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ORIGINAL ARTICLE

Comparison of diabetic ketoacidosis presentations before, during and after COVID-19 in pediatric patients in a hospital in Southern Brazil

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Abstract

Introduction: The COVID-19 pandemic led to changes in hospital care, as well as demands for these services, impacting the management of diseases such as Type 1 Diabetes Mellitus (T1DM). **Objective:** (1) to evaluate the incidence of diabetic ketoacidosis (DKA) in patients already diagnosed with T1DM at admission (group A) and in patients with first-time decompensation (group B); (2) to compare the presentations of DKA in groups A and B according to: age at diagnosis, severity of ketoacidosis, reason for decompensation, diagnostic delay, and relationship with SARS-CoV-2. **Methods:** observational, cross-sectional, retrospective, and descriptive study, obtaining 110 medical records of patients hospitalized with DKA between January 2019 and December 2023. **Results:** There were 16 cases in the pre-pandemic period, 75 during the pandemic, and 19 in the post-pandemic period. The time between symptom onset and diagnosis was 6.9 days in the post-pandemic period and 15.7 days during the pandemic. **Conclusions:** the COVID-19 pandemic impacted the incidence of diabetic ketoacidosis, increasing significantly during this period, with a predominance of group B, and a more discreet increase in the post-pandemic period, with a greater presence of group A. The time to diagnosis was shorter in the post-pandemic period. Decompensation was due to the omission of insulin doses. There were no significant changes in the mean age at diagnosis or severity of ketoacidosis cases, and no direct association with COVID-19 was observed.

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INTRODUCTION

The number of cases of Type 1 Diabetes Mellitus (T1DM) is increasing globally, and Brazil has been following this growth. This is due to the increase in the number of new cases diagnosed, as well as the increase in the survival rate of these patients.[1]

During the COVID-19 pandemic, there were changes in the dynamics of hospital care and patients' demand for these services, resulting from social distancing policies, directly impacting the follow-up of various medical conditions, including T1DM.[2]

Given the pandemic context, some studies around the world were carried out correlating it with DKA presentations; these showed data such as increased severity and incidence,[3, 4, 5, 6, 7, 8] decreases in age at diagnosis of T1DM (at hospitalization for diabetic ketoacidosis [DKA])[9, 10] and delay in diagnosis associated with greater severity.[11]

Considering the results of previous studies and being aware that each location had its particularities, the present work aims to evaluate how the COVID-19 pandemic impacted the presence of DKA in a specific city in the South of Brazil.

The specific objectives of this work were (1) to evaluate the incidence of DKA in patients already diagnosed with T1DM at admission (group A) and in patients with first-time decompensation (group B); (2) to compare the presentations of DKA in groups A and B, in the pre-, during, and post-pandemic periods, based on the following parameters: age at diagnosis, severity of ketoacidosis, reason for decompensation, time elapsed between the onset of symptoms and diagnosis (for group B), and whether there was a relationship with SARS-CoV-2 infection.

METHOD

This is an observational study of a fundamental nature with data collection, cross-sectional, retrospective, and descriptive.

The sample included all patients with DKA between January 1, 2019, and December 31, 2023, treated at a pediatric hospital in Southern Brazil. These children were divided into groups A and B for comparison purposes, with group A being patients previously diagnosed with T1DM at admission and group B being those diagnosed with T1DM at admission due to DKA. A research protocol collected data from electronic medical records in the TASY system, provided by the faithful guardian, excluding personal data that could identify the patient.

The electronic DKA records were selected by searching ICD (International Statistical Classification of Diseases and Related Health Problems) E10, E100, E101, and E109. From 2020 onwards, data collection was also based on medical opinion responses by a pediatric endocrinologist at that institution.

The data collected were: dates of birth and hospitalization to calculate the decimal age; sex; age group; approximate time between the onset of symptoms and diagnosis (group B); the reason for DKA [new diagnosis (1), decompensation due to infection (2), missed doses (of insulin) (3), psychological stress (4), surgical stress (5), inadequate nutrition (6), inadequate follow-up (7) or unknown (8)], laboratory tests upon hospital admission (glycemia, pH, bicarbonate, *base excess* and PCO2) and tests for COVID-19 (not performed, positive, negative).

To establish the diagnosis of DKA, we used the criteria of the International Society of Pediatric and Adolescent Diabetes[12] (ISPAD), which includes hyperglycemia (>11mmol/L or 200mg/dL), venous pH <7.3 or serum bicarbonate <18mmol/L and ketonemia or ketonuria. We also graded severity, according to the ISPAD[12] criteria, as mild (venous pH < 7.3 or serum bicarbonate <18 mmol/L), moderate (pH < 7.2 or serum bicarbonate <10 mmol/L), or severe (pH < 7.1 or serum bicarbonate < 5 mmol/L).

The study was analyzed by comparing data from the pre-, during, and post-pandemic periods to determine whether there was a difference in CAD patterns. These periods were defined based on World Health Organization data, which considers March 11, 2020, and May 5, 2023, as the beginning and end of the pandemic, respectively.[13, 14] It is worth highlighting, in this sense, that the pre-pandemic sample represents a period of 1 year and two months (January 2019 to the beginning of March 2020), the sample during the pandemic covers a period of 3 years and two months (beginning of March 2020 to May 2023) and the post-pandemic period, lasting eight months (May 2023 to December of the same year). For analysis purposes, the periods were converted into decimal years; thus, the pre-pandemic period corresponds to 1.2 years, the pandemic period to 3.1 years, and the post-pandemic period to 0.7 years. Therefore, comparing the number of DKA cases in each period was also converted to the annual average (number of cases/year).

The data obtained were recorded in Microsoft Excel® spreadsheets and analyzed using descriptive statistics to present the results with mean and standard deviation calculation, median, and frequencies. The t-test and the chi-square test for categorical variables were used to calculate numerical variables.

The study was approved by the Ethics Committee on September 5, 2023, with opinion number 6.283.461.

RESULTS

Data from 119 medical records were collected and analyzed between 2019 and 2023, of which 110 had DKA upon admission, and the other nine, despite having typical DKA conditions when admitted, no longer met the ISPAD laboratory parameters, being excluded from the analysis. Of these 110, we obtained 16 in the pre-pandemic period

(an annual average of 13.3 cases), 75 during the pandemic period (a yearly average of 24.1 cases), and 19 in the post-pandemic period (an annual average of 27.1 cases). From the point of view of the incidence of total DKA cases, an increase of 81.20% in the number of yearly cases (13.3 to 24.1) was evidenced during the pandemic years and the pre-pandemic period. Moreover, from the pandemic to the post-pandemic period, there was an increase in the incidence of total cases by 12.25% (24.1 to 27.1).

To analyze the statistical relevance of variations in the incidence of DKA between groups A and B, the sample from the pre-pandemic period was excluded due to the number of cases being equal in that period (eight in each group), which would generate a chi-square test with bias. That said, we first compared the difference between groups A and B in the pandemic period (with group A having eight cases and group B with 17 cases, on average, per year) and in the post-pandemic period (group A with 12 instances and group B with seven cases, on average, per year).

When we compare the difference in the number of cases in a group in different periods, we see that in A, there was a significant increase from the pandemic period to the post-pandemic period (from seven to 12 cases, respectively). Moreover, in group B, there was an increase from the pre-pandemic to the pandemic period (from eight to 17 cases, on average, per year, respectively) and, subsequently, a significant reduction in cases in the post-pandemic period (from 17 to seven cases, respectively), $p<0.050$ by the chi-square test.

Regardless of the period analyzed, the main reason for decompensation in patients in group A was "missed doses" (Table 1). Moreover, this factor was also more prevalent among adolescents (chi-square, $p<0.001$).

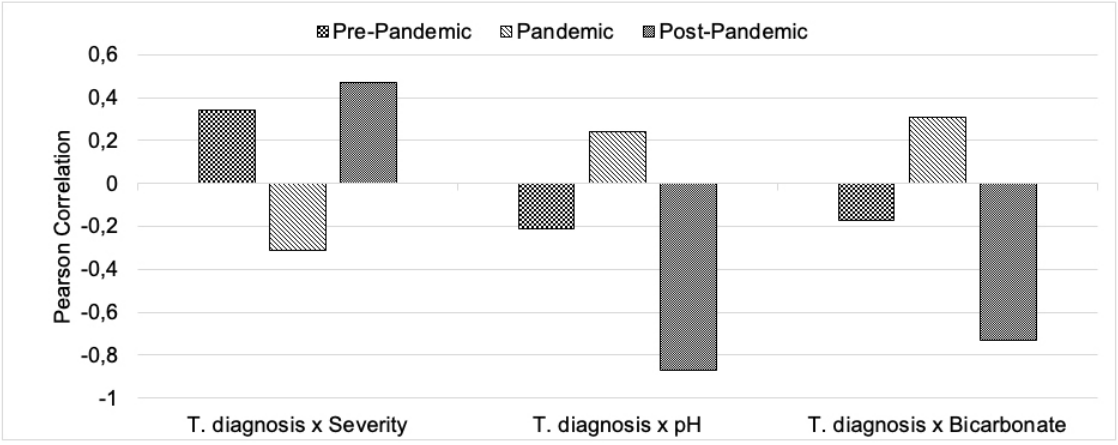
The time elapsed between the onset of symptoms and diagnosis remained constant between the pre-pandemic and pandemic periods (14.6 and 15.7 days, respectively), with a significant reduction in the post-pandemic period (6.9 days) by "t" test ($p<0.050$). However, correlating the diagnostic time with the severity of DKA cases, no correlation was observed between the variables (Graph 1).

Regarding the age of patients in group B, no significant difference was observed (t-test, $p>0.050$) between the periods, with the average age varying from 7.4 to 8.4 years.

Table 1 – Triggering factors for hospitalization due to DKA in the periods before, during, and after the COVID-19 pandemic in a pediatric hospital in Southern Brazil, 2023 (n= 110).

CAD triggers	Pre-pandemic n (%)	Pandemic n (%)	Post-pandemic n (%)
New diagnosis	8 (50,00)	52 (69,33)	7 (33,33)
Infection	0 (0,00)	1 (1,33)	0 (0,00)
Missed doses	5 (31,25)	14 (18,67)	8 (44,44)
Psychological stress	0 (0,00)	1 (1,33)	0 (0,00)
Surgical stress	0 (0,00)	0 (0,00)	0 (0,00)
Inadequate nutrition	2 (12,50)	2 (2,67)	0 (0,00)
Inadequate follow-up	0 (0,00)	1 (1,33)	2 (11,11)
Unknown	1 (6,25)	4 (5,33)	2 (11,11)

N: sample number of patients.



Graph 1 – Time (T.) to diagnosis of DM1 compared to laboratory criteria for DKA severity, before, during, and after the COVID-19 pandemic, in a pediatric hospital in Southern Brazil, 2023.

There was no significant difference in the severity of DKA between the three periods analyzed (Graph 2).

Finally, among the patients studied, there were no suspected respiratory infections or contact with individuals possibly infected by SARS-CoV-2. Therefore, no tests were requested to detect COVID-19.

DISCUSSION

In this work, we observed an increase in the incidence of DKA (mainly during the pandemic period) and a decrease in the time elapsed between the onset of symptoms and diagnosis in the post-pandemic period. Regarding the reasons for DKA, during the pandemic, cases of primary decompensation (group B) predominated, and in the post-pandemic period, cases of decompensation (group A). Regardless of the period evaluated, missed doses were the leading cause of decompensation.

Throughout the pandemic, studies were carried out worldwide to evaluate the dynamics of DKA cases in the new scenario. The results obtained showed an impact on the presentation of ketoacidosis, such as increased severity and incidence, [3, 4, 5, 6, 7, 8] younger age at diagnosis of DM1[9, 10] and diagnostic delays linked to more significant.[11]

A survey in the USA showed an increase in the severity of DKA in patients previously diagnosed with DM1 upon admission.[3] In Türkiye, there was an increase in the frequency of hospitalization due to DKA in cases of primary decompensation.[5] In Spain, two studies demonstrated a higher frequency of new diagnoses of DM1 in younger children compared to previous years.[9, 10]

In Italy, there was a decrease in the number of patients hospitalized for DKA. However, those admitted had more severe conditions, attributing this to a possible diagnostic delay. [11]

In a multicenter study in the United Kingdom, although some children hospitalized for DKA tested positive for COVID-19, no clinical correlation was observed between the two diseases. However, the possibility that DKA was triggered by previous exposure to the virus cannot be excluded.[15]

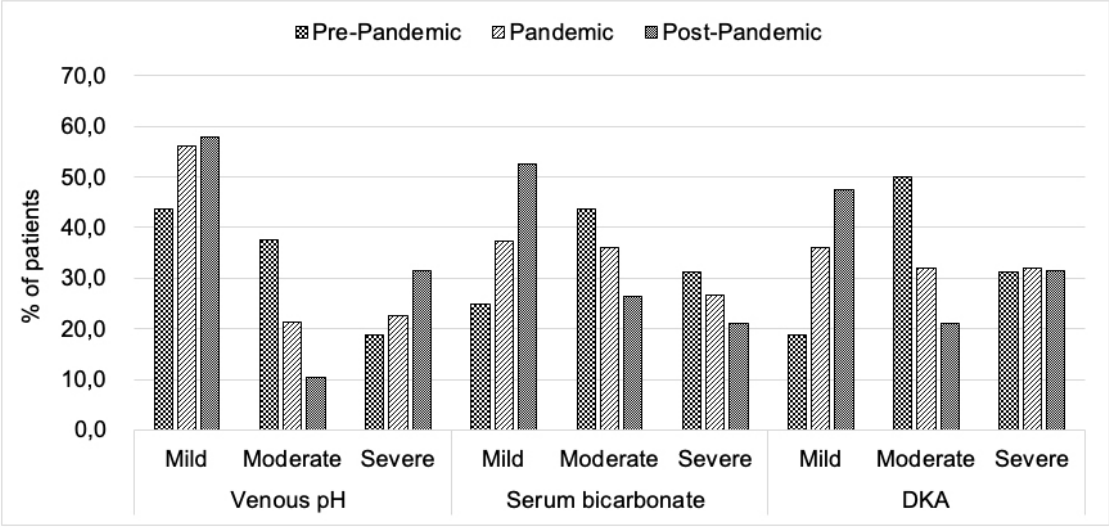
It is also important to highlight a systematic review, with meta-analysis, of cohort studies, carried out in the USA, Norway, Scotland, and Denmark, in which a 42% higher risk of developing DM1 was observed after SARS-CoV-2 infection, only in the group of American patients aged between 0 and 11 years, when compared to non-infected patients.[16]

In the present study, unlike the studies above, no statistically significant changes were observed in the average age at diagnosis or greater severity of DKA episodes throughout the periods analyzed.

Regarding the time elapsed between the onset of symptoms and diagnosis, a decrease in values was evident in the post-pandemic period; during this period, children were taken to the health service earlier. Some hypotheses raised about the possible factors involved were greater access to information on the part of parents, greater awareness and sensitivity to health issues (due to having recently gone through a pandemic), and, perhaps one of the most critical factors, the fact that the pandemic has already passed, making parents feel more comfortable in resorting to health services in the early stages of symptoms.

Although the time between the onset of symptoms and the diagnosis of DM1 was shorter in the post-pandemic period, there was no impact on the classification of DKA severity, even though the pH and bicarbonate values were higher (Graph 1).

When analyzing Graph 1, the negative results show an inversely proportional relationship, and the positive values show a proportional relationship; it can be seen that, during



Graph 2 - Classification of laboratory parameters of diabetic ketoacidosis (DKA) severity before, during, and after the COVID-19 pandemic in a pediatric hospital in Southern Brazil, 2023.

the pandemic, there was an inverse relationship between diagnostic delay and severity, which does not make sense from the pathophysiological point of view. This inversion of proportion is due to two patients who, according to information from their parents, had had symptoms for 60 days; however, according to their blood gas values, they were classified as mild DKA.

Regardless of the period analyzed, the main reason for treatment decompensation and progression to DKA in group, A patients, was the omission of insulin doses (Table1). There was no detail as to whether it was due to negligence, lack of understanding about dose management, or difficulty accessing the medication (especially during the pandemic). However, there was no shortage of insulin at any time.

When comparing the factor "missed doses" and the age group, we observed a higher frequency among adolescents, to whom the responsibility for treatment is usually delegated, even though this is often not feasible. Thus, we can infer that the omission of insulin therapy is something more related to the adolescent's self-care, which may vary according to their self-esteem, body weight (purposeful omission to lose weight), and shame from peers since insulin needs to be used in school environment.[17, 18, 19] In this way, the importance of raising family and patient awareness regarding reasonable glycemic control becomes clear, offering them adequate instruction, support, and attention, directly impacting the adolescent's process of autonomy in self-care.[20]

About the incidence of total cases, an increase of 81.20% was observed during the pandemic period. In the post-pandemic period, there was a more discreet increase in total cases of 12.45%. However, it is essential to highlight that the collection time for the last period was shorter than that of the previous ones.

When comparing the incidence of DKA between groups A and B, there was no difference in the pre-pandemic period. During the pandemic, there was a 38% increase in DKA hospitalizations due to primary decompensation (50% in 2019 vs 69% in 2020). This data is in line with the findings of other studies, such as in Turkey (54.9% in 2019 vs. 63.5% in 2020)[5], Germany (24.5% in 2019 vs. 44.7% in 2020)[6] and Canada (45.6% in 2019 vs 68.2% in 2020).[8] A possible explanation found by these and other previous studies was that the cause was linked to an increase in the time between the onset of symptoms and the diagnosis.[11]

This relationship makes sense when DM1 diagnoses are mainly carried out on an outpatient basis (before there is an acute complication); therefore, if there was a higher incidence of DKA, it is possible that it was due to a delayed diagnosis. However, in our service, even before the pandemic, most children already had DKA leading to DM1; therefore, the "time between the onset of symptoms and diagnosis" would not impact the incidence, as these patients would invariably need hospitalization. This fact was confirmed when we found no significant difference between the periods analyzed regarding the time elapsed for diagnosing DM1.

This tendency towards the presence of DKA in the diagnosis of DM1 in our region is probably due to the socioeconomic context. Brazil has CAD rates ranging from 42.3% to 58.8%[21, 22], compared to 31.1% to 35.6%[23, 24] in developed countries. Socioeconomic factors include lower family income, low education, lack of access to health care, and poor health service quality.[25, 26, 27]

Another hypothesis, also based on previous studies, would be that SARS-CoV-2 infection may have triggered some of the primary decompensations of DM1.[15, 16, 28] It is not yet known for sure whether pancreatic damage is caused directly due to the cytopathic effect of the virus, or indirectly, caused by a high systemic inflammatory response in the severe form of COVID-19.[5]

In the post-pandemic period, cases of decompensation predominated, with 63.16% (group A), while the number of primary decompensations decreased, with 36.84% (group B). Considering that the biggest reason for decompensation is the omission of doses and that the primary age group related to this event is adolescents, it is possible to infer that there was worse adherence to treatment, especially among this group. However, the reasons for this event remain unknown.

Although some studies cite a possible association between DKA and SARS-CoV-2 co-infection, our research could not confirm these data. As they did not present respiratory symptoms or close contact with people with COVID-19, the patients were not subjected to tests to confirm the disease upon admission to the hospital. This finding suggests that there was no relationship between the variables, or, if there was, it occurred in asymptomatic patients.[15]

It is essential to highlight that SARS-CoV-2 has become a seasonal virus in our country. Therefore, a better assessment of its correlation with the precipitation/decompensation of DM1 is relevant, evaluating it as a possible risk factor.

As limitations of the present study, we can mention the retrospective data collection, the non-mandatory inclusion of the ketoacidosis ICD in the hospitalization document until 2019, the failure to carry out tests for COVID-19; the lack of data regarding the history of possible contamination before CAD with SARS-CoV-2, and the relatively short comparison time in the pre-and post-pandemic periods, not excluding the possibility that they represent a random variation.

In our study, we concluded that there were no significant changes in the average age of new DM1 cases or the severity of DKA cases between the periods evaluated. There was an increase in the incidence of DKA during the pandemic period, with a predominance of primary decompensation. Post-pandemic, the incidence reduced, and decompensation in previously diagnosed patients predominated, suggesting a loss of treatment adherence. A significant difference was observed in the time elapsed between the onset of symptoms and the diagnosis of DM1, which was shorter in the post-pandemic period, possibly associated with greater comfort among families in seeking medical care. Among

patients already undergoing treatment, the main reason for decompensation and hospitalization due to DKA was the omission of insulin doses, this factor being more frequent in the group of adolescents. Regarding COVID-19 tests, as we do not have any cases of DKA associated with SARS-CoV-2 infection documented, it is suggested that there was no relationship between the variables.

ADDITIONAL INFORMATION

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Conflicts of interest: The authors declare that there are no conflicts of interest.

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REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021 [cited 2024 Nov 1]. Available from: https://diabetesatlas.org/atlas/tenth-edition/
2. Conselho Nacional de Saúde. Covid-19 provoca impacto negativo na vida das pessoas com doenças crônicas e patologias. Brasília: Conselho Nacional de Saúde; 2020 [cited 2024 Oct 26]. Available from: https://www.gov.br/conselho-nacional-de-saude/pt-br/assuntos/noticias/2020/julho/covid-19-provoca-impacto-negativo-na-vida-das-pessoas-com-doencas-cronicas-e-patologias
3. Gera S, Longendyke RL, Minich NM, Malay S, Wood JR. The COVID-19 pandemic and associated worsening of diabetic ketoacidosis presentation in youth. Diabet Med. 2021;38(10):e14610. doi: http://www.doi.org/10.1111/dme.14610
4. Lawrence C, Seckold R, Smart C, King BR, Howley P, Feltrin R, et al. Increased paediatric presentations of severe diabetic ketoacidosis in an Australian tertiary centre during the COVID-19 pandemic. Diabet Med. 2021;38(1):e14417. doi: http://www.doi.org/10.1111/dme.14417
5. Kiral E, Kirel B, Havan M, Keskin M, Karaoglan M, Yildirim A, et al. Increased severe cases and new-onset type 1 diabetes among children presenting with diabetic ketoacidosis during first year of COVID-19 pandemic in Turkey. Front Pediatr. 2022;10:926013. doi: http://www.doi.org/10.3389/fped.2022.926013
6. Kamrath C, Mönkemöller K, Biester T, Rohrer TR, Warncke K, Hammersen J, et al. Ketoacidosis in children and adolescents with newly diagnosed type 1 diabetes during the COVID-19 pandemic in Germany. JAMA. 2020;324(8):801-804. doi: http://www.doi.org/10.1001/jama.2020.13445
7. Wu S, Gao Y, Guo S, Fu L, Ying Y, Wu W, et al. Characterization of newly diagnosed type 1 diabetes in children and adolescents from 2017 to 2022 in China: a single-center analysis. BMC Pediatr. 2024;24(1):13. doi: http://www.doi.org/10.1186/s12887-023-04498-w
8. Ho J, Rosolowsky E, Pacaud D, Huang C, Lemay JA, Brockman N, et al. Diabetic ketoacidosis at type 1 diabetes diagnosis in children during the COVID-19 pandemic. Pediatr Diabetes. 2021;22(4):552-557. doi: http://www.doi.org/10.1111/pedi.13205
9. Leiva-Gea I, Antúnez-Fernández C, Cardona-Hernandez R, Ferrer-Lozano M, Bahíllo-Curieses P, Arroyo-Díez J, et al. Increased presentation of diabetic ketoacidosis and changes in age and month of type 1 diabetes at onset during the COVID-19 pandemic in Spain. J Clin Med. 2022;11(15):4338. doi: http://www.doi.org/10.3390/jcm11154338
10. Güemes M, Storch-de-Gracia P, Enriquez SV, Martín-Rivada Á, Brabin AG, Argente J. Severity in pediatric type 1 diabetes mellitus debut during the COVID-19 pandemic. J Pediatr Endocrinol Metab. 2020;33(12):1601-1603. doi: http://www.doi.org/10.1515/jpem-2020-0481
11. Rabbone I, Schiaffini R, Cherubini V, Maffeis C, Scaramuzza A, Bertelli E, et al. Has COVID-19 delayed the diagnosis and worsened the presentation of type 1 diabetes in children? Diabetes Care. 2020;43(11):2870-2872. doi: http://www.doi.org/10.2337/dc20-1321
12. Glaser N, Fritsch M, Priyambada L, Rewers A, Cherubini V, Estrada S, et al. ISPAD clinical practice consensus guidelines 2022: diabetic ketoacidosis and hyperglycemic hyperosmolar state. Pediatr Diabetes. 2022;23(7):835-856. doi: http://www.doi.org/10.1111/pedi.13406
13. Pan American Health Organization. Histórico da pandemia de COVID-19. [cited 2024 Oct 26]. Available from: https://www.paho.org/pt/covid19/historico-da-pandemia-covid-19
14. Pan American Health Organization. OMS declara fim da Emergência de Saúde Pública de Importância Internacional referente à COVID-19. 2023 [cited 2024 Oct 26]. Available from: https://www.paho.org/pt/noticias/5-5-2023-oms-declara-fim-da-emergencia-saude-publica-importancia-internacional-referente
15. Unsworth R, Wallace S, Oliver NS, Yeung S, Kshirsagar A, Naidu H, et al. New-onset type 1 diabetes in children during COVID-19: multicenter regional findings in the U.K. Diabetes Care. 2020;43(11):e170-e171. doi: http://www.doi.org/10.2337/dc20-1551
16. Rahmati M, Yon DK, Lee SW, Udeh R, McEvoy M, Kim MS, et al. New-onset type 1 diabetes in children and adolescents as postacute sequelae of SARS-CoV-2 infection: a systematic review and meta-analysis of cohort studies. J Med Virol. 2023;95(6):e28833. doi: http://www.doi.org/10.1002/jmv.28833
17. Sociedade Brasileira de Diabetes. Diretrizes da Sociedade Brasileira de Diabetes 2019-2020. São Paulo: Clannad; 2019 [cited 2024 Nov 1]. Available from: https://www.saude.ba.gov.br/wp-content/uploads/2020/02/Diretrizes-Sociedade-Brasileira-de-Diabetes-2019-2020.pdf
18. Rausch JR, Hood KK, Delamater A, Pendley JS, Rohan JM, Reeves G, et al. Changes in treatment adherence and glycemic control during the transition to adolescence in type 1 diabetes. Diabetes Care. 2012;35(6):1219-1224. doi: http://www.doi.org/10.2337/dc11-2163
19. Ouzouni A, Galli-Tsinopoulou A, Kazakos K, Lavdaniti M. Adolescents with type 1 diabetes: psychological and behavioral problems and compliance with treatment. Int J Caring Sci. 2019;12(2):1183-1190 [cited 2024 Nov 1]. Available from: https://www.internationaljournalofcaringsciences.org/docs/84_.ouzouni_special_12_2.pdf
20. Collet N, Fernandes A, Medeiros V, Teixeira MH, Teixeira LT. Self-care support for the management of type 1 diabetes during the transition from childhood to adolescence. Rev Esc Enferm USP. 2018;52:e03376. doi: http://www.doi.org/10.1590/S1980-220X2017038503376
21. Negrato CA, Cobas RA, Gomes MB. Temporal changes in the diagnosis of type 1 diabetes by diabetic ketoacidosis in Brazil: a nationwide survey. Diabet Med. 2012;29(9):1142-1147. doi: http://www.doi.org/10.1111/j.1464-5491.2012.03590.x
22. Souza LCVF, Kraemer GC, Koliski A, Carreiro JE, Cat MNL, Lacerda LD, et al. Diabetic ketoacidosis as the initial presentation of type 1 diabetes in children and adolescents: epidemiological study in southern Brazil. Rev Paul Pediatr. 2020;38:e2018204. doi: http://www.doi.org/10.1590/1984-0462/2020/38/2018204
23. Eyal O, Oren A, Almasi-Wolker D, Tenenbaum-Rakover Y, Rachmiel M, Weintrob N. Ketoacidosis in newly diagnosed type 1 diabetes in children and adolescents in Israel: prevalence and risk factors. Isr Med Assoc J. 2018;20(2):100-103 [cited 2024 Nov 1]. Available from: https://pubmed.ncbi.nlm.nih.gov/29431304/

24. Dabelea D, Rewers A, Stafford JM, Standiford DA, Lawrence JM, Saydah S, et al. Trends in the prevalence of ketoacidosis at diabetes diagnosis: the SEARCH for Diabetes in Youth Study. Pediatrics. 2014;133(4):e938-e945. doi: http://www.doi.org/10.1542/peds.2013-2795

25. Ramos TTO, Noronha JAF, Lins BS, Santos MCQ, Santos SMP, Cantalice ASC. Diabetic ketoacidosis in children and adolescents with type 1 diabetes mellitus and associated risk factors. Cogitare Enferm. 2022;27:e87274. doi: http://www.doi.org/10.5380/ce.v27i0.87274

26. Duca LM, Reboussin BA, Pihoker C, Imperatore G, Saydah S, Mayer-Davis EJ, et al. Diabetic ketoacidosis at diagnosis of type 1 diabetes and glycemic control over time: the SEARCH for Diabetes in Youth Study. Pediatr Diabetes. 2019;20(2):172-179. doi: http://www.doi.org/10.1111/pedi.12809

27. Lindner LME, Gontscharuk V, Bächle C, Castillo K, Stahl-Pehe A, Tönnies T, et al. Severe hypoglycemia and diabetic ketoacidosis in young persons with preschool onset of type 1 diabetes mellitus: an analysis of three nationwide population-based surveys. Pediatr Diabetes. 2018;19(4):713-720. doi: http://www.doi.org/10.1111/pedi.12628

28. Rahmati M, Keshvari M, Mirnasuri S, Yon DK, Lee SW, Shin JI, et al. The global impact of COVID-19 pandemic on the incidence of pediatric new-onset type 1 diabetes and ketoacidosis: a systematic review and meta-analysis. J Med Virol. 2022;94(11):5112-5127. doi: http://www.doi.org/10.1002/jmv.27996