Spectrochemical Differentiation of Primary Brain Tumors Using Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) Spectroscopy Combined With PCA-DA Modeling

A.V.Alimov[1] , N.U.Alimova[1], A.V.Alieva[1], D.M.Berdikolova[1], A.S.Sadikova[1], M.R.Ibragimova[1*]

[1] Republican Specialized Scientific-Practical Medical Center of Endocrinology named after Acad. Turakulov Y.Kh., Tashkent, Uzbekistan
maftunarustamovna707@gmail.com

Abstract. Type 1 diabetes (T1D) among children and adolescents in Uzbekistan shows a steady increase in both incidence and prevalence. This reseach aims to analyze the dynamics of T1D prevalence and incidence among children and adolescents in Uzbekistan from 2017 to 2024 and compare the findings with data from 2000 to 2016. The study used statistical reports from the regional branches of the Republican Specialized Scientific and Practical Medical Center of Endocrinology named after Academician Y.Kh. Turakulov. The results revealed that T1D prevalence increased from 22.1 to 30.8 per 100,000 among children and from 51.5 to 84.8 per 100,000 among adolescents. The highest rates were recorded in Tashkent city, Tashkent region, and the Republic of Karakalpakstan. Incidence also increased, especially among adolescents, with an annual growth rate of 7.57%. Compared to 2000–2016, T1D prevalence has quadrupled over the past 24 years. This increase may be associated with urbanization, environmental factors, and the effects of the COVID-19 pandemic. The study highlights the urgent need to implement national diabetes registries and strengthen surveillance systems.

Keywords: type 1 diabetes, children, adolescents, epidemiology, incidence, prevalence, Uzbekistan.

1   Introduction

Type 1 diabetes mellitus (T1DM) remains one of the most common endocrinopathies of childhood and adolescence, characterized by chronic autoimmune destruction of pancreatic β-cells and absolute insulin deficiency. Over the past decades, there has been a steady global increase in the incidence of T1DM among children and adolescents [1, 2]. According to the International Diabetes Federation (IDF), in 2024 approximately 1.9 million children and adolescents under 20 years of age were living with clinically diagnosed T1DM worldwide [3].

The IDF estimates that in 2024 there were 503,000 new cases of T1DM across all age groups, of which 219,000 occurred in individuals younger than 20 years. These figures underscore the substantial epidemiological significance of the disease, particularly in young populations.

The incidence of T1DM varies considerably across countries and regions. In 2024, the highest incidence rates among children under 15 years of age were recorded in Finland, Saudi Arabia, Kuwait, Qatar, and Estonia [3]. A sustained increase is also observed in low- and middle-income countries, where, according to the most recent reports, mortality from undiagnosed T1DM remains high—especially among young individuals who die within the first year of symptom onset [3]. This is particularly concerning given that approximately 35,000 deaths in individuals under 25 were attributed to a lack of T1D diagnosis in 2021, disproportionately affecting low- and middle-income countries in regions like Sub-Saharan Africa and South Asia [4]. Such disparities underscore the critical need for enhanced epidemiological surveillance and robust healthcare infrastructure in these areas to mitigate preventable mortality and improve outcomes for young individuals affected by T1D [5, 6].

According to the 10th edition of the IDF Atlas, in 2021 there were 149,500 new cases of T1DM in individuals under 20 years of age [7]. These data confirm the ongoing upward trend, particularly in adolescents aged 15–19 years, with notably high incidence reported in several countries, including regions of North Africa and the Middle East [7]. This global trend of increasing incidence is further supported by observations from 2002 to 2015, where a notable rise in T1DM cases was documented, with Hispanic children and adolescents in the United States experiencing the highest incidence between 2002 and 2020 [8]. Globally, an estimated 9.5 million individuals live with T1D, with a significant proportion, 1.0 million, being aged 0–14 years and an additional 0.8 million aged 15–19 years [9]. Projections suggest a rise to 13.5–17.4 million prevalent cases by 2040, with the most substantial relative increases anticipated in low-income and lower-middle-income countries [5].

The European region, in particular, has exhibited the highest incidence of Type 1 Diabetes (T1D) among youth in recent years, highlighting regional disparities in disease burden [10]. In 2021, only 97 out of 215 countries and territories had their own incidence data, making it challenging to obtain a complete global picture of T1D epidemiology [11]. Thus, given the substantial global data gaps—with only 97 out of 215 countries and territories having their own incidence data, particularly in low- and middle-income countries [4, 11]—timely epidemiological monitoring and regional analysis of T1DM prevalence in children and adolescents, including territorial data such as those from Uzbekistan, remain essential for assessing the current situation, addressing preventable mortality from undiagnosed cases [4, 5], and developing effective prevention strategies and specialized care delivery. This effort is crucial for informing public health initiatives and allocating resources efficiently, especially in regions with limited data.

This study aims to analyze the key epidemiological indicators of T1DM in children and adolescents in Uzbekistan over the past seven years (2017–2024) and to compare these findings with data from the national registry collected between 2000 and 2016. This research will contribute to a more comprehensive understanding of T1DM trends

in a specific Central Asian context, addressing existing gaps in regional epidemiological data, particularly in light of the documented variability in incidence and prevalence worldwide. Furthermore, this analysis will provide critical insights into the local disease burden, which can inform tailored public health interventions and resource allocation strategies within Uzbekistan's healthcare system.

2   Materials and Methods

The data used in this article were obtained from statistical reports of regional branches of the Republican Specialized Scientific and Practical Medical Center of Endocrinology (RSSPMCE) named after academician Yo.H. Turakulov for the period 2017–2024. The study assessed trends in T1DM incidence in the Republic of Uzbekistan as a whole, as well as in individual regions. The statistics included the total number of T1DM patients, newly diagnosed cases, and mortality. Statistical methods were applied to evaluate temporal changes and to identify regional characteristics. Prevalence and incidence rates were calculated for each calendar year relative to the total pediatric population of corresponding age groups and presented as the number of T1DM cases per 100,000 children.

3   Results

3.1   Prevalence of T1DM

During the study period, the prevalence of T1DM per 100,000 pediatric population increased from 2017 to 2024. Across all regions, the highest prevalence rates were recorded in Tashkent City (mean value 53.4 per 100,000), Tashkent Region (mean value 41.6), and the Republic of Karakalpakstan (mean value 32.3). The lowest rates were observed in Surkhandarya Region (mean value 17.3), Namangan Region (mean value 17.7), and Jizzakh Region (mean value 19.1) (Table 1).

Table 1. Dynamics of T1DM prevalence in children per 100,000 pediatric population (2017–2024)

No	Regions	2017	2018	2019	2020	2021	2022	2023	2024
1	Republic of Uzbekistan	22,1	23,7	24,5	25,0	27,8	28,2	29,0	30,8
2	Republic of Karakalpakstan (RKK)	25,9	26,5	28,9	32,3	37,6	37,1	38,5	39,9
3	Andijan Region	19,3	20,5	18,7	16,4	17,8	20,9	24,2	21,4
4	Bukhara Region	27,7	31,0	27,1	32,9	37,1	34,4	37,7	37,7
5	Jizzakh Region	16,3	16,7	17,2	18,1	18,0	19,2	19,5	24,3
6	Kashkadarya Region	16,2	18,4	16,9	17,8	20,6	20,4	19,8	22,7
7	Navoi Region	18	16,8	19,0	19,6	23,1	22,4	25,9	27,2
8	Namangan Region	13,7	15,9	16,0	17,9	20,2	20,3	19,8	20,9
9	Samarkand Region	25	19,3	20,7	20,6	22,0	21,9	20,9	23,7

10	Surkhandarya Region	12,2	13,1	15,1	15,9	18,6	20,2	19,9	21,1
11	Syrdarya Region	25,9	35,3	37,3	29,1	31,4	29,8	35,7	37,2
12	Tashkent Region	34,6	38,0	43,6	40,8	46,3	46,7	48,5	48,5
13	Fergana Region	19	19,7	19,7	19,1	22,1	21,9	21,7	24,2
14	Khorezm Region	24,3	28,2	28,4	30,3	33,8	33,4	32,6	35,7
15	Tashkent City	44,7	47,5	51,4	55,3	58,1	60,4	63,4	69,5

The indicators among adolescents demonstrated a relatively greater increase in prevalence compared to children. In 2017, the prevalence rate was 51.5 per 100,000 adolescents, rising to 84.8 by 2024. The highest prevalence of type 1 diabetes mellitus, Tashkent Region (118.9), and Navoi Region (102.4). The lowest rates were registered in Surkhandarya (59.8) and Kashkadarya (59.0) regions. Over the study period, a positive trend was observed across all regions, with the greatest increase identified in the Republic of Karakalpakstan (RKK), where the prevalence rose from 40.9 in 2017 to 105 in 2024 (Table 2).

Table 2. Dynamics of T1DM prevalence among adolescents per 100,000 adolescent population

No	Regions	2017	2018	2019	2020	2021	2022	2023	2024
1	Republic of Uzbekistan	51.5	60.6	60.1	53.0	59.9	66.8	72.5	84.8
2	Republic of Karakalpakstan (RKK)	40.9	46.0	62.4	45.0	57.8	66.9	81.9	105
3	Andijan	46.3	56.7	59.0	59.4	59.8	61.1	59.2	79.3
4	Bukhara	94.1	99.0	69.5	50.8	59.5	52.9	60.6	66.9
5	Jizzakh	52.9	56.1	69.4	36.7	59.7	63.6	50.0	78.9
6	Kashkadarya	35.6	39.5	42.0	37.6	38.2	58.2	63.6	59.0
7	Navoi	41.6	51.5	51.5	61.6	63.2	77.6	74.3	102.4
8	Namangan	42.7	64.6	60.6	45.4	45.1	45.8	47.0	53.1
9	Samarkand	43.8	52.0	57.0	54.3	54.0	62.7	72.5	81.3
10	Surkhandarya	30.0	31.8	37.4	40.5	40.5	43.8	58.3	59.8
11	Syrdarya	46.4	64.1	86.3	53.5	49.8	74.5	74.3	97.7
12	Tashkent Region	87.5	122.4	86.1	77.5	99.3	99.6	94.3	118.9
13	Fergana	36.3	33.1	45.8	45.9	46.4	53.2	64.5	76.4
14	Khorezm	69.8	81.3	51.5	49.4	65.5	75.9	90.6	91.6
15	Tashkent City	82.7	81.5	99.8	89.6	109.8	119.7	129.4	149

On average, the prevalence rate of T1DM during the study period 2017–2024 was **26.4 per 100,000 children**, with an average annual increase of **4.7%**, whereas among adolescents the mean prevalence was **63.65 per 100,000 adolescents**, with an average annual increase of **7.57%** (Fig. 1).

3.2 Incidence

The incidence of type 1 diabetes mellitus (T1DM) among children in the Republic of Uzbekistan during the period 2017–2024 demonstrated a general upward trend. On

average, the incidence rate increased from 4.8 cases per 100,000 child population in 2017 to 6.3 in 2024 (Figure 2). The lowest incidence was recorded in 2018 (4.2 per 100,000), while the highest was observed in 2024 (6.3 per 100,000).

Among adolescents, the incidence rate varied between 7.2 and 11.0 cases per 100,000 during the study period. The highest incidence was observed in 2018 (11.0 per 100,000), and the lowest in 2020 (7.2 per 100,000). The mean incidence rate over the analyzed period was 9.3 cases per 100,000 adolescents. In recent years (2021–2024), the incidence among adolescents has shown relative stabilization, with minor fluctuations ranging from 8.7 to 10.2 cases per 100,000.

Annual fluctuations in incidence rates revealed notable regional differences. The highest incidence was observed in Tashkent City, where the rate increased from 10.2 cases per 100,000 children in 2017 to 16.4 in 2024. Elevated values were also registered in Tashkent (7.6–10.0) and Syrdarya (8.9–10.4) regions. The lowest incidence rates were reported in Surkhandarya (2.5–4.5) and Namangan (2.2–5.5) regions. In certain areas, variability was evident; for example, in Khorezm region the incidence rose from 2.9 in 2017 to 8.7 in 2024.

Overall, the average annual growth in incidence was 4.9%. The dynamics showed divergent trends: a decline in several regions during 2018–2019 was followed by a steady increase in subsequent years. The mean incidence rate for the study period was 5.3 cases per 100,000 children.

Table 3. Dynamics of type 1 diabetes mellitus (T1DM) incidence among children per 100,000 population in Uzbekistan (2017–2024)

No	Regions	2017	2018	2019	2020	2021	2022	2023	2024
1	Republic of Uzbekistan	4,8	4,2	4,7	5,4	5,6	5,7	5,3	6,3
2	Republic of Karakalpakstan (RKK)	6,1	4,9	6,8	7,8	8,0	7,8	6,6	9,2
3	Andijan	5,2	2,4	3,1	3,3	2,9	5,0	5,2	3,7
4	Bukhara	4,4	3,7	5,9	8,0	8,1	4,1	7,2	3,5
5	Jizzakh	4,3	2,7	2,9	4,1	5,6	3,9	4,0	6,3
6	Kashkadarya	3,5	4,3	2,8	3,1	3,4	3,5	2,8	3,8
7	Navoi	4,2	3,3	3,3	7,1	4,8	3,2	4,4	6,3
8	Namangan	2,2	3,8	2,9	3,4	3,6	3,2	3,1	5,5
9	Samarkand	4,3	2,6	3,0	3,3	3,7	6,4	4,2	6,2
10	Surkhandarya	2,5	2,9	3,5	4,2	4,5	4,3	2,6	4,1
11	Syrdarya	8,9	10,4	7,5	8,9	4,7	5,2	6,2	4,4
12	Tashkent Region	7,6	6,5	8,5	7,9	7,6	9,7	10,0	8,7
13	Fergana	4,2	2,5	3,7	5,0	4,7	4,3	3,4	4,3
14	Khorezm	2,9	4,5	7,3	5,7	6,9	6,3	5,5	8,7
15	Tashkent City	10,2	10,5	9,7	11,6	15,1	12,2	13,2	16,4

Table 4. Dynamics of type 1 diabetes mellitus (T1DM) incidence among adolescents per 100,000 population in Uzbekistan (2017–2024)

No	Regions	2017	2018	2019	2020	2021	2022	2023	2024
1	Republic of Uzbekistan	8,1	11,0	8,0	7,2	10,2	9,0	8,7	10,1
2	Republic of Karakalpakstan (RKK)	2,0	20,8	7,7	2,1	13,0	12,4	6,7	7,7
3	Andijan	10,7	9,8	3,8	5,9	6,6	8,7	8,5	4,3
4	Bukhara	10,5	8,2	22,4	15,4	12,9	5,5	13,8	5,3
5	Jizzakh	5,7	4,4	11,8	1,5	4,4	11,1	2,6	23,7
6	Kashkadarya	9,9	6,3	10,6	5,0	7,6	9,8	3,4	5,2
7	Navoi	13,9	9,4	2,3	4,6	6,7	21,0	6,0	14,1
8	Namangan	9,3	17,0	8,9	5,6	4,0	4,4	5,5	4,8
9	Samarkand	6,9	5,5	3,3	6,5	7,1	7,0	12,1	13,0
10	Surkhandarya	17,3	8,8	7,2	7,1	13,0	8,5	19,9	15,6
11	Syrdarya	4,9	17,3	12,3	12,2	7,4	15,8	10,6	14,9
12	Tashkent Region	10,2	35,4	6,4	7,0	13,9	7,3	6,8	6,8
13	Fergana	1,2	5,7	8,3	12,7	15,7	13,2	8,8	16,5
14	Khorezm	9,7	2,3	2,3	9,0	14,6	9,2	7,9	8,9
15	Tashkent City	2,0	7,1	10,2	6,7	12,8	4,8	5,9	8,1

In 2024, the highest incidence rates of T1DM among adolescents were registered in Fergana (16.5 per 100,000), Jizzakh (23.7 per 100,000), and Syrdarya (14.9 per 100,000) regions. The lowest incidence levels were observed in Namangan (4.8 per 100,000), Kashkadarya (5.2 per 100,000), and Tashkent region (6.8 per 100,000). Overall, an upward trend in incidence was noted across most regions, particularly during the period 2021–2024. A comparative analysis revealed a sharp increase in several regions. In Jizzakh region, the incidence rose dramatically from 2.6 per 100,000 in 2023 to 23.7 per 100,000 in 2024. Similarly, in Navoi region, the rate increased from 6.0 to 14.1 per 100,000 during the same period. In contrast, Bukhara region demonstrated a decline in incidence from 13.8 per 100,000 in 2023 to 5.3 per 100,000 in 2024.

The average incidence rate for the entire study period was 9.2 cases per 100,000 adolescents. The most stable indicators, with minimal fluctuations, were recorded in Tashkent region and the city of Tashkent.

According to Alimova N.U., in 2000 the prevalence of T1DM among children was 7.6 per 100,000 population, which gradually increased, reaching 19.8 per 100,000 by 2016. During the period 2017–2024, our observations confirmed the continuing rise: from 22.1 per 100,000 in 2017 to 30.8 per 100,000 children in 2024. Thus, over a 24-year period, the prevalence increased more than fourfold (from 7.6 to 30.8), indicating a substantial rise in the disease burden (Fig. 3).

The incidence of T1DM among children also demonstrated an upward trend, although annual fluctuations were more pronounced. From 1.7 per 100,000 in 2000, the rate increased to 4.1 in 2015, then slightly declined to 2.3 in 2016. In 2017, growth resumed (4.8) and continued, reaching 6.3 per 100,000 in 2024.

Thus, over a 24-year period, the incidence increased nearly 3.7-fold (from 1.7 to 6.3 per 100,000). (Figure 4)

4   Discussion

An analysis of the dynamics of type 1 diabetes mellitus (T1DM) prevalence among children and adolescents in the Republic of Uzbekistan for the period 2017–2024 revealed a consistent upward trend, with the increase among adolescents being significantly higher. While the average annual increase among children was 4.7%, this figure reached 7.57% in adolescents. Such a difference requires an in-depth analysis of pathogenetic mechanisms specific to adolescence.

The highest prevalence rates of T1DM among adolescents in 2024 were recorded in Tashkent city (149 per 100,000), Tashkent region (118.9), and Navoi region (102.4), which may be associated both with urbanization and improved detection, as well as with risk factors related to lifestyle and environmental conditions.

Particular attention should be paid to the significant increase observed in the Republic of Karakalpakstan, where T1DM prevalence among adolescents increased 2.6-fold during the study period (from 40.9 to 105), suggesting a considerable impact of regional factors and highlighting the need for further epidemiological research.

A comparison of retrospective data presented in the monograph by Alimova N.U. (before 2016) with the results of epidemiological monitoring for the period 2017–2024 demonstrated a marked upward trend in both the incidence and prevalence of T1DM among children in Uzbekistan [12]. According to Alimova N.U., in 2000 the prevalence of T1DM among children was 7.6 per 100,000 and gradually increased, reaching 19.8 by 2016. Based on our observations, this growth continued during 2017–2024, from 22.1 in 2017 to 30.8 per 100,000 children in 2024. Thus, over 24 years, prevalence increased more than fourfold (from 7.6 to 30.8), indicating a substantial increase in the disease burden.

The incidence of T1DM among children also showed an upward trend, although yearly fluctuations were more pronounced. From 1.7 per 100,000 in 2000, the rate rose to 4.1 in 2015, then slightly decreased to 2.3 in 2016. In 2017, growth resumed (4.8) and continued, reaching 6.3 per 100,000 in 2024. Overall, over 24 years, incidence nearly tripled (from 1.7 to 6.3 per 100,000). The highest values were recorded in 2024, 2022, and 2020 [12].

A similar rise in incidence has been reported in Turkey, where the incidence of T1DM among children nearly doubled over the past decade (from 8.3 to 15.8 per 100,000) [13]. In Kazakhstan, according to 2020 data, incidence was about 4.5 per 100,000, which is comparable to Uzbek data [14]. This trend aligns with global observations, as many countries, particularly those in Europe, report a rapid increase in T1DM incidence among pediatric populations [15, 16].

Some studies link the increase in T1DM incidence to the COVID-19 pandemic. A systematic review and meta-analysis including 42 studies demonstrated a higher incidence of T1DM among children and adolescents in the first two years of the pandemic

compared to the pre-pandemic period. Possible mechanisms include direct β-cell damage by SARS-CoV-2 as well as indirect factors such as lifestyle changes, increased stress, and reduced physical activity [17, 18]. However, other studies propose that increased incidence rates are a continuation of long-term trends, rather than solely attributable to the pandemic, suggesting a complex interplay of genetic and environmental factors [19].

However, definitive causal links and the long-term impact of the pandemic on T1DM epidemiology still require further comprehensive investigation. Indeed, projections indicate a continued global rise in T1D cases and prevalence, particularly among males, underscoring the urgent need for enhanced surveillance and preventive strategies [20]. further research is crucial to elucidate the specific drivers behind these trends and to develop targeted interventions, especially in high-incidence countries where rates are projected to increase through 2050.

5   Conclusions

To improve the situation, it is necessary to implement national diabetes registries, conduct multicenter epidemiological studies, and increase healthcare professionals' awareness of the importance of early diagnosis and timely treatment of T1DM. Based on reliable data, effective programs can be developed and implemented to reduce the incidence and improve the quality of life of patients with T1DM in Uzbekistan. A comparative analysis of the incidence and prevalence of type 1 diabetes mellitus (T1DM) among children in the Republic of Uzbekistan and worldwide shows that Uzbekistan's rates remain at the lower end of the global range but demonstrate a steady increase, consistent with global trends.

Data Availability Statement

The data supporting the reported results are available upon request from the corresponding author, subject to ethical and privacy restrictions.

Acknowledgments

We thank the staff of the Republican Specialized Scientific-Practical Medical Center of Endocrinology for their technical support during data collection.

Conflict of Interest

There is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

References

1. Hormazábal-Aguayo, I., Ezzatvar, Y., Huerta-Uribe, N., Ramírez-Vélez, R., Izquierdo, M., García-Hermoso, A.: Incidence of type 1 diabetes mellitus in children and adolescents under 20 years of age across 55 countries from 2000 to 2022: A systematic review with meta-analysis, (2023). https://doi.org/10.1002/dmrr.3749.
2. Lee, J.: Diagnosis and management of pediatric type 1 diabetes mellitus. Journal of Korean Medical Association. 64, 425 (2021). https://doi.org/10.5124/jkma.2021.64.6.425.
3. Duncan, B.B., Magliano, D.J., Boyko, E.J.: IDF Diabetes Atlas 11th edition 2025: global prevalence and projections for 2050. Nephrology Dialysis Transplantation. (2025). https://doi.org/10.1093/ndt/gfaf177.
4. Addissouky, T.A., Addissouky, T.A., Sayed, I.E.T.E., Wang, Y.: Type 1 diabetes mellitus: retrospect and prospect. Bulletin of the National Research Centre/Bulletin of the National Research Center. 48, (2024). https://doi.org/10.1186/s42269-024-01197-z.
5. Ghojazadeh, M., Mobasseri, M., Azar, F.P., Lotfi, A.: Prevalence and Incidence of Type 1 Diabetes in the World. In: IntechOpen eBooks. IntechOpen (2024). https://doi.org/10.5772/intechopen.1007015.
6. Ogle, G.D., James, S., Dabelea, D., Pihoker, C., Svennson, J., Maniam, J., Klatman, E., Patterson, C.C.: Global estimates of incidence of type 1 diabetes in children and adolescents: Results from the International Diabetes Federation Atlas, 10th edition. Diabetes Research and Clinical Practice. 183, 109083 (2021). https://doi.org/10.1016/j.diabres.2021.109083.
7. Magliano, D., J. Boyko, E.: IDF Diabetes Atlas. (2021).
8. Mandura, R.A., Attar, M.H., Alamoudi, R.A.: Diabetes Mellitus and Dental Health in Children: A Review of Literature, (2021). https://doi.org/10.5005/jp-journals-10005-2006.
9. Ogle, G.D., Wang, F., Haynes, A., Gregory, G.A., King, T.W., Deng, K., Dabelea, D., James, S., Jenkins, A.J., Li, X., C.W., R., Maahs, D.M., Oram, R.A., Pihoker, C., Svensson, J., Zhou, Z., Magliano, D.J., Maniam, J.: Global type 1 diabetes prevalence, incidence, and mortality estimates 2025: Results from the International diabetes Federation Atlas, 11th Edition, and the T1D Index Version 3.0. Diabetes Research and Clinical Practice. 225, 112277 (2025). https://doi.org/10.1016/j.diabres.2025.112277.
10. Gong, B., Yang, W., Xing, Y., Lai, Y., Shan, Z.: Global, regional, and national burden of type 1 diabetes in adolescents and young adults. Pediatric Research. (2024). https://doi.org/10.1038/s41390-024-03107-5.

11. Gomber, A., Ward, Z.J., Ross, C., Owais, M., Mita, C., Yeh, J.M., Reddy, C.L., Atun, R.: Variation in the incidence of type 1 diabetes mellitus in children and adolescents by world region and country income group: A scoping review, (2022). https://doi.org/10.1371/journal.pgph.0001099.

12. Alimova, N.U., Rakhimova, G.N.: Epidemiology and treatment of children and adolescents with type 1 diabetes in Uzbekistan during the registry study. (2025).

13. Dündar, İ., Akıncı, A., Çamtosun, E., Kayaş, L., Çiftçi, N., Özçetin, E.: Type 1 Diabetes Incidence Trends in a Cohort of Turkish Children and Youth. Turkish Archives of Pediatrics. 58, 539 (2023). https://doi.org/10.5152/turkarchpediatr.2023.23036.

14. Galiyeva, D., Syssoyev, D., Mussina, K., Gusmanov, A., Aimyshev, T., Atageldiyeva, K., Rakhimzhanova, M., Gaipov, A., Poddighe, D.: Epidemiology of type 1 diabetes mellitus in children in Kazakhstan: Data from unified national electronic health system 2014-2021. Electronic Journal of General Medicine. 20, (2023). https://doi.org/10.29333/ejgm/13663.

15. Niechciał, E., Michalak, M., Skowrońska, B., Fichna, P.: Increasing trend of childhood type 1 diabetes incidence: 20-year observation from Greater Poland Province, Poland. Acta Diabetologica. (2024). https://doi.org/10.1007/s00592-024-02339-5.

16. Głowińska-Olszewska, B., Szabłowski, M., Panas, P., Żołądek, K., Jamiołkowska, M., Milewska, A.J., Kadłubiska, A., Polkowska, A., Łuczyński, W., Bossowski, A.: Increasing Co-occurrence of Additional Autoimmune Disorders at Diabetes Type 1 Onset Among Children and Adolescents Diagnosed in Years 2010–2018—Single-Center Study. Frontiers in Endocrinology. 11, (2020). https://doi.org/10.3389/fendo.2020.00476.

17. D'Souza, D.M., Empringham, J., Pechlivanoglou, P., Uleryk, E., Cohen, E., Shulman, R.: Incidence of Diabetes in Children and Adolescents During the COVID-19 Pandemic. JAMA Network Open. 6, (2023). https://doi.org/10.1001/jamanetworkopen.2023.21281.

18. Kamrath, C., Holl, R.W., Rosenbauer, J.: Elucidating the Underlying Mechanisms of the Marked Increase in Childhood Type 1 Diabetes During the COVID-19 Pandemic—The Diabetes Pandemic. JAMA Network Open. 6, (2023). https://doi.org/10.1001/jamanetworkopen.2023.21231.

19. Bukara-Radujković, G., Miljković, V., Ljuboja, O.: Evidence of increasing incidence of type 1 diabetes and ketoacidosis among children in the Republic of Srpska in period 2017–2022 with special focus on COVID-19 global pandemic years. Frontiers in Public Health. 11, (2023). https://doi.org/10.3389/fpubh.2023.1264099.

20. Xie, J., Li, W., Li, X., Zhang, X., Liu, J., Liu, Z., Jing, S., Shao, H.: Global, regional, and national epidemiology of type 1 diabetes in children from 1990 to 2021: trend and health inequality analyses based on the Global Burden of Disease Study 2021. Diabetology & Metabolic Syndrome. 17, (2025). https://doi.org/10.1186/s13098-025-01905-3.