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Original article

Type 1 Diabetes Mellitus in the COVID-19 Era: A Descriptive Cross-Sectional Study from Al-Jabal Al-Akhdar, Libya

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Abstract
Type 1 diabetes mellitus (T1DM) requires lifelong insulin therapy. The coronavirus disease 2019 (COVID-19) pandemic may have affected diabetes presentation and care directly through infection and indirectly through disrupted access to health services. This study described selected clinical characteristics of people with T1DM followed at a government diabetes center in eastern Libya and examined the temporal context of COVID-19 in the available records. We conducted a retrospective, descriptive cross-sectional review of 126 records from the Educational Diabetes Center in Al-Jabal Al-Akhdar, Libya, covering November 2017 through March 2022. The source data did not indicate whether the 126 records represented unique individuals or included repeat visits; therefore, all denominators are record-based. The analysis summarized counts and percentages, and calendar-period counts were also expressed as averages per observed month to account for the partial coverage of 2017 and 2022. No inferential tests were performed. Of 126 records, 51 (40.5%) were dated 2021, equivalent to 4.25 records per observed month. Renal impairment was recorded in 6 records (4.8%), myopia in 17 (13.5%), a previous viral infection in 2 (1.6%), an associated condition in 2 (1.6%), injection-site lipodystrophy in 1 (0.8%), and hyperlipidemia in 2 (1.6%). A family history of confirmed COVID-19 before diabetes onset was recorded in 3 records (2.4%); all described female patients who reportedly presented with diabetic ketoacidosis approximately three months after the family infection. The dataset documents a small number of T1DM presentations after reported household COVID-19 exposure. Because exposure was based on family history, patient infection was not established, record uniqueness could not be verified, and the design lacked a population denominator or non-T1DM control group, the findings do not demonstrate that COVID-19 caused or increased the risk of T1DM. Larger controlled studies with verified exposure and standardized outcome definitions are required.
Keywords. Type 1 Diabetes Mellitus, COVID-19, Diabetic Ketoacidosis, Children, Libya, Medical-Record Review.

Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by impaired glucose regulation. In T1DM, immune-mediated destruction of pancreatic beta cells produces an absolute insulin deficiency, making exogenous insulin essential for survival [1]. T1DM is an important health concern in children and adolescents, and its incidence has increased in many populations over recent decades [2,3]. Its etiology is multifactorial and reflects interactions among genetic susceptibility, immune mechanisms, and environmental exposures [4]. COVID-19 ranges from asymptomatic infection to critical illness. Early pandemic data showed that pre-existing conditions, including diabetes, were associated with worse outcomes in hospitalized adults, although the magnitude of risk varied by age, disease severity, and setting [5]. These observations led to concern about both the direct effects of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the indirect effects of pandemic-related disruptions on people living with T1DM.

Evidence concerning COVID-19 and T1DM has remained heterogeneous. A systematic review described reports of new-onset diabetes, diabetic ketoacidosis (DKA), and glycemic deterioration in temporal proximity to COVID-19, but it did not establish a simple causal relationship [6]. Pandemic restrictions also interrupted access to medicines, monitoring devices, clinical services, and routine follow-up in some settings [7]. Fear of infection may additionally have delayed emergency-department attendance [8]. These indirect pathways are clinically important because delayed presentation can increase the severity of metabolic decompensation.

Evidence from Libya and comparable settings is limited. A clear description of local clinical records can identify patterns that merit prospective evaluation, but descriptive data must be distinguished from evidence of causation. This study therefore summarizes selected characteristics of patients with T1DM followed at the Educational Diabetic Center in Al-Jabal Al-Akhdar and describes the reported family COVID-19 history preceding diabetes onset.

The primary objective was to describe the distribution of available T1DM records across the study period and the frequency of selected renal, ocular, infectious, developmental, injection-site, and lipid-related findings. A secondary objective was to describe cases in which a family history of confirmed COVID-19 was recorded before the onset of diabetes. The study was not designed to estimate population incidence or to establish a causal association between COVID-19 and T1DM.

Methods

Study design and setting

This was a retrospective, descriptive cross-sectional review of clinical records from the Educational Diabetic Center in Al-Jabal Al-Akhdar, Libya, a governmental service providing follow-up care for patients with diabetes. The observation window extended from November 2017 through March 2022. The period therefore includes both pre-pandemic and pandemic calendar years.

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Study population and sampling

The source manuscript states that all patients attending follow-up during the study period were included. The available dataset contained 126 records, which were treated as a census of the eligible records available to the investigators rather than as a randomly selected sample. Patient identifiers and repeat-visit handling were not documented, so it was not possible to verify whether each record represented a unique individual or whether some individuals contributed more than one visit. Throughout this report, n = 126 therefore denotes records, not confirmed unique patients, and percentages are record-based. If repeat visits were present, the reported percentages would not represent patient prevalence. No sample-size calculation was reported. The source material also did not specify age limits, diagnostic criteria for T1DM, or exclusion criteria; these items should be confirmed by the authors if the original case-report form, patient identifiers, or database is available.

Data sources and variables

Variables reported in the source dataset were extracted from the available clinical records. They included the calendar year represented in the dataset; renal impairment; eye status, specifically myopia versus a normal finding; previous viral infection; associated developmental or chromosomal conditions; injection-site lipodystrophy; hyperlipidemia; and a family history of confirmed COVID-19 before diabetes onset. The narrative record also provided selected case-level descriptors, including sex, age, duration of diabetes, family history, and DKA at presentation. For the COVID-19 variable, the available record indicates that the affected household member was the father in each of three cases and that diabetes reportedly presented approximately three months later. The dataset does not document virologically confirmed SARS-CoV-2 infection in the patients themselves. Consequently, this variable is described as family or household exposure history, not as confirmed patient COVID-19.

Outcome definitions and data quality

The operational definitions and assessment protocols used during routine care were not documented in the available retrospective records. For renal impairment, the records did not provide the serum-creatinine criterion, estimated glomerular filtration rate equation or cutoff, urine albumin-to-creatinine ratio or microalbuminuria threshold, repeat-testing interval, or chronicity requirement. For myopia, the records did not provide a spherical-equivalent cutoff, visual-acuity criterion, cycloplegic or non-cycloplegic refraction method, examiner qualification, or retinal examination protocol. Myopia was therefore treated only as a recorded refractive error and was not classified as diabetic retinopathy or as an acute microvascular complication of diabetes. For hyperlipidemia, fasting status, total-cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride thresholds, age-specific reference ranges, and laboratory methods were not available. For injection-site lipodystrophy, the records did not describe systematic inspection or palpation of injection sites, anatomical coverage, subtype, grading criteria, or assessor. The records also lacked diagnostic thresholds for diabetic ketoacidosis, poor glycemic control, and viral infection, and did not specify how COVID-19 in household members was verified. No standardized screening coverage or number of missing observations was available for these variables. The study therefore reports categories exactly as charted and does not assign guideline-based definitions retrospectively. Misclassification, under-ascertainment, and unknown missingness are explicit data limitations.

Statistical analysis

The analysis was strictly descriptive. Categorical variables were summarized as counts and record-based percentages. Percentages were calculated by dividing the number of records in a category by 126 and multiplying by 100; values were rounded to one decimal place. Because the observation window included only November–December 2017 and January–March 2022, Table 1 also reports the number of observed months and the average number of records per observed month for each calendar period. The monthly average was calculated as the period count divided by the number of covered months and rounded to two decimal places. This adjustment standardizes only the amount of calendar time observed. It is not an annualized incidence rate because no catchment-population or person-time denominator was available and record uniqueness could not be verified. No inferential hypothesis was prespecified, and no inferential statistical test, degrees of freedom, significance level, effect estimate, confidence interval, or multivariable model was used.

Results

The analyzed dataset contained 126 records. Whether these were unique patients or included repeat visits could not be determined from the available data. All percentages in Tables 1–7 therefore use 126 records as the denominator unless otherwise stated and should not be interpreted as patient prevalence. Every table is presented as an editable Word table. The highest count and observed-month average occurred in 2021: 51 records (40.5%) and 4.25 records per month. This pattern may reflect referral practices, service availability, data capture, repeat visits, or true changes in presentations. The data cannot distinguish these explanations and cannot be interpreted as annual T1DM incidence or as evidence of a temporal trend.

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Table 1. Distribution of records by calendar period and average per observed month (126 records)

Calendar period	Frequency, n	Percent, %	Observed months	Average records per observed month
November–December 2017	5	4.0	2	2.50
2018	16	12.7	12	1.33
2019	18	14.3	12	1.50
2020	26	20.6	12	2.17
2021	51	40.5	12	4.25
January–March 2022	10	7.9	3	3.33
Total	126	100.0	53	2.38

Note: Observed months are the calendar months covered in each period. The monthly average equals the number of records divided by observed months. It adjusts for unequal calendar coverage only and is not an incidence rate because no population or person-time denominator was available and the 126 records were not confirmed to represent unique individuals.

Renal impairment was recorded in 6 of 126 records (4.8%). This record-based percentage cannot be interpreted as patient prevalence or compared clinically without a standardized renal definition, screening coverage, and information on age, diabetes duration, glycemic exposure, blood pressure, albuminuria, and estimated glomerular filtration rate.

Table 2. Recorded renal impairment among T1DM records (126 records)

Renal impairment	Frequency, n	Percent, %
Yes	6	4.8
No	120	95.2

Note: No estimated glomerular filtration rate equation or cutoff, urine albumin-to-creatinine ratio or microalbuminuria threshold, repeat-testing interval, or chronicity criterion was available. The category is reported exactly as recorded in the chart.

Myopia was recorded in 17 of 126 records (13.5%). Myopia is a refractive error, not diabetic retinopathy or a classic acute microvascular complication of diabetes. Without standardized refraction, age-specific reference data, verified record uniqueness, and a suitable comparison group, these data do not establish that T1DM or glycemic control increased myopia risk.

Table 3. Recorded eye findings among T1DM records (126 records)

Eye finding	Frequency, n	Percent, %
Myopia	17	13.5
Normal	109	86.5

Note: Six of the 17 records with myopia included a reported family history of myopia. No spherical-equivalent or visual-acuity cutoff, refraction protocol, examiner qualification, or retinal assessment protocol was available.

Each domain was recorded in 2 of 126 records (1.6%). These isolated observations are descriptive and do not support an etiologic inference regarding viral infection, autism spectrum disorder, Down syndrome, or T1DM.

Table 4. Recorded viral-infection history and associated conditions (126 records)

Domain	Category	Frequency, n	Percent, %
Previous viral infection	Yes	2	1.6
	No	124	98.4
Associated condition	Yes	2	1.6
	No	124	98.4

Note: The two recorded infections were chickenpox and measles. The two associated conditions were autism spectrum disorder and Down syndrome, one record each. Diagnostic verification and systematic assessment protocols were not available.

Injection-site lipodystrophy was documented in 1 of 126 records (0.8%). Because systematic examination of injection sites and repeat-visit handling were not described, under-ascertainment or duplicate-record bias cannot be excluded. This observation cannot establish an association with sex, diabetes duration, or glycemic control.

Table 5. Recorded injection-site lipodystrophy among T1DM records (126 records)

Lipodystrophy	Frequency, n	Percent, %
Yes	1	0.8
No	125	99.2

Note: The record described a 17-year-old male with an 11-year duration of diabetes and reportedly poor glycemic control. No standardized inspection or palpation protocol, anatomical coverage, subtype, grading criteria, or assessor was documented.

Hyperlipidemia was recorded in 2 of 126 records (1.6%). This record-based percentage cannot be compared reliably with other cohorts without a laboratory definition, screening coverage, verified record uniqueness, age distribution, pubertal status, body mass index, and glycemic-control data.

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Table 6. Recorded hyperlipidemia among T1DM records (126 records)

Hyperlipidemia	Frequency, n	Percent, %
Yes	2	1.6
No	124	98.4

Note: The two records described males aged 16 and 18 years with a reported family history of hyperlipidemia. Fasting status, lipid-panel values, total-cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride cutoffs, age-specific reference ranges, and laboratory methods were not available.

A family COVID-19 history before diabetes onset was recorded in 3 of 126 records (2.4%). The temporal sequence is hypothesis-generating only. Household exposure does not establish patient infection, and a record-based, single-arm cross-sectional dataset cannot estimate the risk of developing T1DM after COVID-19.

Table 7. Family history of confirmed COVID-19 before diabetes onset (126 records)

Family COVID-19 history	Frequency, n	Percent, %
Yes	3	2.4
No	123	97.6

Note: The three records described female patients whose father was the reportedly confirmed family case; T1DM reportedly presented with diabetic ketoacidosis approximately three months later. Patient SARS-CoV-2 infection and the method used to verify the household diagnosis were not documented.

Discussion

This study describes 126 T1DM records collected over a period spanning the years before and during the COVID-19 pandemic; the available data did not establish whether those records represented unique individuals. The highest calendar-period count occurred in 2021, with 51 records (40.5%) and an average of 4.25 records per observed month. Three records described female patients with a family history of confirmed COVID-19 before diabetes onset and DKA approximately three months later. These findings identify a temporal sequence in a small number of records, but they do not establish a direct association between SARS-CoV-2 infection and T1DM. Differences across calendar periods may reflect referral practices, delayed access to care, service availability, repeat visits, documentation, the catchment population, or true disease occurrence. Monthly averages address unequal calendar coverage but do not resolve these explanations. Pandemic-related disruptions to diabetes services and access to monitoring supplies have been documented internationally [7]. Fear of attending emergency services may also contribute to delayed presentation [8]. However, this dataset does not contain the measures needed to distinguish these mechanisms.

Renal impairment was recorded in 4.8% of records. Long-term glycemic status and coexisting vascular risk factors are relevant to kidney disease development [9]. Nevertheless, comparison with other studies is limited because the present records lack a definition of renal impairment, duration-specific denominators, albuminuria measurements, estimated glomerular filtration rate, and longitudinal follow-up. Myopia, a refractive error rather than diabetic retinopathy or a classic acute microvascular complication, was recorded in 13.5% of records. Prior work has shown gaps in awareness and practices related to eye disease among people with diabetes [10], underscoring the value of structured ophthalmic care. The present finding should not be interpreted as diabetic retinopathy or as evidence that glycemic control caused myopia. Standardized refraction, retinal examination, age-specific comparison, and family-history assessment are required for a valid ocular analysis. The viral-infection and associated-condition findings were rare.

Down syndrome has been linked with immune-related disorders, including an increased occurrence of T1DM [11]. Enteroviruses and other viral exposures have also been investigated as possible contributors to T1DM pathogenesis [12]. In this dataset, however, one case each of chickenpox and measles, one case of autism spectrum disorder, and one case of Down syndrome are insufficient to test these hypotheses. Injection-site lipodystrophy was recorded in one record. Pediatric studies have documented insulin-induced lipodystrophy and its potential relationship with glycemic variability [13]. The apparent frequency in this study may be influenced by whether injection sites were examined systematically. Similarly, two records contained hyperlipidemia. Prior pediatric studies have described dyslipidemia in young people with diabetes and obesity [14] [15], but those reports focused on type 2 diabetes and therefore provide only limited comparability with this T1DM cohort. The three presentations after household COVID-19 exposure warrant cautious interpretation. A population study in England found that people with established type 1 or type 2 diabetes had higher COVID-19-related mortality than people without diabetes [16]. That evidence concerns outcomes after COVID-19 among people with diabetes; it does not show that COVID-19 causes new-onset T1DM. The present study likewise cannot answer that causal question because patient infection was not confirmed and there was no population-based exposed comparison group.

Strengths and limitations

The principal strength is the description of clinical records from a setting for which published data are limited. The report distinguishes household COVID-19 history from confirmed infection in the patient and presents every reported table as editable data. The study has important limitations. It is retrospective and based on a single center. The dataset lacks population denominators, a non-T1DM control group, verified SARS-CoV-2 testing in patients, complete demographic and glycemic data, and adjustment for confounding. Operational definitions, clinical cutoffs, laboratory methods, assessment protocols, screening coverage, and missing-data counts were unavailable for renal impairment, myopia, hyperlipidemia,

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lipodystrophy, and other charted outcomes. Consequently, misclassification and under-ascertainment cannot be quantified. The first and last calendar periods cover only two and three months, respectively; the reported monthly averages adjust for coverage but are not incidence rates. Most importantly, patient identifiers and repeat-visit handling were not documented, so the 126 records cannot be confirmed as 126 unique individuals and the record-based percentages may not equal patient prevalence. No inferential analysis was performed. These limitations preclude conclusions about incidence, prevalence, risk, temporal trends, or causality.

Conclusion

Among 126 T1DM records reviewed at a governmental diabetes center in Al-Jabal Al-Akhdar, 2021 had the highest observed count and average records per month, and three records documented a family history of COVID-19 before diabetes onset. Because unique individuals could not be distinguished from possible repeat visits, these figures are record-based and do not estimate patient prevalence or population incidence. The study provides a descriptive local snapshot but does not demonstrate that COVID-19 caused or increased the risk of T1DM. Future research should use a prospective multicenter design, unique patient identifiers, confirmed patient-level SARS-CoV-2 exposure, standardized outcome definitions and assessment protocols, complete age and glycemic data, population denominators, an appropriate comparison group, and prespecified statistical methods.

Conflict of interest. Nil

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