Research paper

Impact of COVID-19 lockdown on glycemic control in type 1 diabetes

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A R T I C L E   I N F O

A B S T R A C T

Aim: The COVID-19 pandemic has forced governments to impose lockdown policies, thus impacting patients with chronic diseases, such as type 1 diabetes. The aim of this study was to evaluate the impact of lockdown on glycemic control in type 1 diabetes patients.
Patients and methods: We retrospectively evaluated patients using a continuous subcutaneous insulin infusion device during the nationwide lockdown. Children and adolescents aged 2−18 years followed up at the Pediatric Endocrinology Unit of Hospitalar São João in Portugal were included in the study. We collected data on the age, weight, insulin doses, and glycemic control of the patients before and after the restrictions.
Results: The study included 100 patients, 59 males, with a mean age of 12.5 years. Baseline data showed a suboptimal glycemic control with a median HbA1c of 7.9%. The lockdown was associated with an increase in the body mass index (BMI) of all patients ($p = 0.009$), particularly girls and older teenagers. Metabolic control deteriorated in the 10−13 age group ($p = 0.03$), with a 0.4% increase in HbA1c.
Conclusion: To date, this is the largest study on the impact of lockdown on type 1 diabetes in patients using an insulin pump. The results highlight the importance of physical activity, parental supervision, and continuation of healthcare assistance through telemedicine in young individuals with type 1 diabetes.

1. Introduction

Coronavirus Disease 2019 (COVID-19) has led to worldwide public health concerns. In Portugal, a national state of emergency across the entirety of the Portuguese territory was declared on March 18, 2020, following the coronavirus outbreak. Full lockdown began on March 22, when movement restrictions, self-isolation, and social distancing were imposed throughout the country [1]. These lockdown policies disrupted the organization of our National Health System (NHS). Routine healthcare activities were deferred, and outpatient services were closed, including those for patients with chronic diseases such as type 1 diabetes (T1D). Current guidelines recommend assessment of glycemic status every 3 months in children with T1D [2]. The widespread use of technology allowed for remote monitoring of many individuals during lockdown. Patients were contacted by phone or e-mail, glucose diaries were exchanged, and therapy adjustment was instituted. Through telemedicine, doctors supported patients at home so as to avoid possible repercussions on disease management.

After suspension of outside structured physical and leisure activities, housebound children and adolescents with T1D faced some challenges in their disease care [3]. It is well known that changes in daily routines of people with T1D can have an impact on glucose levels [4].

An expected reduction of exercise and an increase of sedentary behavior could, therefore, have a harmful influence on glycemic control.

Due to the gradual reduction of new COVID-19 cases, from 4 to 18 May 2020, the lockdown was gradually lifted. Recent studies across Europe showed that the glucose profile of adult patients with T1D improved during national lockdown [5−9]. Nevertheless, studies conducted with children have had inconsistent outcomes. Glycemic control may have improved [10,11], did not worsen [12,13], or it deteriorated [14] in some cases. Only one study included solely patients using continuous subcutaneous insulin infusion devices (CSII).

To date, subgroups of T1D patients who may have a more difficult glucose control during lockdown have not been identified in the literature, and no study has been conducted in Portugal. The aim of this study was to evaluate the impact of lockdown on glycemic control, weight, and insulin requirements in a cohort of T1D patients using CSII.

2. Patients and methods

We retrospectively evaluated glycemic control of T1D patients using a CSII device in the period before and after the nationwide lockdown. The study was conducted at the Pediatric Endocrinology Unit, Centro Hospitalar São João in Porto, Portugal. All children and

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adolescents with T1D aged 2−18 years on CSII for at least 6 months before the pandemic were included in the study. NHS-funded insulin pumps consisted of Accu-Chek® Combo (Roche) and Paradigm Veo™ (Medtronic). Telemedicine visits began mid-March 2020 and continued until late May 2020. We collected information on the age, weight, total daily dose of insulin (TDD), and glycemic control of patients before (January to February 2020) and after (June to August 2020) the restrictions, when outpatient visits were resumed. Body mass index standard deviation scores (BMI SDS) were determined employing the Pediatric Z-score calculator using World Health Organization reference charts. The majority of patients used flash glucose monitoring (FreeStyle Libre®); however, the data derived from the LibreView™ software were incomplete.

Glycated hemoglobin (HbA1c) was measured with a Siemens DCA 2000® device at each clinical visit. We extracted data on daily insulin dosages from CareLink™ (Medtronic) and Accu-check Guide Link™ (Roche) personal reports.

Patients were subgrouped into three age categories: 3−9 years, 10−13 years, and 14−18 years.

All statistical analysis were conducted with SPSS v.25. Quantitative data are expressed as mean and standard deviation ($\pm$SD). Data were compared before and after the lockdown. A paired t-test was used to evaluate the presence of significant differences between the periods. A value of $p < 0.05$ was considered statistically significant.

This study was approved by the local ethics committee and no consent was deemed necessary as all the data are fully anonymized.

3. Results

3.1. Baseline characteristics

The study included 100 patients, 59 males, with a mean age of 12.5 $\pm$ 4 years and median diabetes duration of 7 $\pm$ 4 years (Table 1). The mean BMI SDS was 0.26 $\pm$ 0.79. Reference data showed a suboptimal glycemic control before the lockdown with a median HbA1c of 7.9%. Glycated hemoglobin was higher in older adolescents (14−18 years) than in other age groups ($p = 0.001$). No difference between genders was found.

Overall, females presented a greater BMI and TDD than their male counterparts. Mean TDD was 0.94 U/kg for girls and 0.75 U/kg for boys. Mean TDD had a linear increase according to age: 0.65, 0.77, and 0.98 U/kg for 3−9, 10−13, and 14−18 age groups respectively.

3.2. Change from baseline due to the lockdown

Table 2 illustrates changes in BMI and diabetic parameters. The lockdown was associated with an increase in the BMI SDS ($p = 0.009$) of all patients, particularly girls and older teenagers.

Differences in glycemic control before and after lockdown were only significant in the 10−13 age group ($p = 0.03$), where the baseline and follow-up HbA1c was 7.8% and 8.2%, respectively. Furthermore,

Table 1
Patient characteristics (n = 100).

Parameters	n
Gender	
Male	59
Female	41
Age group (years)	
3−9	22
10−13	33
14−18	45
CSII	
Roche	46
Medtronic	54

CSII, continuous subcutaneous insulin infusion devices.

TDD was slightly higher after lockdown in this age group (0.81 U/kg/day vs. 0.77 U/kg/day, $p = 0.025$). The rate of bolus/basal insulin did not change (50:50).

4. Discussion

In this retrospective analysis, we collected the data of 100 children and adolescents with T1D using a CSII during the COVID-19 pandemic. The data showed a suboptimal glycemic control at baseline which, overall, did not worsen with the restrictions. A negative impact of the COVID-19 lockdown on BMI may be correlated with a lack of physical activity, poor eating habits, and mood deterioration. Our results are in accordance with those of a recent study from Saudi Arabia [15], which reported a rise in the BMI of T1D patients.

The impaired glucose control in adolescents aged 10−13 years may be explained by the typical insulin resistance of early pubertal children, along with an expected increase in insulin requirements. By contrast, a similar study [16] conducted in Italy found that glycemic control did not worsen in this age group. The main difference from our study is the authors relied only on short-term indicators of glucose excursions, i.e., continuous glucose monitoring (CGM) metrics and estimated A1c, and not capillary HbA1c. In addition, their results showed improved glycemic control among university students and young adults with T1D. This is in conformity with a range of behavioral changes reported in adults during the lockdown (self-management, reduced stress, regular lifestyle) [9].

A recent study from the United States with 110 pediatric patients [17] revealed no significant change in HbA1c between the pre- and post-pandemic lockdown periods; between boys and girls; between insulin pump users and non-pump users; and between pubertal vs. prepubertal individuals. Likewise, in our study, metabolic control in older adolescents remained stable during the lockdown. This may be due to regular home-cooked meals, close monitoring by parents, and reduced stress levels caused by school, despite a reduction in physical activity. Furthermore, the continuation of healthcare assistance through telemedicine probably made a significant contribution [18]. We reinforced the importance of non-omission of insulin, healthy eating, continuing physical activity at home, and remaining hydrated to prevent acute complications. One additional factor reported to be beneficial is the use of CGM [17,19]. Unfortunately, this technology is not covered by insurance in Portugal, thus the children in our study were not equipped with this device.

The only study [14] that showed a negative impact of lockdown on T1D patients younger than 30 years has possible sociodemographic limitations. The main reason described was non-availability of insulin and glucostrips during the lockdown period in India, due to limited stock in rural areas. Fortunately, no shortage of diabetes supplies was reported in Portugal.

To date, this is the largest study conducted of the impact of lockdown on T1D patients using CSII. Our sample included all T1D patients followed at a diabetes clinic at the time of the pandemic, which eliminates selection bias.

Our study has some limitations. First, it is a single-center study. Second, we were unable to obtain data regarding time in/above/below range and number of glucose readings for all patients, and therefore we did not include these metrics. Third, diet and physical activity levels during confinement were not analyzed.

Nevertheless, these results highlight the importance of a stable daily routine and parental supervision in young individuals with T1D. Also, our study emphasizes the importance of telemedicine in situations of forced isolation. We believe our results offer a reproducible model useful for clinical practice and for further research.

Declaration of Competing Interest

None.

Table 2
Comparison of diabetic parameters before (pre) and after (post) lockdown.

Variable	All	Age groups (years)			Gender	
		3–9	10–13	14–18	Male	Female
BMI (SDS)						
Pre	0.26 ± 0.79	0.45 ± 0.83	0.14 ± 0.82	0.27 ± 0.26	0.14 ± 0.73	0.44 ± 0.85
Post	0.35 ± 0.83	0.55 ± 0.87	0.17 ± 0.84	0.37 ± 0.35	0.21 ± 0.83	0.54 ± 0.8
HbA1c (%)						
Pre	7.9 ± 1	7.4 ± 0.7	7.8 ± 0.9	8.3 ± 1	7.9 ± 1	7.9 ± 0.9
Post	8.1 ± 1	7.7 ± 0.8	8.2 ± 1.3	8.2 ± 1	8 ± 1	8.1 ± 1
TDD (U/kg/day)						
Pre	0.83 ± 0.3	0.65 ± 0.2	0.77 ± 0.3	0.98 ± 0.3	0.75 ± 0.3	0.94 ± 0.3
Post	0.84 ± 0.3	0.66 ± 0.2	0.81 ± 0.3	0.96 ± 0.3	0.76 ± 0.3	0.94 ± 0.2

BMI, body mass index; SDS, standard deviation score; TDD, total daily dose of insulin.
*Significant at 0.05.

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