COVID-19 outbreak and pediatric diabetes: Perceptions of health care professionals worldwide

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Abstract

Background: Coronavirus disease (COVID-19) is an infectious disease that started in Wuhan, China in late 2019 and later spread around the world. Diabetes has been recognized as a possible risk factor for COVID-19 complications.

Objective: International Society for Pediatric and Adolescent Diabetes (ISPAD) investigated perceptions, challenges and experience of health care professionals (HCP) taking care of children and young people with diabetes worldwide during COVID-19 pandemic.

Methods: From 21st April to 17th May 2020, during COVID-19 pandemic, a web-based survey was sent to ISPAD members and former participants of ISPAD conferences by email.

Results: Responders from 215 diabetes centers from 75 countries completed the survey. Majority were from UK (35; 16.3%), USA (20; 9.3%), and India (15; 7%). HCP were mostly pediatric endocrinologists (64%). During COVID-19 pandemic, 16.5% of responders continued face-to-face consultation while most changed to telephone (32%) or video (18%) consultations. 19% reported a shortage of medical supplies. 22% reported a delay in diagnosis of patients with new-onset diabetes, while 15% reported a higher incidence of DKA. 12% reported having one or more patients with COVID-19. Most of the 86 children and adolescents with diabetes and COVID-19 had only mild/moderate symptoms, while 5 required admission to an intensive care unit. No deaths were reported.

Conclusions: This large global survey during COVID-19 pandemic showed that many HCP adapted to the pandemic by resorting to telemedicine. One fourth of HCP reported delays in diagnosis and an increased rate of DKA. The emergence of COVID-19 pandemic had an important impact on family's behavior that might have led to increase in diabetic ketoacidosis presentation.

Keywords
children, COVID-19, diabetes, diabetic ketoacidosis, telemedicine

1 INTRODUCTION

Coronaviruses are a large family of viruses that can cause disorders ranging from a mild cold to severe diseases. In December 2019, a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused an outbreak of Coronavirus disease (COVID-19). Typical symptoms of COVID-19 include fever, cough, shortness of breath, and muscle pain.1 In the time frame studied, a large cohort with COVID-19 from China showed that illness severity can range from mild (81%), severe (14%) to critical (5%). All

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improving the management in this area.

demic so we can guide our future educational activities toward management strategies, challenges, knowledge, and practice of adolescents with diabetes. This survey should help to identify differ-

tances on use of concomitant drugs, blood glucose measurement, parents' beliefs and psychological aspects faced. The last two sections included questions sought to characterize the profile of patients who tested positive for SARS-CoV-2 virus, including their characteristics, clinical presentation, diagnosis, and treatment (the full version of the survey is available as a supplemental material).

2.2 | The survey

The survey questions were developed by six pediatric endocrinologists. The survey was sent to about 2300 HCP. A direct electronic link of the survey and consent was sent to the HCP by email and also via social media platforms (Facebook, Twitter, and LinkedIn). The completion of the survey took no more than 20 min. It was created in an online format with 47 questions divided into five sections. The first section concerns targeted HCP consent to participate in the survey and confirm their voluntary participation, and the following section included responders' professional and practice profiles. Three questions were aimed to define the professional profile of the responders, size of their clinic and their country of practice. To further understand challenges and changes that HCP have had to make in caring for children and adolescents with diabetes during the pandemic, the next section included a set of questions focused on diabetes management. The questions covered the HCP's perceptions and practices including medication prescriptions, their availability, how they managed education sessions, acute complications seen, special considerations on use of concomitant drugs, blood glucose measurement, parents' beliefs and psychological aspects faced. The last two sections included questions sought to characterize the profile of patients who tested positive for SARS-CoV-2 virus, including their characteristics, clinical presentation, diagnosis, and treatment (the full version of the survey is available as a supplemental material).

2.3 | Statistical analysis

Analysis of data was performed using Google Sheets. Descriptive statistics were used to present demographic data and to evaluate knowledge, attitudes, and perceptions of HCP during COVID-19 pandemic. Quantitative variables were described in the form of mean and SD, and qualitative variables were described as number and percentage. Some questions were open-ended questions.

3 | RESULTS

3.1 | Responders' professional and practice profiles

In total, we received 303 responses to the survey. Since for some center more than one response was received, we merged all the responders from the same center and considered it as one response.
A convenient sample of 215 diabetes centers from 75 countries participated in the study. The majority of participants were from UK (35; 16.3%), followed by US (20; 9.3%), and India (15; 7%). Among the responders 193 (64%) were pediatric endocrinologists, 46 (15%) pediatricians with interest in diabetes, 26 (9%) nurse practitioners. The remaining were dietitians, trainee, diabetes educator, and adult physicians. Majority of the participants (72.5%) had clinic size of more than 100 children with diabetes (Table 1).

### 3.2 Perceptions and practices of HCP toward diabetes during COVID-19

During COVID-19 pandemic, face-to-face consultation has been maintained by 16.7% of responders, and only once adequate personal protective equipment has been provided. Most of the HCP offered only phone call (32%) and video consultations (18%) for existing patients. However, for patients with new onset diabetes, a majority of HCP (38%) offered face-to-face education wearing appropriate personal protective equipment followed by phone calls (25.5%) and video consultations (22%) (Table 1).

We asked if any shortage of supply has been perceived as a result of COVID-19 where there previously had not been shortages. There is very wide variation in insulin and supply refil prescription duration, varying from 1 month to always (Table 1). Scarcity of any diabetes supply has been observed only by 19%, while 65% had not had any shortage of supplies, and 16% of them were not aware of any challenging situation. Main shortage of diabetes care supplies have been glucose test strips (26%), basal and bolus insulins (22% each), glucose sensors (10.5%).

Immune stimulants have been prescribed only by one fourth of the responders, most of them, however, at less than 50% of their pediatric diabetes population (Table 1).

### 3.3 General management practices of diabetes care during COVID-19

Twenty-two percent of responders reported a potentially delayed diagnosis of children with new onset diabetes mellitus during the pandemic and 15% reported a higher incidence of DKA in their practice. (Table 2).

Coming to the potential fear of COVID-19, most participants (68%) had the feeling that caregivers/families avoided contact with the diabetes team during pandemic because of this fear.

### 3.4 Management of children and young people with diabetes mellitus that were COVID-19 positive

Twelve percent of HCP reported caring for one or more patients with COVID-19 (Table 2).

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**Table 1** Clinical profile, centre characteristics, and patients feature during COVID-19 pandemic

| Characteristics (number of responses) | Responses (%) |
|--------------------------------------|---------------|
| **Centres by country** (215)a         |               |
| United Kingdom                       | 35 (16.3)     |
| United States                        | 20 (9.3)      |
| India                                | 15 (7.0)      |
| Canada, Italy                        | 9 (4.2) each  |
| Australia, Belgium                   | 7 (3.3) each  |
| Denmark, Spain                       | 5 (2.3) each  |
| Brazil, Germany, Netherlands, Portugal, Sweden | 4 (1.9) each |
| Argentina, Austria, Egypt, Greece, Ireland | 3 (1.4) each |

| **Participants’ clinical role** (303) |               |
|--------------------------------------|---------------|
| Pediatric Endocrinologist/diabetologist | 193 (64) |
| Pediatrician with interest in diabetes | 46 (15) |
| Nurse practitioner/registered nurse | 26 (9) |
| Resident/fellow/trainee in pediatrics/pediatric endocrinology or diabetology/diabetes researcher | 13 (4) |
| Diabetes educator                    | 7 (2) |
| Dietitian                            | 6 (2) |
| Primary care practitioner/family doctor with interest in diabetes | 5 (2) |
| Adult physician looking after pediatric or adolescent patients | 4 (1) |
| Mental health professional           | 3 (1) |

| **Children and young people aged 0-18 y with diabetes being looked after** (301) |               |
|-----------------------------------------------------------------------------|---------------|
| Less than 100                                                               | 83 (27.5)     |
| 100-200                                                                     | 83 (27.5)     |
| 201-500                                                                     | 97 (32)       |
| More than 500                                                               | 38 (13)       |

| **Current routine check-up** (832)b                                         |               |
|-----------------------------------------------------------------------------|---------------|
| Telephone consultation                                                      | 266 (32.0)    |
| Video consultation                                                          | 150 (18.0)    |
| Face to face consultation with appropriate PPE                              | 139 (16.5)    |
| Sent SMS, use of cross-platform messaging (eg, WhatsApp) and emails for consultations | 128 (15.5)   |
| Apps or patient portal                                                      | 79 (9.5)      |
| Only newly diagnosed patients or patients in a complex social system visit our center | 45 (5.5)      |
| As usual, no changes                                                       | 16 (1.9)      |
| HbA1c drive through staff in PPE but not at hospital site                  | 8 (1.0)       |
| I am retired and no longer evaluate patients                               | 1 (0.1)       |

Multidisciplinary team deliver education to patients with new onset type 1 diabetes (565)b

|                                                                  |               |
|-----------------------------------------------------------------|---------------|
| Face to face education wearing appropriate PPE                  | 214 (38)      |
| By telephone                                                   | 144 (25.5)    |
| Video consultation                                             | 126 (22)      |
Most of responders reported using RT-PCR SARS-CoV-2 as method to confirm the diagnosis (78%), using both nasal (56%), and oropharyngeal (37%) swab, while serologic tests and bronchi alveolar lavage were used in very few patients (Table 2).

Only a small number of pediatric patients with positive testing for COVID-19 were reported in this global survey: 61 with type 1 diabetes mellitus and 25 with type 2.

### TABLE 1 (Continued)

| Characteristics (number of responses) | Responses (%) |
|---------------------------------------|---------------|
| Via application                       | 37 (6.5)      |
| As usual, no changes                  | 44 (8)        |
| Refill prescription period (303)      |               |
| Every month                           | 44 (14.5)     |
| Every 3 mo or less                    | 129 (43)      |
| Every 6 mo or less                    | 35 (11.5)     |
| Every year                            | 27 (9)        |
| Automatically from pharmacy           | 13 (4)        |
| As required                           | 15 (5)        |
| Refill prescription is not allowed    | 3 (1)         |
| I am not directly involved with prescription | 37 (12) |
| Shortage of any diabetes medical supplies (303) | |
| Yes                                   | 57 (19)       |
| No, everything was secured            | 198 (65)      |
| I was not aware of situation          | 48 (16)       |
| Main shortage of diabetes supplies (134) |                |
| Glucose test strips                   | 35 (26)       |
| Basal Insulin                         | 30 (22)       |
| Bolus Insulin                         | 30 (22)       |
| Blood glucose sensors                 | 14 (10.5)     |
| Ketone strips                         | 13 (10)       |
| Pump supplies                         | 9 (7)         |
| Alcohol wipes                         | 2 (1.5)       |
| Syringe and needles                   | 1 (1)         |
| Adaptations on blood or sensor glucose monitoring (237) | |
| No changes from usual practice        | 104 (44)      |
| Monitor blood glucose and review CGM data more frequently | 100 (42) |
| Check sick day management with diabetes team | 12 (5) |
| Review CGM data more frequently       | 8 (3.5)       |
| Change to CGM, when available         | 7 (3)         |
| Monitor blood glucose more frequently | 2 (1)         |
| Strict hand hygiene                   | 2 (1)         |
| Check ketones more frequently         | 1 (0.5)       |
| Most used antipyretics (118)          |               |
| Paracetamol (acetaminophen)           | 96 (81)       |
| Combination of both ibuprofen and paracetamol | 14 (12) |
| Ibuprofen                             | 5 (4)         |
| None                                  | 2 (2)         |
| Metamizole (dipyrone)                 | 1 (1)         |
| Aspirin                               | 0             |
| Report of more falsely elevated CGM readings (193) | |
| Yes                                   | 13 (7)        |
| No                                    | 180 (93)      |
| CGM sensor affected during pandemic (37) |                |
| Freestyle libre                       | 16 (43)       |
| Dexcom G6 system                      | 10 (27)       |

### TABLE 1 (Continued)

| Characteristics (number of responses) | Responses (%) |
|---------------------------------------|---------------|
| Dexcom G5                              | 9 (24)        |
| Eversense                              | 1 (3)         |
| Medtronic enlite                       | 1 (3)         |
| Prescription of immunostimulants (301) |            |
| None                                  | 225 (75)      |
| Less than 10%                          | 54 (18)       |
| Around 25%                             | 12 (4)        |
| Around 50%                             | 6 (2)         |
| More than 75%                          | 4 (1)         |
| Recommendations of use of ACEi in patients with diabetic nephropathy/hypertension during pandemic (101) | |
| Yes                                   | 76 (75)       |
| No                                    | 25 (25)       |
| Complications of using ACEi during pandemic (61) | |
| No patient with nephropathy or on ACEi | 28 (46)      |
| No complications                      | 17 (28)       |
| Patients on ACEi have not had COVID-19 | 16 (26)      |
| Most reported psychological effects (491)b | |
| Anxiety                               | 151 (31)      |
| Parental stress                       | 118 (24)      |
| None have had psychological problems so far | 73 (15) |
| Depression                            | 40 (8)        |
| Insomnia/hypersonomnia                | 33 (7)        |
| Eating disorder                       | 31 (6)        |
| Panic attacks                         | 20 (4)        |
| Patient or caregivers have improved the mood | 18 (3.5) |
| Denial                                | 3 (0.5)       |
| Night terror                          | 2 (0.5)       |
| Suicide attempt                       | 2 (0.5)       |

Abbreviations: ACEi: Angiotensin-converting-enzyme inhibitors; CGM: continuous glucose monitor; PPE: personal protective equipment.

bRemaining countries that contributed with two or less centers: Bulgaria, Chile, Indonesia, Japan, Liberia, Mexico, New Zealand, Nigeria, Norway, Poland, South Africa, Turkey, Algeria, Bangladesh, Barbados, Burma, Cameroon, Colombia, Congo, Costa Rica, Cote D'Ivoire, Croatia, Czech Republic, Ecuador, Estonia, Ethiopia, France, Georgia, Ghana, Haiti, Iraq, Kenya, South Korea, Kuwait, Luxembourg, Macedonia, Malawi, Malaysia, Malta, Mauritius, Nepal, Pakistan, Peru, Philippines, Romania, Russia, Saudi Arabia, Serbia and Montenegro, Slovenia, Switzerland, Tanzania, Tunisia, Ukraine, United Arab Emirates, Vietnam, Zambia.

bNumber of responses are over of number of participants due to multiple-choice selection.

Most of responders reported using RT-PCR SARS-CoV-2 as method to confirm the diagnosis (78%), using both nasal (56%), and oropharyngeal (37%) swab, while serologic tests and bronchi alveolar lavage were used in very few patients (Table 2).

Only a small number of pediatric patients with positive testing for COVID-19 were reported in this global survey: 61 with type 1 diabetes mellitus and 25 with type 2.
TABLE 2  Reported effects among patients with diabetes during COVID-19 pandemic  (Continued)

| Characteristics (number of responses) | Responses (%) |
|--------------------------------------|---------------|
| **Main symptoms**                     |               |
| Fever                                | 29            |
| Cough                                | 28            |
| Hypoglycemia                         | >23           |
| Myalgia                              | 16            |
| Rhinorhrea                           | 15            |
| Headache                             | 15            |
| Pharyngeal erythema                  | 11            |
| Hyperglycemia                        | >10           |
| Gastrointestinal symptoms            | 9             |
| Diabetic ketoacidosis                | >8            |
| Shortness of breath                  | 6             |
| Mean HbA1c, % (SD; range min-max)    | 7.6 (1.6; 5.7-13.0) |
| **Therapies required**               |               |
| Admission to hospital                | >15           |
| Admission to ICU                     | 2             |
| Oxygen                               | 1             |
| Bronchodilators and glucocorticoids  | 0             |
| Non-invasive ventilation             | 0             |
| Intubation and ventilation           | 0             |
| Antibiotics                          | 2             |
| Antipyretics                         | 3             |
| Antihistamine                        | 1             |
| DKA management                       | 2             |
| Dextrose                             | 1             |

**T2D patients that experienced COVID19 (25)**

| Age (years)  |          |
|--------------|----------|
| 0-5          | 0        |
| 6-10         | 0        |
| 11-16        | 4 (57)   |
| More than 16 | 3 (43)   |

| Reported gender |          |
|-----------------|----------|
| Boys            | 6 (54)   |
| Girls           | 5 (46)   |

| Duration of diabetes (years) |          |
|-----------------------------|----------|
| Less than 3                 | 3 (50)   |
| 3-10                        | 3 (50)   |
| More than 10                | 0        |

| Symptoms |          |
|----------|----------|
| Hyperglycemia | >10   |
| Hypoglycemia  | >6    |
| Diabetic ketoacidosis | 4     |
| Fever       | 3       |
| Cough       | 3       |
| Duration of disease (years) |          |
| New onset     | 3 (10.5) |
| Less than one | 2 (7)    |
| 1-5           | 8 (29)   |
| 5-10          | 12 (43)  |
| More than 10  | 3 (10.5) |

(Continues)
TABLE 2 (Continued)

| Characteristics (number of responses) | Responses (%) |
|--------------------------------------|---------------|
| Shortness of breath                  | 3             |
| Myalgia                              | 3             |
| Pharyngeal erythema                  | 1             |
| Rhinorrhea                           | 1             |
| Hyperglycemic hyperosmolar state     | 1             |
| Respiratory failure                  | 1             |
| Headache                             | 0             |
| Gastrointestinal symptoms            | 0             |
| Mean HbA1c, % (SD; range min-max)    | 7.8 (1.3; 5.8-9.9) |
| Therapies required                   |               |
| Admission to hospital                | 5             |
| Admission to ICU                     | 3             |
| Oxygen                                | 3             |
| Bronchodilators and glucocorticoids  | 2             |
| Non-invasive ventilation             | 2             |
| Intubation and ventilation           | 2             |
| Pressor drugs                        | 2             |

Abbreviation: DKA, diabetic ketoacidosis; RT-PCR SARS-CoV-2, reverse-transcription-polymerase chain reaction for detecting severe acute respiratory syndrome coronavirus 2; ICU, intensive care unit.

4 | DISCUSSION

This is the first study to quantitatively investigate the perceptions, challenges, and experience of HCP for children and adolescents with diabetes mellitus during COVID-19 pandemic.

Since its outbreak in Wuhan, China, in December 2019 COVID-19 has spread to more than 200 countries and has been labeled as pandemic. Epidemiologic studies have consistently demonstrated that children are at lower-risk of developing severe symptoms or critical illness compared with adults. Despite many uncertainties, the COVID-19 pandemic recommendations in most countries include people with diabetes within the “at risk” population. ISPAD guidance for HCP reassured people from anecdotal reports coming from Wuhan, China, and Italy, stating that children with diabetes have not shown a different disease pattern compared to their peers and that children in general had less severe clinical manifestations than adults.

Diabetic ketoacidosis is an acute, major, life-threatening complication of diabetes. Early diagnosis of type 1 diabetes is essential to allow treatment to start as soon as possible. Although 15% of responders reported increased incidence of DKA in children in their centers, delayed diagnosis and admission to hospital were seen in 22% of the centers. This would suggest that for a significant number of centers, newly diagnosis of type 1 diabetes would be postponed, and possibly, they would be facing a similar rate of DKA during the pandemic, but with more severe DKA due to the delay of the diagnosis. In the midst of the COVID-19 pandemic, people are sheltering in place and practicing social distancing. Parents and caregivers are delaying seeking emergency help out of fear of being infected in the hospital or due to the reduced service for non-COVID-19 care. Moreover, delayed diagnosis of new cases of type 1 diabetes could be due to the front-line health workers focusing on respiratory symptoms of the unwell child (with DKA), without considering type 1 diabetes as a potential diagnosis. Thus, anecdotal reports have suggested that as a result of delay in seeking medical attention, affected individuals have presented with more severe DKA.

The importance of following public health measures of containment in addition to standard diabetes mellitus care and, whenever needed, the sick day management guidelines of ISPAD should be emphasized. Emergency department doctors should remember general pediatric evaluation in the time of a pandemic, such as recently observed, to avoid the need for hospitalization and emergency. Pediatric diabetes teams should be informed immediately to avoid complications; recommendations should be produced as soon as possible to allow appropriate treatment to start. We recommend that every opportunity should be taken to raise awareness of the symptoms of diabetes among parents, caregivers, school staff, and the general population. It is the role of HCP to urge experiencing symptoms to seek care for these life-threatening events.

COVID-19 pandemic has forced a majority of the diabetologists to adapt to providing diabetes mellitus care remotely through telehealth. However, healthcare disparities continue to challenge...
In a recent two case series, DKA was prevented via telemedicine by availability of diabetes technologies for underprivileged communities. Clinical outcomes were similar without any hospital admissions, thus saving significant cost. Telemedicine and digital medicine also offer critically important approaches to improve access, efficacy, efficiency, and cost-effectiveness of medical care for people with diabetes. It will be important to include these measures as well after the pandemic. Telemedicine, technology, and digital health care have demonstrated their role in diabetes mellitus care during a period of crisis, and this experience may be used to convince payers and policy makers of the lasting benefits for this high-risk population, and to systemize them. It is strongly encouraged to upgrade telehealth services by institutions to continue caring for patients, as well as protect the health care workers and community.

Face-to-face consultation, with appropriate personal protective equipment, was used at 16.5% of the centers. This pandemic is bringing health care systems worldwide to the brink of collapse based on the rapidly increasing number of severe infections, including the high rate of infections among frequently exposed HCP. Telemedicine or another virtual diabetes clinic can be a useful tool to ease data exchange between patients and HCP, as well as to reduce the number of physician-patient contacts. However, it is of note that even for newly diagnosed patients (for whom usually the face-to-face education is the gold standard) more than 50% of patients received education via telehealth systems.

Consequences of the lockdown for persons with diabetes could be absent or major, based on less exercise, changes in dietary habits (eg, increased snacking, consumption of “comfort” dense-calorie foods), restrictions in routine visits to the physician, and decreased availability of insulin and/or oral hypoglycemic agents. Although HCP kept insulin available for almost 3 months ahead and all insulin and technology companies announced that they did not anticipate disruptions of the medical supply line, 19% of responders had shortage in basic diabetes supplies: blood glucose test strips, basal and bolus insulins, as well as sensors for CGM. This is an alarming fact that might lead to uncontrolled glycemia or worsening status of comorbid diseases in some region of the world. It should be emphasized to urge companies on providing all diabetes medical supplies around the globe. A link to their online shop for supplies should also be provided. Telehealth consultations should be supported, and virtual training sessions should be readily available.

In our survey, 12% reported on COVID-19 positive patients. These were mainly type 1 and type 2 diabetes patients. In type 1 diabetes patients mean HbA1c was 7.6%, diabetes duration range 1-5 years, while for type 2 was 7.8% and diabetes duration range 3-10 years. It seems that most of cases were well controlled with standard therapy, and just few needed ICU admission; two adolescents with type 2 diabetes admitted to ICU required intubation and ventilation. Fortunately, no death was reported. A study from China reported that adults with diabetes had a significantly higher-risk than people without, of severe pneumonia, release of tissue injury-related enzymes, excessive uncontrolled inflammatory responses, and hypercoagulable state associated with dysregulated glucose metabolism. A recent study reported that a higher HbA1c level is associated with inflammation, hypercoagulability, and low-oxygen saturation in COVID-19 patients, leading to a higher mortality rate.

As cardiovascular diseases and diabetes are strongly associated with elevated adipose tissue mass and low-grade inflammation, a higher body mass index might be an important risk factor for a more severe course of the disease, particularly of pneumonia, in these people. It is notable that the only ones who underwent intubation and ventilation were two adolescents with type 2 diabetes. Knowledge about insulin resistance is also important, because it is among the strongest determinants of impaired metabolic health and cardiac dysfunction. Measurement of anthropometrics and metabolic parameters is crucial as both might be useful in a hospital setting to assess the risk of a complicated course of disease in patients with positive COVID-19 tests.

Current knowledge suggests the virus can be transmitted through droplets, direct contact, and aerosols. Droplets transmission may occur when respiratory droplets of an infected person, are ingested or inhaled by individuals nearby. This is also been reported in our survey, as 50% of respondents reveal direct contact with confirmed case among family members in previous 2 weeks. Though, 30% responded that the source of infection was unknown. Fecal shedding may be another source of transmission.

The clinical spectrum of COVID-19 is very heterogeneous. The most commonly reported symptoms were fever, cough, and hypo/hyperglycemia. However, shortness of breath, headache, myalgia, upper respiratory symptoms (eg, sore throat and rhinorrhea), and gastrointestinal symptoms (eg, nausea and diarrhea) can also occur, as recently reported. Caution should be taken to potential hypoglycemic events either from severe illness and lack of food intake, ibuprofen should be handled with care as it could increase the hypoglycemic effect of insulin and with the use of chloroquine in these subjects. Patient tailored therapeutic strategies, rigorous glucose monitoring and careful consideration of drug interactions seem to reduce adverse outcomes.

Another issue during this COVID-19 pandemic has been the use of immunostimulants to help preventing the disease. To date there is insufficient evidence to conclude that children with type 1 diabetes are immunocompromised. The evidence indicates that an immunocompromised state occurs only in the context of poor glycemic control and/or with severe complications, such as DKA or in adults with vasculopathy and chronic kidney disease. The link between catching COVID-19 infection and diabetes was explored in this survey and 75% of HCP responded that parents did not ask for immunostimulant treatments. Interestingly, about the 25% who were asked for immunostimulant supplement, there is not a specific region of the world where this habit is consistent, but it was spread in several countries. It is important to note that immune supporting effects of supplements and vitamins, in the context of the COVID-19, are not proven. Furthermore, attention to nutrition, protein intake and vitamin status is important for individuals with diabetes at any time and thus as well
during this pandemic. Although a few studies recommend vitamin C supplementation as an antioxidant and higher doses of vitamin D in elderly in the first few weeks of COVID-19 infection or those with vitamin deficiency, neither vitamin D nor vitamin C supplementation appears to have any effect in protecting from COVID-19.

Of all respondents, 81% used paracetamol as antipyretic, in line with some non-confirmed recommendations, which hypothesized that ibuprofen or other non-steroidal anti-inflammatory drugs could be harmful for patients with COVID-19.

A low percentage of responders reported false positive elevated CGM reading (7%), especially among FreeStyle Libre users, perhaps due to acetaminophen interference; this kind of interference has been previously reported for several CGM systems, including Free-Style Libre.

In the lower respiratory tract, it appears that decreased angiotensin-converting enzyme 2 (ACE2), which binds to the receptor binding domain of SARS-CoV-2 virus, could portend a higher-risk of developing severe acute respiratory distress and lung injury. For this reason, 25% of responders advised their patients to interrupt ACEI in advance. No substantial increase in the likelihood of a positive test for COVID-19 or in the risk of severe COVID-19 was reported in association with five common classes of antihypertensive medications. In fact, the American Heart Association and other major associations recommend their continued use. Achieving glycemic targets should be the goal, no matter which drugs are being used.

Anxiety and parenting stress were the most commonly seen psychological problems among our responders. Living with diabetes and managing the condition on a day-to-day basis are associated with heightened levels of anxiety and distress. In a recent study, 25% experienced diabetes distress at the beginning of the COVID-19 pandemic, which corresponds to what is found under normal circumstances. A Danish study showed that people with diabetes have COVID-19-specific worries related to their disease, which is associated with poorer psychosocial health. These worries should be addressed through support targeting specific questions and needs of individuals with diabetes as well as frequent updates on new knowledge regarding COVID-19 and diabetes mellitus.

It is important to prioritize mental health in these stressful days for both patients and their families, which can have a big impact on diabetes control and blood glucose levels. People with diabetes are two to three times more likely to have depression. Use of technology to stay connected to friends and family; trying an online meeting or calling a friend may lessen the stress patients might experience.

Strengths of our study are the global sourcing (215 centers in 75 countries) among HCP with a focus on pediatric diabetes and the timeliness of the survey, which was initiated very shortly after substantial lockdown in most countries due to the COVID-19 pandemic. Although SARS-CoV-2 infection in adults includes persons with diabetes in the vulnerable, high-risk population, our report suggests that children with diabetes do not belong to the high-risk group. This might have some important implications for children with diabetes and the restart of school, since does not seem they have to be more cautious than their healthy peers.

Limitations of the survey may be that we present observational data from some countries but not all where COVID-19 spread out, even if the most interested ones (by numbers of infected people and deaths) are all represented. While 15% reported a higher incidence of DKA, only registry data prospectively will show accurately any impact on the rates of DKA presentation. However, we acknowledge that the missed countries could have had different experience or knowledge in handling these patients. Relating to this issue we would like also to highlight that out of approximately 2300 emails sent, we received only 303 responses (13%). Even if in line with the answer rate to similar surveys, these low numbers could be due either to the pandemic itself and much less time to manage usual daily workload, and the fact that some of the email addresses could have been changed or not active anymore.

Follow-up survey could be of utmost importance to improve our knowledge and to evaluate the effects of COVID-19 over time.

In conclusion, this large global survey, done with HCP coming from centers treating children and adolescents with diabetes, showed how HCP adapted their current practices during COVID-19 pandemics. Social isolation highly influenced patients care around the world, favoring remote consultation through telehealth/telemedicine as an option to maintain assistance to patients with diabetes, in comparison to traditional face-to-face consultation. The great majority of centers did not have diabetes children COVID-19 positive, and from those who had, the majority had just mild/moderate disease course. The emergence of COVID-19 pandemic had an important impact on family’s behavior that might be associated with increase in DKA at diagnosis and delaying new onset diagnosis.

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CONFLICT OF INTEREST
The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS
Nancy Samir Elbarbary, Tiago Jeronimo dos Santos, Carine de Beaufort, Juliana Chizo Agwu, Luís Eduardo Calliari, Andrea Enzo Scaramuzza drafted, revised, and approved the survey. Nancy Samir Elbarbary and Tiago Jeronimo dos Santos analyzed data. Nancy Samir Elbarbary and Andrea Enzo Scaramuzza drafted the manuscript. All Authors edited and discussed the manuscript. All Authors approved the final version of the manuscript.

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