EPIDEMIOLOGY OF HOSPITALIZATIONS OF CHILDREN WITH ACUTE COMPLICATIONS OF TYPE 1 DIABETES: AGE, SEASONAL, AND WEEKLY ASPECTS

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1-ТУР ҚАНДЛИ ДИАБЕТНИНГ ЎТКИР АСОРАТЛАРИ БЎЛГАН БОЛАЛАРНИ КАСАЛХОНАГА ЁТҚИЗИШ ЭПИДЕМИОЛОГИЯСИ: ЁШ, МАВСУМИЙ ВА ҲАФТАЛИК ЖИҲАТЛАРИ

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ЭПИДЕМИОЛОГИЯ ГОСПИТАЛИЗАЦИИ ДЕТЕЙ С ОСТРЫМИ ОСЛОЖНЕНИЯМИ САХАРНОГО ДИАБЕТА 1 ТИПА: ВОЗРАСТНЫЕ, СЕЗОННЫЕ И НЕДЕЛЬНЫЕ АСПЕКТЫ

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Резюме. 2018–2023 йиллар давомида 1-тип қандли диабетнинг ўткир асоратлари сабабли болаларда кузатилган 1377 та госпитализация ҳолатининг ретроспектив таҳлили мавсумий ва ҳафталик қонуниятларни аниқлади. Госпитализациялар қиш мавсумида энг юқори, кузда эса энг паст даражада кузатилди (p < 0,0001). Бу ҳолат инфекцион касалланиш ва аутоиммун жараёнлар фаоллигининг мавсумий ўзгаришлари билан боғлиқ эканлиги аниқланди. Энг кўп госпитализация қилинган гуруҳ 12–18 ёшли ўсмирлар бўлган бўлса, биринчи марта ташхис қўйилган ҳолатлар кўпроқ кичик ёшдаги болалар орасида кузатилди (p < 0,0001). Ҳафтанинг бошида госпитализация қилиш ҳолатлари кўпроқ учраган. Ушбу натижалар профилактик чора-тадбирлар ишлаб чиқиш ва тиббий ёрдамни оптималлаштириш учун муҳим аҳамият касб этади.

Калит сўзлар: Қандли диабет, 1-тип, педиатрия, госпитализация, мавсумлар, ўсмир, бола, мактабгача ёш.

Abstract. A retrospective analysis of 1,377 pediatric hospitalizations due to acute complications of type 1 diabetes from 2018 to 2023 identified seasonal and weekly trends. Hospitalizations peaked in winter and were lowest in autumn (p < 0.0001), correlating with infectious morbidity and autoimmune activity. Adolescents (12–18 years) were most frequently hospitalized, while newly diagnosed cases were more common in younger children (p < 0.0001). Admissions were more frequent at the beginning of the week. These findings provide valuable insights for preventive strategies and healthcare optimization.

Keywords: Diabetes Mellitus, Type 1, Pediatrics, Hospitalization, Seasons, Adolescent, Child, Preschool.

Introduction. Type 1 diabetes is a chronic autoimmune disease characterized by the destruction of insulin-producing beta cells in the pancreas. It is one of the most common chronic diseases in childhood and adolescence, affecting millions of young people worldwide. Optimal management of type 1 diabetes is crucial to prevent acute complications such as diabetic ketoacidosis and hypoglycemia, as well as long-term complications affecting the eyes, kidneys, and nerves [1]. Hospitalizations due to acute complications represent a significant burden on patients, families, and healthcare systems, and are often preventable with appropriate diabetes management. This study investigates the factors associated with hospitalizations in children and adolescents with type 1 diabetes to identify potential areas for intervention and improve disease management. We hypothesize that younger age, longer diabetes duration, and suboptimal glycemic control are significant risk factors for hospitalization.

Age Risk Groups. Different age groups of children and adolescents experience T1D in unique ways. Young children (0–6 years) may have a more acute disease onset

due to metabolic adaptation challenges, whereas adolescents (12–18 years) often struggle with disease management due to hormonal changes, stress, and lifestyle factors. Analyzing hospitalization rates by age helps identify vulnerable groups that require special medical attention [2].

Seasonal Factors. Research indicates that seasonal factors influence T1D hospitalization rates. Increased hospitalizations in winter are associated with a rise in viral infections, which can exacerbate diabetes, while spring and autumn fluctuations may be linked to autoimmune activity [3]. Understanding these patterns can improve disease management strategies.

Hospitalization Trends by Weekdays. Studying the distribution of hospitalizations by day of the week provides insights into social and medical factors affecting patient admissions [12]. Hospitalizations tend to peak on weekdays, particularly at the beginning of the week, reflecting healthcare system workflows and parental decision-making patterns [4].

Materials and Methods. This retrospective cohort study analyzed data from medical records of the Republican Centre of Endocrinology from January, 2018 to December, 2023. The study population included children and adolescents aged 0-18 years with a diagnosis of type 1 diabetes. Patients with type 2, and other types of diabetes were excluded. Data collected included age, sex, date of admission, reason for DKA onset, diabetes duration, and length of stay. Patients' data were anonymized before processing. Statistical analysis was performed using SPSS data software V.23 with a significance level of $p<0.05$. Parametric variants are presented as Average±SD.

Data Analysis Methods:
- Age-based analysis of hospitalization distribution among different pediatric groups.
- Seasonal trend assessment by aggregating hospitalization data for winter, spring, summer, and autumn.
- Examination of weekday hospitalization patterns to identify trends.
- Visualization of data using graphs for clearer representation.

Results. A total of 1,377 children and adolescents with type 1 diabetes were included in the study. The mean age was 11.07±4.36 years. 18.0% of patients were 0-6 years of age, 29.2% were aged 7-11 years, and 52.8% of patients were teenagers aged 12-18 years. All patients were hospitalized with DKA. The average length of stay was 1.66±1.34 days.
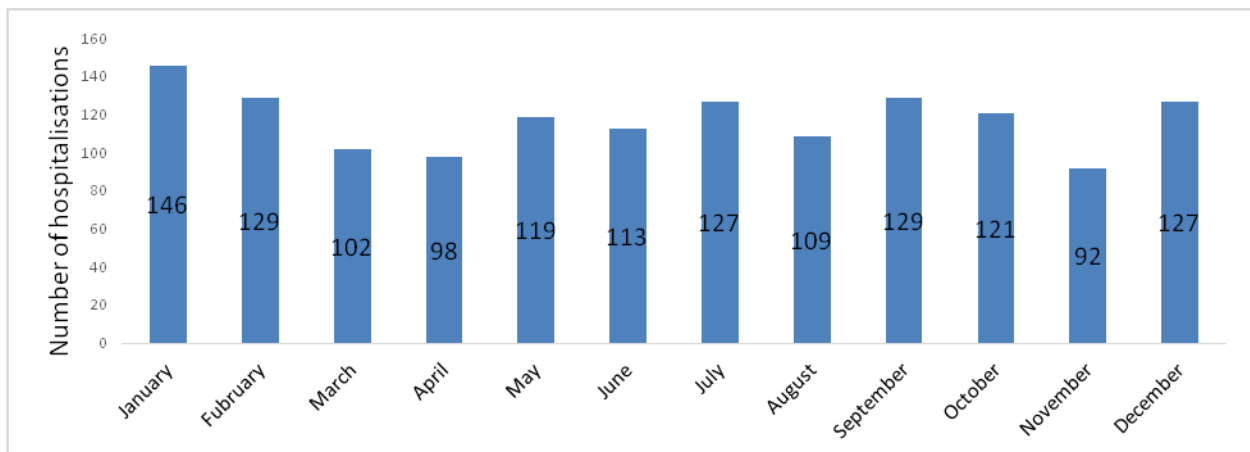
Age Distribution of Hospitalizations. 18.0% of patients were 0-6 years of age, 29.2% were aged 7-11 years, and 52.8% of patients were teenagers aged 12-18 years.
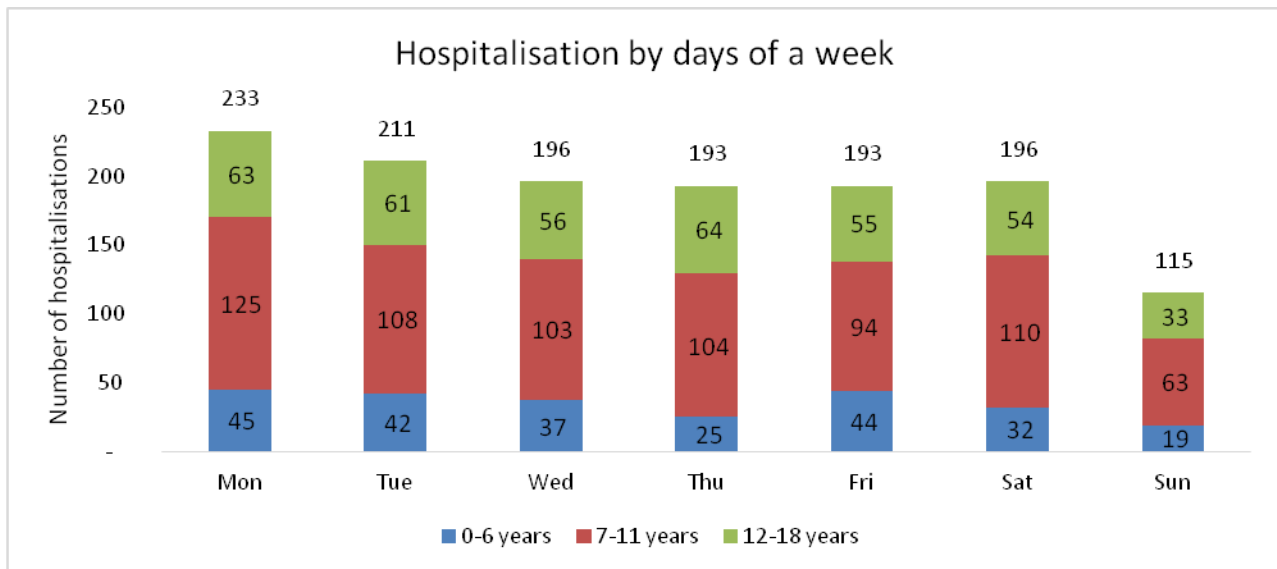
Table 1. Age Distribution of Hospitalizations

Age Group	Number of Hospitalizations	Average Length of Stay (days)
0-6 years	254	1.67 ± 1.15
7-11 years	413	1.82 ± 1.77
12-18 years	745	1.56 ± 1.09
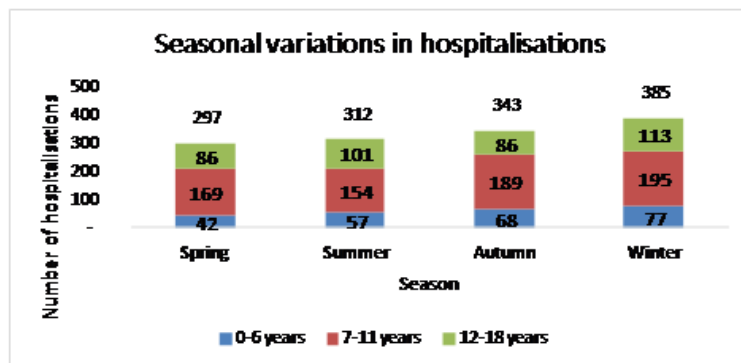
Fig. 1. Seasonality of hospitalizations due to acute complications of diabetes mellitus among children and adolescents

Fig. 2. Seasonality of hospitalizations for newly diagnosed diabetes mellitus among children and adolescents

Fig. 3. Distribution of hospitalizations of children and adolescents with acute complications of diabetes mellitus by days of the week

Table 2. Age and length od stay of children and teenagers with DKA depending to the diabetes duration

Group	N	Mean	SD	SE	95% CI (Lower)	95% CI (Upper)	p
Age - Known Diabetes	1,197	11.35	4.325	0.125	11.10	11.59	<0.0001
Age - Newly Diagnosed	214	9.49	4.226	0.289	8.92	10.06	
Length of Stay - Known Diabetes	926	1.65	1.365	0.045	1.56	1.73	0.549
Length of Stay - Newly Diagnosed	187	1.71	1.197	0.088	1.54	1.88	

Seasonal Variation in Hospitalizations. Data revealed a significant seasonal dependence in hospitalization frequency, with peaks in winter and autumn.

Possible contributing factors include:

• Increased viral infections in winter exacerbating diabetes control challenges [6].

• Lifestyle and daily routine changes in autumn due to school schedules, affecting adherence to treatment regimens [8].

Spring and summer saw relatively lower hospitalization rates, potentially due to more stable environmental conditions, reduced academic stress, and improved disease management facilitated by parental oversight during school holidays [14].

Newly Diagnosed T1D Cases and Seasonality. A pronounced seasonal trend was observed in the incidence of newly diagnosed T1D cases, with the highest hospitalizations in January and the lowest in November (p < 0.0001).

Hospitalization Distribution by Weekday. The distribution of hospitalizations by days of the week showed the expected trend: the largest number of hospital admissions occurs on weekdays, especially at the beginning of the week (Monday and Tuesday), while on weekends on Sundays the number of hospitalizations decreases (Fig. 4). [10].

It was found that the manifestation of type 1 diabetes mellitus in newly diagnosed patients occurs at an earlier age than in other hospitalized patients with diabetes (p < 0.0001). However, the duration of hospital stay between the groups does not differ significantly (p = 0.549).

Discussion. The highest hospitalization rate was among adolescents (12–18 years, 53%), followed by children aged 7–11 years (29%) and the youngest group (0–6 years, 18%). This trend highlights the challenges in diabetes management during puberty, including increased insulin resistance due to hormonal changes and the psychological and social factors affecting treatment adherence.

Puberty significantly affects the hormonal background of adolescents, leading to a sharp increase in insulin resistance, and worsening glycemic control [11]. Psychological and social aspects of adolescents' lives also affect treatment adherence [13]. Often, adolescents try to reduce the frequency of insulin injections or do not monitor their blood glucose levels in a timely manner, which can lead to weak diabetes control and, as a result, to the need for emergency hospitalization [9]. In younger children (0-6 years), the frequency of hospitalizations is lower, which may be due to the active involvement of parents in treatment management [7]. At the same time, younger children are more vulnerable to acute conditions such as diabetic ketoacidosis, which often causes hospitalization [5].

A pronounced seasonal trend was observed in the incidence of newly diagnosed T1D cases, with the highest hospitalizations in January and the lowest in November (p < 0.0001).

This could be attributed to:

• Increased respiratory infections in winter, potentially triggering autoimmune activity leading to β-cell destruction.

• Seasonal variations in vitamin D levels, which play a role in immune regulation, influencing autoimmune processes.

Hospitalization rates peaked on weekdays, especially on Mondays and Tuesdays, while weekend admissions were lower.

Possible reasons include:

• Greater availability of healthcare services on weekdays, facilitating hospital admissions.

• Parents opting to seek medical care at the beginning of the week rather than over the weekend.

The duration of hospital stay does not differ depending on the duration of diabetes. This may indicate the similarity of the treatment and diagnostic tactics and the course of the disease in hospital settings.

Our study has several limitations: the only source of data was the medical records of patients hospitalized with DKA to the Republican Centre of Endocrinology. Still, the Centre is the leading facility treating DKA, some cases may be missed due to hospitalization to other health care facilities and/or misdiagnosis.

Conclusions. Based on the analysis of hospitalization data of children with acute T1D complications, the following conclusions can be drawn:

1.Adolescents (12–18 years) have the highest hospitalization rates compared to younger age groups due to puberty-related metabolic and behavioral challenges. Educational programs for adolescents and parents should emphasize diabetes management strategies.

2.Winter and autumn are associated with the highest hospitalization rates, likely due to seasonal infections and lifestyle changes. Preventive initiatives should be reinforced before these seasons.

3.A significant seasonal trend was observed in new T1D diagnoses, with the highest incidence in January and the lowest in November. This pattern may be linked to increased viral infections, immune activity, and vitamin D deficiency.

4.Hospitalizations predominantly occur on weekdays, especially at the beginning of the week, reflecting healthcare system workflows and parental healthcare-seeking behaviors. Adjustments in healthcare schedules could improve emergency care services.

5.Newly diagnosed T1D patients tend to be younger than those with an existing diagnosis (9.49 ± 4.23 years vs. 11.35 ± 4.33 years, $p < 0.0001$). However, hospital stay duration did not significantly differ between the two groups ($p = 0.549$), suggesting similar treatment approaches.

6.These findings can be used to optimize healthcare planning and develop preventive programs aimed at reducing hospitalization rates and improving the quality of life for children and adolescents with T1D.

The authors declare they have no conflict of interest.

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ЭПИДЕМИОЛОГИЯ ГОСПИТАЛИЗАЦИИ ДЕТЕЙ С ОСТРЫМИ ОСЛОЖНЕНИЯМИ САХАРНОГО ДИАБЕТА 1 ТИПА: ВОЗРАСТНЫЕ, СЕЗОННЫЕ И НЕДЕЛЬНЫЕ АСПЕКТЫ

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Резюме. *Ретроспективный анализ 1377 госпитализаций детей с острыми осложнениями сахарного диабета 1 типа за период с 2018 по 2023 год позволил выявить сезонные и недельные закономерности. Частота госпитализаций достигала максимума зимой и была минимальной осенью ($p < 0,0001$), что коррелирует с сезонной инфекционной заболеваемостью и активностью аутоиммунных процессов. Наиболее часто госпитализировались подростки в возрасте от 12 до 18 лет, в то время как впервые выявленный диабет чаще встречался у детей младшего возраста ($p < 0,0001$). Госпитализации чаще происходили в начале недели. Полученные результаты представляют ценность для разработки профилактических мер и оптимизации медицинской помощи.*

Ключевые слова: *сахарный диабет 1 типа, педиатрия, госпитализация, сезоны года, подросток, ребенок, дошкольный возраст.*