biochemistry and molecular biology. - 2018. - T. 175. - C. 60-81.
8. Teleni L. et al. Clinical outcomes of vitamin D deficiency and supplementation in cancer patients //Nutrition reviews. - 2013. - T. 71. - №. 9. - C. 611-621.
9. Khademi Z., Hamed-Shahraki S., Amirkhizi F. Vitamin D insufficiency is associated with inflammation and deregulation of adipokines in patients with metabolic syndrome //BMC Endocrine Disorders. - 2022. - T. 22. - №. 1. - C. 223.
10. Dianna J. Magliano, Co-chair, Edward J. Boyko, Co-chair; IDF Diabetes Atlas 10th edition scientific committee . Brussels: International Diabetes Federation; 2021.
11. Dong J. Y. et al. Vitamin D intake and risk of type 1 diabetes: a meta-analysis of observational studies //Nutrients. - 2013. - T. 5. - №. 9. - C. 3551-3562.
12. Littorin B. et al. Lower levels of plasma 25-hydroxyvitamin D among young adults at diagnosis of autoimmune type 1 diabetes compared with control subjects: results from the nationwide Diabetes Incidence Study in Sweden (DISS) //Diabetologia. - 2006. - T. 49. - C. 2847-2852.
13. Mukhamedova V. M., Nishanova M. S. Obesity is a Risk Factor for Prediabetes. American Journal of Medicine and Medical Sciences p-ISSN: 2165-901X e-ISSN: 2165-9036 2024; 14(4): 1077-1079 doi:10.5923/j.ajmms.20241404.57
14. Yusupova S, Nishanova M. ASSESSMENT OF PREDIABETES PREVALENCE AMONG RURAL AND URBAN POPULATIONS OF ANDIJAN. MSU [Internet]. 2025 Apr. 16 [cited 2025 May 17];(2):169-76. Available from: <https://fdoctors.uz/index.php/journal/article/view/157>
15. Юсупова Ш, Мухамедова В, Маткаримова М. ОЦЕНКА ЧАСТОТЫ ВСТРЕЧАЕМОСТИ ФАКТОРОВ РИСКА НАРУШЕНИЙ УГЛЕВОДНОГО ОБМЕНА. MSU [Интернет]. 16 апрель 2025 г.;(2):18-20. доступно на: <https://fdoctors.uz/index.php/journal/article/view/107>.doi: <https://doi.org/10.56121/2181-3612-2025-2-18-20>