

Polish Recommendations for the Early Detection of Type 1 Diabetes in the Pediatric Population: A Position Statement of the Polish Society of Pediatric Endocrinology and Diabetology and the Pediatric Section of the Diabetes Poland 2026.

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Significant advances in the understanding of the diversity of the clinical picture of type 1 diabetes (T1D) and in the development of disease-modifying therapies for T1D since the beginning of the 21st century – including the approval of teplizumab in the USA and other countries as the first agent to delay disease progression from stage 2 to clinically manifest T1D (stage 3) – have spurred the intensification of screening initiatives in many countries [1 – 7]. T1D is a common autoimmune disease with substantial socioeconomic consequences. In 2022, approximately 9.5 million people worldwide were living with T1D, and prognoses indicate that this number will double within the next 2 decades [8]. A high increase in the incidence of T1D among children and adolescents has also been documented in epidemiological studies conducted in Poland [9 – 12]. Among children under 14 years of age, the incidence has risen more than fourfold over the past 33 years, reaching 30.45 cases per 100,000 children per year in 2022. The most pronounced increases in new diagnoses have been observed in children under 4 years of age [13]. A global survey showed that the main reason for diabetes care teams to perform screening – including population-based screening – is the presence of such programs and the chance to identify individuals who might benefit from prevention or disease-modifying treatments designed to delay the progression of T1D [7].

Screening for T1D based on the assessment of islet autoantibodies – GADA (glutamic acid decarboxylase antibodies), IA-2A (insulinoma-associated protein 2 antibodies, i.e., antibodies against tyrosine phosphatases), ZnT8A (zinc transporter 8 antibodies), and IAA (insulin autoantibodies) – is both effective and sensitive [1 , 5]. Immunological testing alone is sufficient to determine the risk of developing T1D [14]. National screening programs have already been implemented in some countries, for example, Italy, Israel, and Australia (in pilot form) [15 – 17].

Because first-degree relatives of people with T1D are at higher risk, early screening programs initially focused on this high-risk group. However, about 85–90% of T1D patients have no family history of the disease [18 , 19]. Therefore, to improve early detection, population-based screening for children is ultimately necessary [1 , 15 , 20 – 24]. Notably, the progression from stage 1 T1D to more advanced stages is similar in children with and without a positive family history [18 , 25 , 26]. A summary of the key international and Polish T1D screening studies is shown in Table 1 .

Selected studies on screening for the detection of preclinical stages of T1D

Screening and monitoring of individuals in the preclinical stages of T1D provide significant clinical, economic, and health system benefits, as emphasized by recent study results and recommendations from scientific societies [1 , 20 , 40 , 41].

1. Reduction in diabetic ketoacidosis (DKA) at diagnosis of clinically manifest T1D to below 5% [1 , 22 , 28 , 42 – 46]. DKA not only poses an immediate life-threatening risk but can also result in numerous acute complications, including cerebral edema, ischemic stroke, and hypovolemic shock, as well as long-term sequelae such as cognitive impairment. It also reduces the likelihood of partial remission [1 , 46]. Children under 5 years of age are particularly vulnerable to a more rapid disease course [20 , 47], and both the youngest children and adolescents are at the highest risk for DKA [48 , 49]. Currently, the prevalence of DKA at diagnosis ranges from 15% to 70% in Europe and North America [45], whereas in Poland, it remains approximately 50% [50].

Shorter duration of untreated hyperglycemia.

Time for children and families to prepare for the transition to insulin therapy, enabling a smoother initiation of treatment [1 , 4 , 23 , 28 , 51].

Lower HbA1c and higher time in range (TIR, 70–180 mg/dL) at diagnosis, along with preservation of higher C-peptide secretion, are associated with improved long-term metabolic control and reduced risk of diabetes-related complications in adulthood [1 , 18 , 40].

Reduced parental/caregiver stress. The psychological burden at the time of T1D diagnosis following screening is lower than the distress associated with the intensive management of clinically overt T1D with accompanying DKA [27 , 28].

Opportunities for therapeutic intervention. The approval of the first disease-modifying therapy and ongoing development of additional agents provide the potential for early intervention in individuals identified in preclinical stages of T1D [4 – 6 , 22 , 40].

A substantial reduction in the incidence of DKA at the time of T1D diagnosis translates into shorter hospital stays and decreased healthcare expenditures. Moreover, preventing DKA at onset, along with achieving lower HbA1c levels, reduces the risk of long-term complications [30 , 31 , 41]. Collectively, this renders screening cost-effective, as it also contributes to long-term health preservation resulting from lowering the risk of severe hypoglycemia and vascular complications associated with T1D [1 , 31 , 51].

1. Screening for T1D may be cost-effective if early diagnosis and intervention lead to sustained metabolic benefits [1]. Analyses conducted in the USA indicate that screening for islet autoantibodies is cost-effective if it reduces the incidence of DKA at diagnosis by 20% and achieves a lifetime HbA1c reduction of 0.1% (1.1 mmol/mol) [31].

Advances in autoantibody detection technologies, such as multiplex ELISA, may further decrease costs by reducing required sample volumes and laboratory workload [52].

European experience suggests that the cost of screening can be as low as EUR 22 per child tested, with the cost of identifying one case of presymptomatic T1D estimated at EUR 7,035. The most significant contributors to total costs are sample collection, followed by laboratory analyses and program coordination [53].

Although the approval of preventive therapies such as teplizumab (initially available in the USA [54] and currently also in some other countries) is associated with substantial increases in treatment costs aimed at delaying T1D progression, the potential health benefits may justify their cost-effectiveness. Further analyses are needed to develop less expensive and more widely accessible preventive strategies [1 , 41 , 55 , 56].

Definitions and diagnostic criteria of the different T1D stages are presented in Table 2 [1 , 4].

Definitions and diagnostic criteria for the stages of T1D [1 , 4]

Fasting glycemia <100 mg/dL (<5.55 mmol/L)

Glycemia at 120' of the OGTT <140 mg/dL (<7.77 mmol/L)

Fasting glycemia 100–125 mg/dL (5.55–6.94 mmol/L)

Glycemia at 120' of the OGTT 140–199 mg/dL (7.77–11.05 mmol/L)

Blood glucose ≥ 200 mg/dL (≥ 11.1 mmol/L) in intermediate time points of the OGTT (30, 60, 90 min)

HbA1c 5.7–6.4% (38.89–46.44 mmol/mol) or its 10% increase over >6–12 months

TAR >140 mg/dL (7.77 mmol/L) 10–19% in a 10-day CGM report*

OGTT, oral glucose tolerance test; TAR, time above range 140 mg/dL (7.77 mmol/L); CGM, continuous glucose monitoring.

*International consensus on cutoff values is lacking; current thresholds are based on data from studies employing blinded devices.

Detected islet autoantibodies at screening require referral to a pediatric diabetology clinic and/or a hospital department specializing in the diagnosis and management of diabetes in children, to confirm the diagnosis and determine the stage of T1D (Fig. 1). Although the oral glucose tolerance test (OGTT) remains the gold standard for diagnosis, it is not always feasible; therefore, alternative diagnostic approaches are presented in Table 2 . In several countries, dedicated ICD-10 codes have been introduced for the individual stages of T1D, which substantially support administrative and epidemiological reporting of new cases [1 , 4]: E10.A0 – presymptomatic T1D, unspecified,

E10.A2 – presymptomatic T1D, stage 2 (Fig. 2).

Proposed scheme for early detection of T1D in the Polish pediatric general population and follow-up based on the obtained results.

Stages of T1D. Abnormalities in glucose metabolism for dysglycemia and hyperglycemia occur in one or more of the listed parameters (* – an international consensus on cutoff values has not been established; current thresholds are based on data from studies using blinded devices).

The estimated risk of progression from early stages to stage 3 T1D depends on the type and combination of parameters used to assess it [57]. T1D progression is influenced by factors such as genetic risk heterogeneity and metabolic phenotypes of the disease. Various immunogenetic pathways collectively affect beta cells and cause other pancreatic pathologies, eventually leading to clinically overt T1D, which presents at different ages and with varying severity [58].

Individuals with a single islet autoantibody (depending on its titer and type) have a higher risk of progression to stage 3 T1D than the general population [37 , 58]. Once at least 2 islet autoantibodies are detected, progression to the overt stage 3 T1D typically occurs over several years (Table 3) [22 , 28 , 58 , 59]. The risk of progressing to more advanced stages of T1D increases in the presence of IA-2A or ZnT8A autoantibodies and a high titer of any islet autoantibody. Other factors associated with an increased risk of progression include, among others,

genetic background, higher body mass index, insulin resistance, and the mass and function of beta cells [27 , 37 , 60 – 62].

Risk of progression to stage 3 T1D depending on autoimmunization or stage of T1D in children [4]

*Presence of a single islet antibody is lost over time in approximately 50% of children. Many individuals with one antibody will never develop T1D. Assessing the meaning and clear procedures in case of a single islet antibody presence are still being investigated.

The tempo of T1D progression from stage 1 to the next stages does not differ significantly between individuals with and without a positive family history of T1D [18 , 25 , 26]. The appearance of islet autoantibodies has a distinct peak between 9 months and 3 years of age. In 80% of children who developed stage 3 T1D before the age of 20, autoantibodies had appeared before the age of 5 years [61 , 63]. The earlier the onset of autoimmunity, the faster the progression to stage 3 T1D, with the most rapid course observed when autoantibodies appear before 10 years of age and particularly before 3 years [60 , 63].

Currently, screening for T1D is performed using capillary (including dried blood spot) and venous blood, optimally with micro-methods that minimize blood volume requirements and increase the comfort and acceptance of the test [23 , 40]. Combining them with other screening tests is advantageous.

Screening assays include detection of the following antibodies: GADA, IA-2A, ZnT8A, and IAA (optimally all four) using various laboratory tests [1 , 5 , 23 , 40 , 64]. Screening must be based on double evaluation. The first assessment should be performed with a high-sensitivity test, so that the absence of antibodies can be considered definitive. A result revealing the presence of antibodies must be verified by performing a second, confirmatory autoantibody assessment. It is advised that the confirmatory test be performed from a different, preferably venous blood sample, in accordance with the Islet Autoantibody Standardization Program and in a laboratory certified for such tests [22 , 64]. The interval between the two measurements should be short (ideally within 3 months) to avoid delaying referral for specialized care. Already from the first blood draw, the child's caregivers need to be informed about the clinical signs and symptoms of T1D and DKA and instructed to urgently seek medical care if such symptoms develop.

Populations at increased risk for T1D in whom screening should be performed include the following: Children with a first-degree relative (parent or sibling) with T1D,

children with high genetic risk (e.g., HLA-DR3/DR4, HLA-DQ8),

children with other autoimmune diseases, including autoimmune thyroid disease, celiac disease, Addison's disease, juvenile idiopathic arthritis, and vitiligo.

Approximately 85–90% of children diagnosed with T1D do not have an affected relative. Therefore, population-based screening enables the identification of the majority of individuals with presymptomatic T1D or at risk of progression.

Current estimates suggest that screening at:

Age 3 years identifies ~35% of cases progressing to stage 3 T1D by age 18 [1 , 23 , 57 , 61],

Ages 2 and 6 years identifies ~65% of cases [1 , 23 , 41 , 61],

Ages 2, 6, and 10 years identify ~80% of cases [1 , 61].

The absence of any islet antibody does not mean that there is absolutely no risk of developing T1D in the future. Individuals participating in screening and their caregivers should be clearly informed that, depending on the child's age, re-screening may be possible. There is also a possibility that antibodies will develop between screening tests.

The management algorithm for antibody detection in screening and subsequent stages of T1D is presented in Figure 1 . The type and frequency of assessments in children at risk of disease progression depend on: The number of present islet autoantibodies,

A child diagnosed with stage 1 T1D who subsequently has absent antibodies remains at increased risk and should continue to undergo monitoring for disordered glucose metabolism [22]. For individuals with stage 2 T1D, follow-up visits with a pediatric endocrinologist and diabetologist and/or diabetologist and diabetes educator should occur every 3 months. These visits aim to foster understanding of autoimmunity, provide knowledge about T1D and its progression, and prepare the patient and family for subsequent stages of management [65].

System regulatory actions should be aimed at avoiding discrimination against people with islet antibody/ies detected in the screening test and diagnosed with an early stage of T1D. Preclinical diagnosis often has implications for the daily lives of children and their families. The screening result causes the caregivers and children to feel natural stress and anxiety, which results mainly from uncertainty about when the clinical symptoms will develop, as well as ambiguity about further management. It is underlined that anxiety is often most pronounced immediately after receiving the result informing about the presence of antibodies but tends to diminish with the provision of additional information and psychological support. Stress may persist longer if there are no clear guidelines for ongoing monitoring [1 , 22 , 65]. Therefore, it is advised to plan systemic medical care actions. After confirmation of the presence of islet antibodies, further diagnostic and therapeutic management should be scheduled as soon as possible. Best practices include ensuring continuous access to an educator, dietitian, psychologist, and other members of a specialized diabetes care team, as well as access to educational resources specifically designed for children and families with preclinical T1D [1 , 65].

Structured family education and psychological support are crucial for effectively adapting to screening results and adopting healthy, long-term nutrition and activity habits. These measures strengthen family competence in managing the child's health, provide emotional support, and facilitate effective preparation for subsequent disease stages.

Although introducing a healthy lifestyle does not prevent the development of T1D, it supports metabolic health, reduces oxidative and inflammatory stress, improves the quality of life in children at risk of T1D, and, in some cases, may prolong the presymptomatic period of T1D. In all cases of stage 1 or 2 T1D, the diagnosis should be communicated to the child's primary care physician to heighten vigilance for disease progression, including opportunistic assessment of random glucose levels during any primary care visit.

Specialist nutritional, educational, and psychological counseling should be targeted at people with the presence of islet autoantibody/ies and/or a diagnosis of early-stage T1D, suited to the speed of the disease progression and the family conditions of the child, and provided in accordance with the current recommendations of Diabetes Poland and ISPAD [1 , 20 , 22 , 65 , 66].

The aim is to provide basic knowledge regarding the management of preclinical stages of T1D and to support families in adapting to the new circumstances. The scope of education primarily includes the following: Basic information regarding the etiopathogenesis and development of T1D,

lucose monitoring – training in the use of blood glucose monitoring devices,

principles of a healthy lifestyle, including nutrition, physical activity, avoidance of harmful substances, and adequate sleep,

Opportunities for participation in clinical trials and therapeutic interventions aimed at slowing disease progression.

The aim is to provide education on healthy nutrition and to ensure an adequate energy supply [65]. A balanced diet should be based on foods with a low glycemic index, healthy fats, and a high fiber content, which help stabilize blood glucose levels. An anti-inflammatory diet, rich in antioxidants and polyphenols, supports reducing chronic inflammation and oxidative stress.

Avoidance of simple sugars and processed foods promotes glycemic stability and reduces the risk of insulin resistance. Processed products (including trans fats and high fructose corn syrup) exacerbate inflammation and increase the risk of metabolic disturbances. Adequate intake of protein, plant-based fats, and foods rich in omega-3 fatty acids, magnesium, and zinc supports glucose metabolism, enhances insulin sensitivity, and exerts anti-inflammatory effects. Vitamin D supplementation is recommended.

Its purpose is to provide psychological support and cognitive-behavioral therapy, while maintaining a balance between parental supervision and the child's autonomy – avoiding excessive control and positively fostering healthy habits [27 , 66 , 67]. The diagnosis of presymptomatic T1D in children often triggers natural, strong emotional reactions, including anxiety, fear, sadness, confusion, and depressive symptoms. Awareness of the risk of developing a chronic disease can further generate heightened stress related to the future, uncertainty regarding life goals, and concerns about physical and cognitive functioning.

Families also experience considerable emotional distress, including feelings of guilt, worry, and helplessness. Increased parental monitoring of nutrition, physical activity, and lifestyle may contribute to family tensions, stress, and parental burnout.

Therapy for individuals with stage 1 and stage 2 T1D focuses on immunomodulation and the preservation of pancreatic β -cell function against autoimmune destruction. Teplizumab (Tzielid), a humanized anti-CD3 monoclonal antibody, is the first agent approved by the US Food and Drug Administration (FDA, November 2022) and European Medicines Agency (EMA, January 2026) for delaying progression to stage 3 T1D in individuals with stage 2 disease. In phase 2 clinical trials involving relatives of individuals with T1D, aged 8–45 years and diagnosed with stage 2 T1D, a single 14-day infusion of teplizumab prolonged the median time to progression to stage 3 T1D by approximately 2.7 years and improved β -cell function. The most frequently reported adverse events were transient cytopenia, flu-like symptoms, rash, and an increased risk of infections [2 , 68 , 69].

At present, several clinical trials are evaluating additional disease-modifying therapies for T1D, intending to treat or delay disease progression in individuals at early preclinical stages. Selected examples are presented in Table 4 . However, among the numerous completed and ongoing randomized, placebo-controlled trials investigating interventions such as nicotinamide, insulin administered via various routes, GAD65, and abatacept, most have failed to demonstrate the anticipated efficacy in delaying progression to subsequent stages of T1D [70].

Selected clinical trials of disease-modifying interventions in preclinical stages of T1D [70 – 73]

Screening for T1D in children from the general population is fully justified, as its purpose is to detect risk or presymptomatic disease by identifying islet autoantibodies. Early diagnosis provides numerous clinical, systemic, and economic benefits.

International guidelines [1 , 22 , 69] summarize the available scientific evidence and present its practical applications. National recommendations [15 , 74 , 75] adapt these guidelines to the

specific conditions of local healthcare systems. The position statement of the Polish Society of Pediatric Endocrinology and Diabetology and the Pediatric Section of Diabetes Poland on early detection of T1D in the pediatric population is based on the most up-to-date knowledge (as of January 2026). It will be updated as future developments unfold.

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