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# Availability and access to pediatric diabetes care: a global descriptive study

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## Highlights

- Pediatric endocrinologists are not widely available to manage pediatric diabetes.
- Patients are either partially or completely responsible for insulin payments in some countries.
- Government support for insulin pumps and continuous glucose monitors is only available in a few countries.

**Abstract.** A decade since the discovery of insulin, the increasing prevalence of type 1 diabetes mellitus (T1DM) has underscored the prevailing inequalities in the provision of essential care for T1DM worldwide. However, the details on the availability of insulin types and associated medical devices remain unclear. A cross-sectional electronic survey was distributed across a global network of pediatric societies under the umbrella of the International Pediatric Association (IPA). Access to and availability of pediatric diabetes care were investigated using standardized questions. Responses from 25 of 132 pediatric societies across six regions were included. Pediatric endocrinologists typically manage T1DM together with pediatricians or adult endocrinologists. Nonetheless, 24% of the respondents reported pediatricians to be the sole healthcare professionals. According to the respondents, the patients were either partially or completely responsible for payments of insulin (40%), A1C (24%), C-peptide (28%), and antibody testing for diagnosis (28%). Government support is generally available for insulin, but this was merely 20% for insulin pumps and 12% for continuous glucose monitors. There are considerable disparities in the access, availability, and affordability of diabetes testing, medications, and support between countries with significant out-of-pocket payments for care. Country- and region-specific improvements to national programs are necessary to achieve optimal pediatric diabetes care globally.

**Key words:** type 1 diabetes mellitus (T1DM), diabetes, children, access, availability

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## Introduction

The Sustainable Development Goals adopted by the United Nations in 2015 address non-communicable diseases (NCDs) as a significant public health challenge. With less than a decade to reach SDG target 3.4, substantial work still needs to be done to reduce premature mortality from NCDs by a third (1). These targets cannot be achieved if diabetes in children is not considered a global priority. In 2019, the International Diabetes Federation Diabetes Atlas estimated that over 1 million children between the age of 0 and 19 yr are living with diabetes. This number continues to rise as an estimated 98,200 children aged 0–14 yr develop type 1 diabetes mellitus (T1DM) every year (2).

A century after the discovery of insulin, much progress has been made in the diagnosis and management of T1DM globally. Concurrently, the life expectancy of children and adolescents has increased substantially (3, 4). However, the high and rising prevalence of diabetes in children constitutes an increasingly important challenge that highlights the prevailing inequalities in the provision of essential care for pediatric diabetes patients worldwide (3). As per estimates, almost half the proportion of children in low-income countries (12.7%) compared to high-income countries (32.4%) reached optimized glycemic control, as indicated by the levels of glycated hemoglobin (< 7.5%) (5). Amidst the COVID-19 pandemic, additional challenges concerning the care and management of pediatric diabetes have arisen. These include delayed hospital admissions that lead to a higher proportion of severe diabetic ketoacidosis cases (6).

Available data from the Global Health Observatory suggest that less than half of the countries in Central Asia, East Asia, and Western Sub-Saharan Africa have insulin available in the public health sector (7). However, further details regarding the availability of insulin types and associated medical devices remain unclear. Also, little is known about national programs and registries that are specifically dedicated to children and adolescents living with diabetes.

To highlight the opportunities for improvement in the quality of pediatric diabetes care, this study reports the global picture of access to diabetes medication and testing. It includes the types of units that are mostly available and the payment scheme implemented, based on an international cross-sectional survey collaboratively conducted by the International Pediatric Association (IPA) and NCD Child.

## Methods

### Study setting and design

The target population was identified from the global network of national pediatric societies under the IPA umbrella. The link to the electronic survey was sent by email to the presidents of 132 national pediatric societies across six regions of the World Health Organization: South-East Asian Region, the Western Pacific Region, the European Region, the Eastern Mediterranean Region, the African Region, and Region of the Americas.

The survey period was from September 29 to October 19, 2021. The respondents received an invitation email explaining the survey's background, followed by a reminder email sent one day before the deadline. The extended deadline to complete the survey, from October 7 to October 19, 2021, was informed to respondents through an email sent on October 13, 2021.

The cross-sectional electronic survey was conducted using a web-based commercial survey software (Google Forms, Google LLC, California, USA). The rationale was explained in the first section of the survey, and respondents voluntarily provided their consent to participate by proceeding with the survey questions in the following sections. The response to each question was automatically collected, stored, and subsequently analyzed in an electronic spreadsheet. All subjects included were presidents of the national pediatric societies, presidents of the national pediatric endocrinologist association, or another person appointed as the representative of the society. Only a single response from each country was analyzed.

### The survey

The survey was developed by two pediatric endocrinologists, one representing IPA and the other representing NCD Child. The survey consisted of multiple-choice and open-ended questions that took approximately 10 min to complete. There were four sections of the survey. It started with a section explaining the objective of the survey. The second section covered the demographic profiles of respondents, while the third section included questions to assess general practices of diabetes care in children and adolescents. Additionally, a general question on the availability of C-peptide testing for confirmation of diabetes diagnosis, without limiting to a specific type of C-peptide evaluation among the various methods available, and questions on the availability of glucagon injection type only for the management of severe hypoglycemia were included. The questions in the last section were specifically aimed at obtaining information on the units of insulin and availability of associated devices along with the payment schemes implemented in the respective countries.

### Statistical analysis

Data analysis was performed using Google Sheets and SPSS version 25.0. Descriptive statistics were used to display demographic data and to evaluate the access, availability, and quality of diabetes care globally. Qualitative variables were presented as numbers and percentages. The sum of some results was less than the total number of participants because several questions were optional follow-up questions for those who answered "Yes" in the previous question. The open-


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ended answers were summarized by approximation into similar semantic content.

## Results

### Demographic profiles of respondents

A total of 27 responses were received. The responses from one country with two national pediatric societies were merged and considered as one response. In addition, one response that was not representative of a national pediatric society or a national pediatric endocrinologist society was excluded. Although it is non-representative, the illustrative sample of 25 pediatric societies from 25 countries across all regions was included in the final analysis for a preliminary discussion in this area (**Table 1**).

Most of the participants were from Europe and Africa (24% each), followed by the Eastern Mediterranean Region (20%). This survey included respondents from all four income group classifications by the World Bank. Among the respondents, more than half were the presidents of the national pediatric societies, while the remaining were representatives appointed by the societies.

### General practices of diabetes care in children and adolescents

The healthcare professional (HCP) who typically manages diabetic children and adolescents is generally a pediatric endocrinologist/diabetologist alone (11; 44%), together with a pediatrician (6; 24%), or with a pediatrician and an adult endocrinologist/diabetologist (3; 24%). In Afghanistan, Ethiopia, and Gambia, pediatricians are the sole HCPs responsible for pediatric diabetes care (**Table 2**).

The Clinical Practice Consensus Guideline from International Society for Pediatric and Adolescent Diabetes (ISPAD) was the most widely used. It was implemented with locally developed guidelines in most countries (8; 32%), and intensive insulin therapy was mainly prescribed. The testing methods to monitor T1DM are predominantly glucose strips (12; 48%) or together with Continuous Glucose Monitoring/CGM (6; 24%). All respondents reported that the A1C test was included in the protocol for metabolic control (**Table 2**). Also, 64% of respondents reported the availability of a comprehensive team. Only 56% reported the presence of a registry for T1DM patients in their country (**Table 2**).

Amidst the COVID-19 pandemic, most participants reported an interruption in the treatment of T1DM and an increase in the number of patients experiencing Diabetic Ketoacidosis (DKA). An increase in the number of T1DM cases was reported by 48% of the respondents, while the remaining individuals disagreed (28%) about such an incidence. Additionally, 24% of the individuals mentioned that they had not observed this trend.

### National program and supportive groups for children and adolescents with T1DM

The national diabetes campaign/media targeting healthy lifestyles was sometimes promoted (64%) or promoted regularly (24%) (**Table 3**). We asked if any kind of support groups for diabetes were active (**Fig.**

**Table 1.** Characteristics of respondents

| Characteristics | Number of Responses (%) |
|---|---|
| Region (based in WHO regions) | |
| South-East Asia | 3 (12) |
| Indonesia, Myanmar, Sri Lanka | |
| West Pacific | 3 (12) |
| Australia, Malaysia, New Zealand | |
| Eastern Mediterranean | 5 (20) |
| Afghanistan, Egypt, Palestine, Iran, Turkey | |
| Europe | 6 (24) |
| Republic of Kosovo, Lithuania, Russian, Armenia, Serbia, Germany | |
| Africa | 6 (24) |
| Côte d'Ivoire, Botswana, Ethiopia, Gambia, Ghana, Tanzania | |
| America | 2 (8) |
| Mexico, Guatemala | |
| Respondent's Country of Origin, based on Income Level (World Bank Classification 2021-2022) | |
| Low Income | 3 (12%) |
| Lower-middle income | 9 (36%) |
| Upper-middle income | 9 (36%) |
| High income | 4 (16%) |
| Designation within the Pediatric Society | |
| President | 14 (56) |
| On behalf of the President | 11 (44) |


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**Table 2.** Practices of diabetes care in children and adolescents

| Characteristics (number) | Number of Responses (%) |
|---|---|
| HCP typically manage children and adolescents with T1DM (25) | |
| - Pediatric endocrinologist/diabetologist | 11(44) |
| - Pediatric endocrinologist/diabetologist, Pediatrician | 6 (24) |
| - Pediatric endocrinologist/diabetologist, Pediatrician, Adult endocrinologist/diabetologist | 3 (12) |
| - Pediatrician | 3 (12) |
| - Pediatric endocrinologist/diabetologist, Adult endocrinologist/diabetologist | 1 (4) |
| - Pediatrician, Adult endocrinologist/diabetologist | 1 (4) |
| Availability of treatment guidelines for children and adolescents with T1DM (25) | |
| No | 2 (8) |
| Yes | 23 (92) |
| If yes, please indicate which treatment guidelines are used (23) | |
| - ISPAD, Locally developed | 8 (32) |
| - ISPAD | 5 (20) |
| - Locally developed | 3 (12) |
| - IDF/ISPAD | 2 (8) |
| - ISPAD, IDF/ISPAD, and Locally developed | 2 (8) |
| - ISPAD, IDF/ISPAD | 1 (4) |
| - ISPAD, IDF/ISPAD, CDiC, Life for a child | 1 (4) |
| - ISPAD, Locally developed, BSPED | 1 (4) |
| Type of insulin therapy used for majority of the children and adolescents with T1DM (25) | |
| - Intensive | 7 (28) |
| - Conventional | 6 (24) |
| - Conventional, Intensive | 5 (20) |
| - Intensive, Pump (CSII) | 5 (20) |
| - Conventional, Pump (CSII) | 1 (4) |
| - Pump (CSII) | 1 (4) |
| Testing method used to monitor T1DM (25) | |
| - Glucose strip | 12 (48) |
| - CGM | 2 (8) |
| - Glucose strip and CGM | 6 (24) |
| - Glucose strip and urine test | 4 (16) |
| - Glucose strip, urine test, and CGM | 1 (4) |
| A1C test included in the protocol for metabolic control (25) | |
| Yes | 25 (100) |
| No | 0 (0) |
| A comprehensive team (endocrinologist, educator/nurse, and dietician) is available in the diabetes clinic in respective country (25) | |
| Yes | 16 (64) |
| No | 9 (36) |
| A registry for T1DM patients is available in respective country (25) | |
| Yes | 14 (56) |
| No | 11 (44) |
| Treatments of T1DM is interrupted by the COVID-19 pandemic (25) | |
| Yes | 13 (52) |
| No | 10 (40) |
| Don't know | 2 (8) |
| The number of patients with T1DM increased during the COVID-19 pandemic (25) | |
| Yes | 12 (48) |
| No | 7 (28) |
| Don't know | 6 (24) |
| The number of patients experiencing DKA increased during the COVID-19 pandemic (25) | |
| Yes | 13 (52) |
| No | 7 (28) |
| Don't know | 5 (20) |

HCP, health-care professional; T1DM, type-1 diabetes mellitus; ISPAD, International Society for Pediatric and Adolescent Diabetes; IDF, International Diabetes Federation; CSII, continuous subcutaneous insulin infusion; CGM, continuous glucose monitoring.


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**Table 3.** National program and campaign on diabetes

| Characteristics (number) | Number of Responses (%) |
|---|---|
| How often a national diabetes campaign/media campaign targeting a healthy lifestyle is conducted in the respective country (25) | |
| Sometimes | 16 (64) |
| Often | 6 (24) |
| Rarely | 2 (8) |
| Never | 1 (4) |

**Table 4.** Availability of diabetes testing/medications

| Characteristics (number) | Number of Responses (%) |
|---|---|
| C-peptide testing available for confirmation of diabetes diagnosis (25) | |
| Yes | 21 (84) |
| No | 4 (16) |
| Antibody testing is typically available for diagnosis of T1DM (25) | |
| Yes | 14 (56) |
| No | 11 (44) |
| Glucagon injection available for management of severe hypoglycemia (25) | |
| Yes | 13 (52) |
| No | 11 (44) |
| Don't know | 1 (4) |
| If yes, how often is it available for children and adolescents with T1DM? (13) | |
| Rarely | 5 (38.5) |
| Sometimes | 5 (38.5) |
| Often | 3 (23.1) |

**1**). Altogether, 25 participants reported that diabetes associations (88%), diabetes camps (84%), and groups of diabetes care providers (76%) provided the most active support in their respective countries. In contrast, only a few studies have indicated the contribution of a dedicated diabetes phone helpline (28%).

## Availability of diabetes testing/ medication and payment scheme

The most commonly available diagnostic tool among our respondents was C-peptide testing. Its availability was confirmed by 21 respondents (84%). On the other hand, antibody testing is less widely available, with only 14 respondents (56%) confirming its availability in their respective countries (**Table 4**).

For the management of diabetes, glucagon injection was found to be available in 13 countries (52%), with 11 respondents reporting its unavailability (44%) whereas a single respondent was unaware of its availability (4%). When asked about the availability of glucagon injections, three respondents stated that it was "often" (23.1%) available, five stated that it was "sometimes" (38.5%) available, and another five stated that it was "rarely" available (38.5%) (**Table 4**).

As summarized in **Fig. 2**, various tools for the diagnosis and management of diabetes are available at no charge in different government hospitals. Majorly, insulin was available at no charge in 14 countries (56%), A1C in 15 countries (60%), C-peptide in 10 countries (48%), and antibody testing for the diagnosis of T1DM in 12 countries (48%). However, a significant portion of respondents also stated that the payment scheme was partially aided by both the government and the patient. This was applicable in ten countries for insulin (40%), six countries for A1C (24%), seven countries for C-peptide (33.3%), and seven countries for antibody testing concerning the diagnosis of T1DM (28%).

Unfortunately, there continue to be countries that mainly rely on out-of-pocket payments for patients. This is reflected in the case of insulin injections in one country (4%), A1C testing in four countries (16%), C-peptide testing in four countries (19%), and antibody testing diagnosis for T1DM (24%) in six countries.

## Access to insulin and accessories for children and adolescents with diabetes

In the final section of the survey, we sought in-depth information concerning access to insulin and accessories for diabetic children and adolescents. This included information on the availability of various units of tools and medications, the vendors that provide such tools and medications, and their general availability.

Cartridge for pens (300 IU) was reported as the most commonly available unit for short-acting insulin


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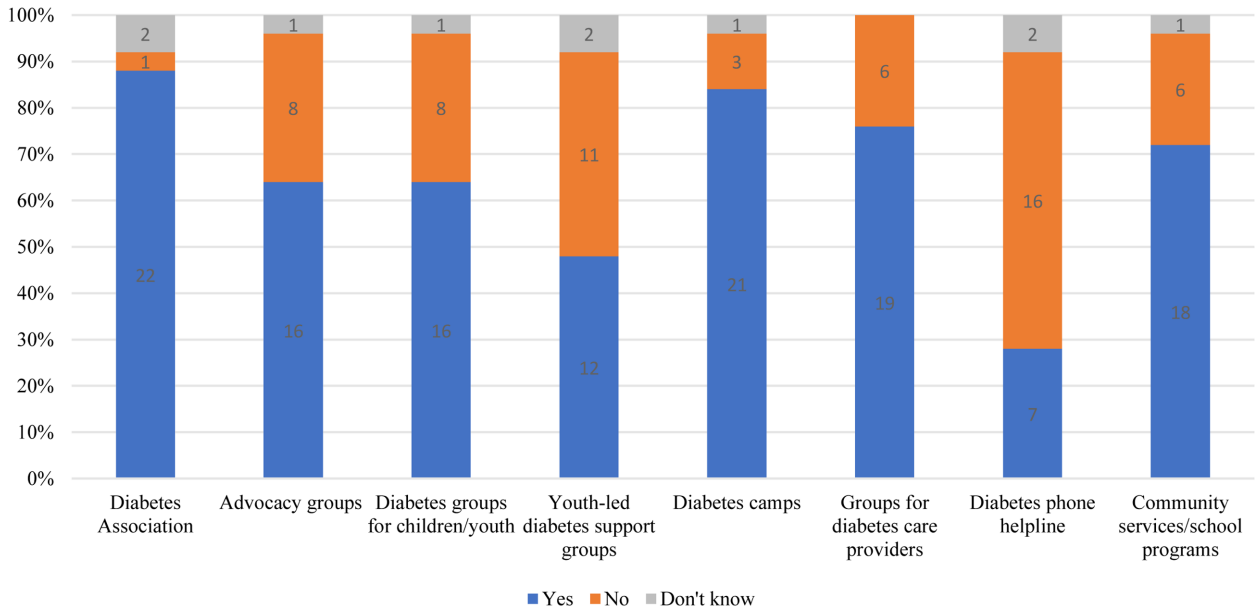


**Fig. 1.** HCP's perspective on the engagement of different types of support groups for diabetes.

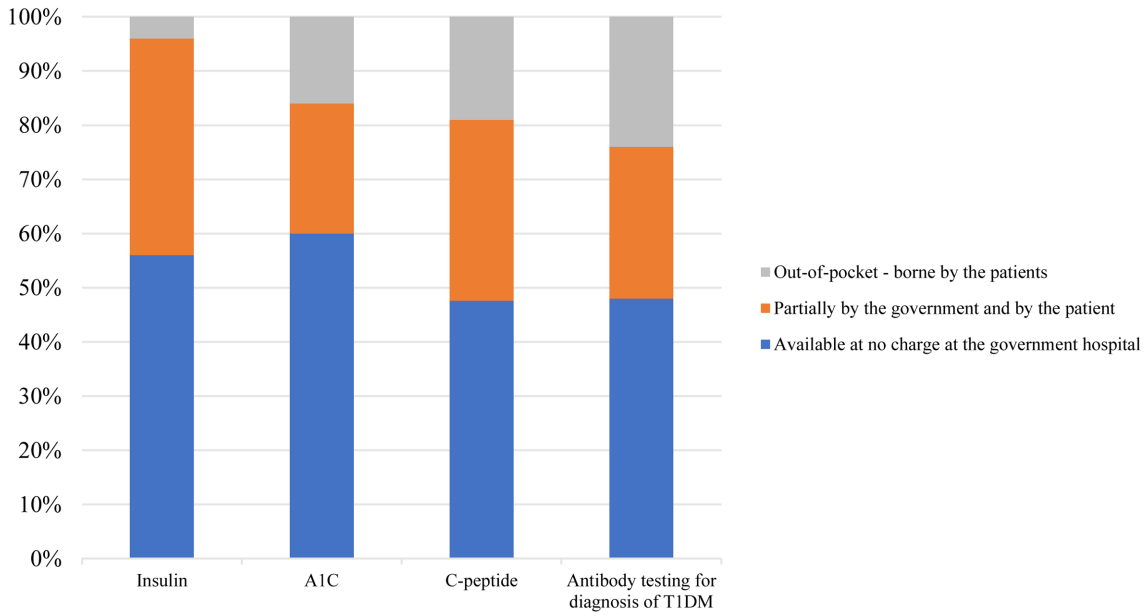


**Fig. 2.** Payment scheme of various diabetes testing tools and management.

(16; 64%), intermediate-acting insulin (15; 60%), rapid-acting insulin (19; 76%), and long-acting insulin (20; 80%). Meanwhile, fewer respondents answered vial (1,000 IU) as the most commonly available unit for short-acting insulin (9; 36%), intermediate-acting insulin (10; 40%), rapid-acting insulin (6; 24%), and long-acting insulin (5; 20%) (**Table 5**).

The government provides the majority of the insulin and syringes as evidenced from the positive responses ranging from 40% to 60%. The number of respondents that reported government support for other accessories such as glucose monitors for self-monitoring of blood glucose (SMBG) (8; 32%), insulin pumps (5; 20%), CGM (3; 12%), and glucagon injection (9; 36%), was relatively lower. As mentioned by the respondents, these items were mainly provided by out-of-pocket payments (**Table 5**).

Concerning the availability of medicines and accessories, 13 respondents (52%) reported that short-acting insulin, intermediate-acting insulin, rapid-acting insulin, and long-acting insulin are all available at all times in their countries. The results of the availability rate of other categories further showed that in comparison to rapid-acting insulin and long-acting insulin, the availability of short- and intermediate-acting insulin was more abundant.

Tools such as syringes and insulin pens were more commonly available. Altogether, 12 respondents reported


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**Table 5.** Access to insulin and accessories for children and adolescents with diabetes

| | Short-acting insulin | Inter-mediate-acting insulin | Rapid-acting insulin | Long-acting Insulin | Syringes | Insulin Pens | Glucose moni-tors for SMBG | Test strip | Insulin pumps | CGM | Glucagon injection |
|---|---|---|---|---|---|---|---|---|---|---|---|
| The most commonly available unit | | | | | | | | | | | |
| | vial (1,000 IU): 9 (36) cartridge for pens (300 IU): 16 (64) | vial (1,000 IU): 10 (40) cartridge for pens (300 IU): 15 (60) | vial (1,000 IU): 6 (24) cartridge for pens (300 IU): 19 (76) | vial (1,000 IU): 5 (20) cartridge for pens (300 IU): 20 (80) | 40 IU: 8 (32) 100 IU: 17 (68) | N/A | N/A | N/A | N/A | N/A | N/A |
| Provider of medicines and accessories for children and adolescents with diabetes | | | | | | | | | | | |
| Government | 12 (48) | 13 (52) | 13 (52) | 15 (60) | 10 (40) | 12 (48) | 8 (32) | 10 (40) | 5 (20) | 3 (12) | 9 (36) |
| NGO | 0 (0) | 1 (4) | 1 (4) | 0 (0) | 2 (8) | 1 (4) | 2 (8) | 2 (8) | 0 (0) | 0 (0) | 0 (0) |
| Both | 11 (44) | 10 (40) | 7 (28) | 6 (24) | 7 (28) | 6 (24) | 7 (28) | 5 (20) | 4 (16) | 4 (16) | 3 (12) |
| Out of pocket | 2 (8) | 1 (4) | 4 (16) | 3 (12) | 4 (16) | 4 (16) | 8 (32) | 8 (32) | 13 (52) | 15 (60) | 8 (32) |
| Don't know | 0 (0) | 0 (0) | 0 (0) | 1 (4) | 2 (8) | 2 (8) | 0 (0) | 0 (0) | 3 (12) | 3 (12) | 5 (20) |
| Rate of medicines and accessories availability for children and adolescents with diabetes | | | | | | | | | | | |
| Available 100% of the time | 13 (52) | 13 (52) | 13 (52) | 13 (52) | 12 (48) | 12 (48) | 10 (40) | 10 (40) | 7 (28) | 6 (24) | 8 (32) |
| 75%–99% | 8 (32) | 7 (28) | 4 (16) | 4 (16) | 5 (20) | 3 (12) | 6 (24) | 6 (24) | 2 (8) | 2 (8) | 0 (0) |
| 25%–74% | 2 (8) | 3 (12) | 4 (16) | 4 (16) | 4 (16) | 3 (12) | 7 (28) | 6 (24) | 4 (16) | 4 (16) | 2 (8) |
| < 25% | 1 (4) | 1 (4) | 3 (12) | 3 (12) | 2 (8) | 4 (16) | 0 (0) | 2 (8) | 8 (32) | 9 (36) | 10 (40) |
| Don't know | 1 (4) | 1 (4) | 1 (4) | 1 (4) | 2 (8) | 3 (12) | 2 (8) | 1 (4) | 4 (16) | 4 (16) | 5 (20) |

SMBG, self-monitoring blood glucose; CGM, continuous glucose monitoring; NGO, non-governmental organization.

100% availability (48%), and five (20%) and three (12%) respondents reported 75% to 99% availability, respectively. Glucose monitors for SMBG and test strips are also commonly available with ten respondents reporting their 100% availability (40%). Additionally, more respondents reported a 75% to 99% availability of these items compared to syringes and insulin. On the other hand, insulin pumps, continuous glucose monitors, and glucagon injections were less commonly available, with eight (32%), nine (36%), and ten (40%) respondents reporting less than 25% availability of those items in their countries (**Table 5**).

## Discussion

This study provides initial insights into the general practice of T1DM care in children and adolescents globally, including the availability and access to testing and medication. Data were collected from the representatives of the national pediatric societies or pediatric endocrinologist societies from 25 countries across all six regions of the WHO (Southeast Asia, West Pacific, Eastern Mediterranean, Africa, and America). Although it is not representative of the world or low- and middle-income countries (LMICs) at large, the data still reveal an insight into a neglected area of care for children and adolescents. We intend to expand this survey to include a more regular reporting of the situation.

While the prevalence of type 2 diabetes mellitus (T2DM) in children and adolescents has been increasing globally in the past two decades, T1DM remains the most prevalent type of diabetes in young people (8) that requires effective management. In addition to the need for insulin injections for survival, the expected outcomes can be achieved only with multiple daily injections, self-monitoring of blood glucose (SMBG), comprehensive diabetes education, and guidance from skilled HCPs. Nonetheless, there is a shortage of skilled providers with expertise in diabetes care (9). Moreover, the implementation of specific benchmarks of care is limited by a lack of resources.

A comprehensive team was reported as not available by 36% of the respondents (**Table 2**). The survey showed that the HCP who typically manages diabetic children and adolescents is a pediatric endocrinologist/diabetologist. Such a professional might either work alone or in conjunction with a pediatrician. Meanwhile, all three representatives from low-income countries in this study, including Ethiopia, reported that the pediatrician was the sole HCP responsible for pediatric diabetes care. In Ethiopia, there is only one pediatric endocrinologist for more than 40 million children (10). Shortage and poor distribution of qualified HCPs is a recurring problem in low- and middle-income countries. The problem is further aggravated by the lack of technical guidance, training programs, and financial resources to support such programs (11). This highlights the global difference in access to not only medications but also human resources.

In the majority of the participants' countries, the Clinical Practice Consensus Guideline from ISPAD and Global International Diabetes Federation (IDF)/ISPAD


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Guideline for Diabetes in Childhood and Adolescence (12, 13) are used along with locally developed guidelines.

Intensive insulin regimens delivered by combinations of injections or pump therapy with differential substitution of basal and prandial insulin have become the gold standard for all age groups in pediatric diabetology (14). It is reported as the type of insulin regimen prescribed for the majority of the children and adolescents with T1DM (28%), followed by conventional (24%), a combination of intensive and conventional (20%), and a combination of intensive and Continuous Subcutaneous Insulin Infusion (CSII)/ insulin pump therapy (20%). Only one respondent from the high-income country category reported CSII as the major type of insulin therapy that was used in the country. Two respondents who answered using a combination of intensive and conventional therapies reported that intensive therapy was mainly prescribed in big cities or teaching hospitals, while the other was for hospitals in peripheral areas.

Glycemic control in children and adolescents with diabetes is essential. Both quarterly hemoglobin A1c (HbA1c) and regular home glucose monitoring (accurate finger stick blood glucose measurements, with or without CGM) are needed for assessment (15). All respondents reported that HbA1c was included in the metabolic control protocol. Finger stick blood glucose monitoring was reported as the most widely used method to determine blood glucose levels, while CGM was available to be used only in about one-third of the respondents' countries.

Recent findings show that compared with MDI, CSII is associated with improved long-term clinical outcomes, and the implementation of CGM in patients with T1DM is a cost-effective strategy driven by reducing short- and long-term complications (15, 16). Also, CGM has been associated with lower HbA1c compared to finger-stick only and has been approved for pediatric use (17).

During the COVID-19 pandemic, around 50% of respondents reported delayed treatment of T1DM despite an increased number of patients with T1DM and DKA. An international survey conducted by the ISPAD showed similar results. At the height of the COVID-19 pandemic, fear, and hesitation associated with hospital visits as well as recurrent lockdowns and public health measures affected the frequency of hospital visits, thereby restricting patients' and families' access to essential diabetes care and ability to consult with healthcare professionals (18, 19). In a significant number of centers, a new diagnosis of T1DM would have been possibly postponed, resulting in a more severe DKA due to delayed diagnosis during the pandemic (20).

Approximately, half of the countries participating in this study reported that a national registry for T1DM was available. Registries have the potential to collect large datasets that can be utilized for local quality control and benchmarking against national targets (21). Countries with national diabetes registries have demonstrated improved metabolic control over time through benchmarking and exchange of expertise facilitated by national and international network establishments. Additionally, quality registry study results may further serve as a basis for policy decision-making. The development of new registries where they are not available is highly encouraged (22).

The effectiveness of diabetes management relies on adequate support and structured education for children and parents. Studies have shown that the availability of various forms of support including emotional, informational, and physical support plays a significant role in the effective care of T1DM, contributing to a reduction in stress and enhancing well-being (23). ISPAD highlights the role of diabetes peers and/or youth leaders who aid patients and families in learning about their condition. Additionally, they also reinforce the principles of better living with diabetes (24). Most of our respondents reported the support of diabetes associations (88%), diabetes camps (84%), and groups for diabetes care providers (76%) in their respective countries.

Appropriate education concerning diabetes is not only important for patients and families, but children and adolescents with T1DM are also negatively impacted by a lack of knowledge and misinformation (25). The stigma that arises from hypoglycemia disruptions, social prohibitions in meals, and continuous self-caring causes internal conflicts, influencing some adolescents to avoid disclosing their disease (25, 26) and potentially making them targets of bullying (27). Furthermore, the rise in obesity in children contributes to the increase in type 2 diabetes (28). This highlights the need for greater concerted efforts in national education programs.

Affordability and accessibility are important determinants of healthcare utilization (29). Studies have established that geographic and economic access to healthcare is strongly tied to positive health outcomes (30, 31). It is well established that insulin analogs, blood glucose test strips, insulin pumps, and continuous glucose monitoring are provided differently by national health facilities in high- and low-income nations (8, 32). Our study found that approximately half of our respondents still have patients either partially or completely responsible for payments of insulin, A1C, C-peptide, and antibody testing for diagnosis. While a majority of respondents reported that government support is available for insulin, there is still a lack of government support for insulin pumps and continuous glucose monitors. Altogether, 52% and 60% of respondents reported that patients rely on out-of-pocket payments for insulin pumps and continuous glucose monitors, respectively. Better accessibility, availability, and affordability are necessary to achieve optimal glycemic control in diabetic children and adolescents.

This study has several limitations. We received fewer responses than expected. We hypothesize that this is because the surveys were delivered to the presidents of IPA national member societies, who might not have

direct access to pediatric endocrinologists representing their countries. This lack of direct access may have resulted in an inaccurate portrayal of the availability and accessibility of insulin and various diabetic care products in their respective countries. The other reason for non-response might include survey fatigue, as the survey was sent during the COVID-19 pandemic with a limited response timeline of one month. With a smaller-than-anticipated survey response rate, the distribution of respondents was slightly limited, and participation from major countries, where advanced diabetes technologies are more frequently used, was missing in this study. This highlights the need for more representative data collection in the future. Nevertheless, this is one of the very few studies in recent years that provide an update on pediatric diabetes care globally.

In conjunction with the 100th anniversary of the discovery of insulin, the WHO Member States convened a meeting to adopt the first-ever global coverage targets for diabetes at the 75th World Health Assembly. Among the five targets set for 2030, ensuring 80% 'have good control of glycemia' and '100% of people with T1DM have access to affordable insulin and blood glucose self-monitoring' were of special significance (33). Our data demonstrate that although much progress has been made, access and availability of various medicines and accessories vastly differ between countries. With inequities in access and availability, patients' capability to maintain glycemic control is compromised, leading to a cascade of symptoms from decreased cognitive function and psychiatric disorders to an increase in disability-adjusted life years (34, 35). Furthermore, disparities are not only limited to medicines and accessories but also to healthcare professionals concerning their competency to handle pediatric diabetes cases comprehensively and effectively. This reflects the unmet need for training pediatricians and pediatric endocrinologists.

## Conclusion

The general care, access, availability, and affordability of diabetes testing, medications, accessories, and support differ across different countries. Country- and region-specific improvements to national programs and further support for patients and their families are needed to achieve optimal care for diabetic children and adolescents worldwide.

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