KONWANT, Dawid, KURDYŚ-BYKOWSKA, Paulina, ARMATYS, Aleksandra and STENCEL-GABRIEL, Krystyna. Child and adolescent diabetes as a social medicine challenge in Poland. Journal of Education, Health and Sport. 2024;75:56181. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.75.56181
https://apcz.umk.pl/JEHS/article/view/56181

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 13.11.2024. Revised: 20.11.2024. Accepted: 05.12.2024. Published: 05.12.2024.

Child and adolescent diabetes as a social medicine challenge in Poland

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Summary

Introduction: Diabetes prevalence among children and adolescents poses a significant challenge to health care systems worldwide. Insufficient control of lifestyle diseases, including diabetes, can lead to an increased need for the use of outpatient services and hospitalization to stabilize the course of the disease.

Aim and methods: Demonstrate type 1 diabetes as an interdisciplinary problem of civilization diseases combining diagnosis and treatment along with the costs incurred by the health care

system. Analysis of data on the amount of health services provided and costs for type 1 diabetes of children and adolescents in 2016-2019 in Poland was made.

Results: The number of pediatric patients who received services with the diagnosis E10 increased by 9.6% in the analyzed interval of years. The cost of health services provided increased by 27.2% during this period. The average annual cost of health services per patient in the last year of analysis (2019) increased by 16%.

Conclusions: Educational activities should be intensified among children and adolescents to increase proper diabetes self-management. This intervention will reduce the impact of diabetes, which results in increased use of health services to stabilize the disease and its effects.

Key words: diabetes mellitus, children and adolescents, pediatrics, community medicine

Introduction

According to the definition of the Polish Diabetes Association and the World Health Organization diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from a defect in insulin secretion and/or action. Chronic hyperglycemia is associated with damage, dysfunction and failure of various organs especially eyes, kidneys, nerves, heart and blood vessels. It is not only a medical problem but also a socio-economic problem associated with living with the disease and the costs incurred for health care in this area [1-2]. Type 1 diabetes mellitus (T1DM), classified according to ICD-10 with code E10 (ICD-11: 5A10 Type 1 diabetes mellitus) is the most common form among Caucasian children and adolescents and represents a serious challenge for public health in Poland constitutes approximately for 10% of all diabetic patients. The onset of the disease usually occurs between the age of 10 and 14. The incidence of the disease varies between countries, regions of a country and ethnic groups. Currently there is no effective method of preventing type 1 diabetes introduced into clinical practice, both in the general population and in people at risk. [1,3]. Type

1 diabetes of immunological etiology is caused by lack of insulin production due to destruction of pancreatic islet β-cells resulting from genetic autoimmunity. Idiopathic diabetes has no established etiology for β-cell destruction. Early diagnosis of type I diabetes in a child is not easy but it allows for the introduction of a number of actions leading to a reduction of the risk of complications [4]. The state strives to provide children with sufficient health care which is proved by the article 68 of the Constitution of the Republic of Poland which specifies the obligation of public authorities to provide exceptional health care for children. This gives the possibility to use health care services financed from the public funds free of charge until the age of 18 [5]. Diabetes is not only a medical challenge, but also an organisational, financial and psychological one for the family. The child's chronic illness undoubtedly has an impact on the parents' emotional state, which can significantly alter their attitudes towards their child. The course of the disease depends not only on health care but also on the parents' influence on the child's learning to control and self-care. Caring for a child with diabetes mellitus is a lot of challenges for parents and undoubtedly affects the quality of life of the whole family which the indicator is health related quality of life (HRQoL) [6-7]. In adolescents with type 1 diabetes individualized nutritional therapy is recommended as an essential element of the overall treatment plan, nutritional education and motivation for physical activity and exercise [8-9].

In the economic context human health in population terms undoubtedly determines the economic development of a country, thus creating development for the individuals and for the society. A limitation of this development is a disease especially a chronic disease which prevents an individual from active exercise in everyday social life. The increase in health care costs especially through the increasing incidence of chronic diseases causes increasing problems with the efficiency of health care systems [10-11]. Diabetes is undoubtedly a significant financial burden for patients and the budget of the National Health Fund. The right approach for health care systems among the many challenges of civilisation diseases should be to invest in health rather than in disease. More resources should therefore be spent on disease prevention. As a result the costs of prevention will be much lower than the current financial outlays [12].

The expenditures related to the burden of costs generated by civilisation diseases, (including diabetes) on the economy are classified into direct, indirect and non-measurable costs. Direct costs are related to medical costs incurred by the health care system and non-medical costs resulting directly from the diagnostic and therapeutic process. In the case

of children and adolescents these costs include the costs of transport and care provided for minors. The indirect costs relate to premature disability caused by the disease including the burden on the social security system of the individual's reduced productivity and use of support services. Non-measurable costs on the other hand concern the psychological and social aspects of living with a disease such as emotions, pain, frustration and social exclusion [13-14].

A very important element of treatment is health education and prevention understood as stopping the progression of the disease. The active participation of patients in the treatment process should assume the implementation and application of recommendations by a team of specialists. Lifestyle as a modifiable factor can significantly change the perception of living with the disease. A balanced diet and regular and tailored physical exercise positively influence treatment effects and patient's quality of life. Trials have shown that monitoring islet autoantibodies combined with genetic risk assessment can identify the majority of children who will develop T1D when β-cells still present sufficient function to control glucose without the need for insulin [15-16]. Additionally (in case of pediatric patients) health education of the caregivers is crucial as early in of health promoting behavours increases chances of sustaining healthy lifestyle including balanced diet and sufficient excercise in the adulthood [17].

Materials and methods

An analysis of data extracted from the eHealth Centre's records on the number of health services provided and the costs associated with them in type 1 diabetes in children in years 2016-2019. The data is taken from the statement "Information on the number of services provided to children with a diagnosis of E10 compared to the general patient population". The aim of this study is to show type 1 diabetes way a holistic view of the problem. Microsoft Excel and Statistica 13.3 were used to statistically analyse the data obtained. The reimbursement value of services refers to services where its value can be directly attributed to the benefit, i.e. it does not take into account the capitation rate of basic health care, services at Hospital Emergency Departments and Emergency Rooms. In case of services financed as part of a lump sum (the so - called hospital network), the value of 1 point = 1 PLN was assumed.

Results

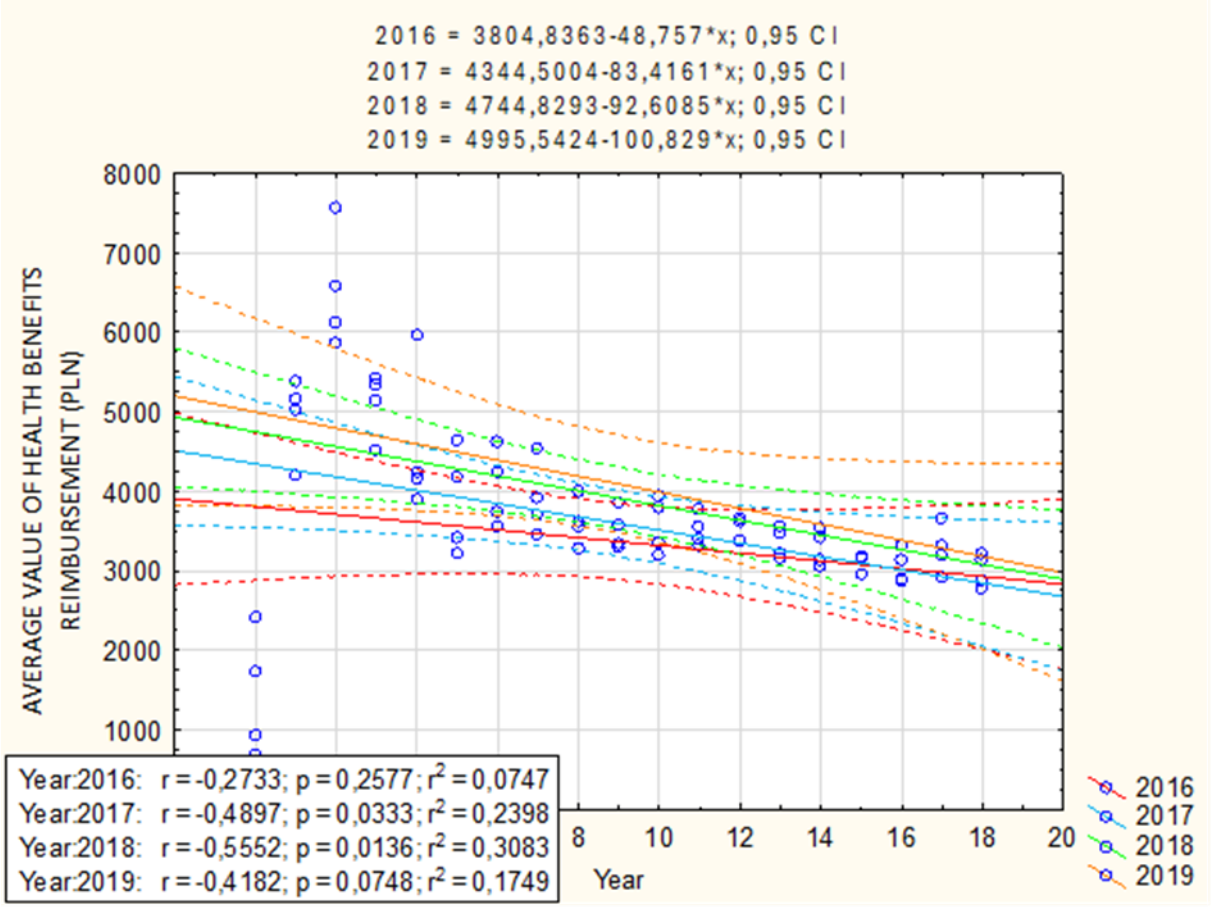
Statistical data shows that the number of patients who received services with the diagnosis E10 increases with age. The number of patients increased by 9.6% in 2019 compared

to 2016 while the cost of health services increased by 27.2% during this period. The average annual cost of health services per patient in 2019 was PLN 3,726.3, an increase of 16%. The highest number of patients in 2016 was seen at the age of 15 (1,292), while in 2019 it was already at the age of 18 (1,459). The total number of patients with diagnosis E10 in the years under study was 59,767, and the total cost of reimbursement for the health services provided was PLN 207,464,593. (Table 1.)

Table 1. Number of patients with the provided health service E10 and their costs. Own study

AGE	**NUMBER OF PATIENTS**				**VALUE OF HEALTH BENEFITS REIMBURSEMENT (PLN)**			
	2016	***2017***	***2018***	***2019***	***2016***	***2017***	***2018***	***2019***
0	28	38	17	19	19 245	65 275	40 875	17 581
1	85	60	52	70	356 763	301 215	279 234	360 133
2	156	132	140	139	955 374	773 131	920 473	1 051 258
3	244	226	229	208	1 098 699	1 223 554	1 174 309	1 108 284
4	325	324	321	316	1 264 386	1 342 806	1 355 734	1 884 690
5	403	400	424	394	1 294 594	1 367 318	1 766 356	1 825 165
6	592	502	495	517	2 105 080	1 873 839	2 096 390	2 388 113
7	654	689	637	613	2 254 622	2 546 792	2 485 680	2 781 707
8	782	789	794	764	2 553 844	2 855 206	2 818 853	3 052 618
9	879	912	922	916	2 920 827	3 002 150	3 290 678	3 520 463
10	927	1 022	1 089	1 066	2 950 364	3 430 045	4 269 671	4 036 227
11	946	1 061	1 161	1 230	3 197 315	3 507 242	4 387 120	4 359 992
12	1 029	1 084	1 222	1 340	3 462 147	3 644 301	4 418 036	4 901 815
13	1 052	1 132	1 225	1 363	3 307 172	3 632 933	4 351 030	4 736 525
14	1 125	1 128	1 226	1 334	3 426 046	3 539 331	4 167 467	4 697 023
15	1 292	1 178	1 212	1 299	3 799 933	3 724 803	3 834 671	4 095 360
16	1 291	1 329	1 248	1 295	3 740 450	3 805 433	4 127 253	4 055 068
17	1 235	1 334	1 405	1 321	3 603 701	4 262 758	4 661 366	4 810 034
18	1 243	1 294	1 363	1 459	3 574 175	3 595 145	4 277 046	4 682 281

Diagram 1. Scatterplot of the average cost of E10 benefits by age from 2016 to 2019.



The correlation between the age of patients and the average cost of health services provided for diagnosis E10 occurs in 2017 (p=0.03) and 2018 (p=0.01). In 2016 and 2019, a statistically significant correlation was not indicated. The values in the diagram indicate that higher costs for health services are incurred in the younger age group, particularly in patients aged 2 years. The average cost decreases with age, regardless of the year considered. (Diagram 1.)

The highest number of hospitalisations took place in the diabetes ward for children (4021; VIII part of the departmental code of the organisational unit) and the paediatric ward (4401;VIII part of the departmental code of the organisational unit). In each year the number of reported hospitalisations with the main diagnosis E10 was greater than the number of patients, which leads us to believe that some patients were hospitalised more than once in a given

calendar year. The increase in hospitalisation costs in the period under review increased by 25.2% with a 7.5% increase in the number of hospitalisations. The average cost of hospitalisation was PLN 3,415 in 2019. (Table 2.) The most frequent product codes were: 5.51.01.0014024, 5.51.01.0014034, 5.51.01.0014033 according to the Uniform Patient Groups in the payer's healthcare settlement system - the National Health Fund, i.e. P24, P33, P34.

Table 2. Number of hospitalizations with main diagnosis E10. Own study

YEAR	NUMBER OF HOSPITALIZED PATIENTS	NUMBER OF HOSPITALIZATIONS	VALUE OF HOSPITALIZATION REIMBURSEMENT (PLN)
2016	6 924	8 528	25 020 416
2017	7 270	8 777	26 484 921
2018	7 131	8 697	29 194 574
2019	7 595	9 174	31 330 389

The number of first-time patients in the outpatient specialist care with a principal or co - morbid diagnosis E10 decreased in 2019 compared to 2018 by once 2017, while the reimbursement costs for first-time services did not decrease but increased to PLN 109,880. (Table 3.)

Table 3. Number of first-time patients in outpatient specialist care with primary or comorbid diagnosis E10. Own study

YEAR	NUMBER OF FIRST-TIME PATIENTS IN OUTPATIENT HEALTH CARE	VALUE OF THE REIMBURSEMENT OF FIRST-TIME IN OUTPATIENT HEALTH CARE (PLN)
2016	1 228	81 112
2017	1 407	95 966
2018	1 486	108 384
2019	1 346	109 880

In the age group up to 18 years, a significant proportion of patients as many as 72.6% of those receiving outpatient specialist diabetes care in 2019 had the diagnosis E10. The

average cost of outpatient services for one person with this diagnosis was PLN 347 and the number of patients increased by 11% in the period under study. (
Table *4*.)

Patients also received ophthalmology, neurology or psychiatry consultations. The number of patients with a principal or co-morbid diagnosis E10 who were provided with ophthalmology services in years 2016-2019 accounted for 7 patients, and the value of reimbursement of services with procedure 95.1902 - examination of the fundus of the eye amounted to 608 PLN. The number of patients who received services in the field of neurology with a principal or co-morbid diagnosis E10 in years 2016-2019 accounted for 162 patients, and the value of reimbursement of services amounted to PLN 17,723. The number of patients who received services in the field of psychiatry with a principal or coexisting diagnosis E10 in years 2016-2019 was 77 patients, and the value of reimbursement of services amounted to PLN 12,310.

Table 4. Number of diabetic patients in outpatient specialist care. Own study

YEAR	TOTAL NUMBER OF DAIBETOLOGY PATIENTS	NUMBER OF DAIBETOLOGY PATIENTS DIAGNOSED WITH E10	VALUE OF REIMBURSEMENT OF SERVICES IN THE FIELD OF DAIBETOLOGY WITH DIAGNOSIS E10 (PLN)
2016	16 615	12 185	3 629 152
2017	17 312	12 617	3 640 681
2018	18 014	13 126	4 094 333
2019	18 624	13 522	4 689 926

Discussion

Civilization diseases occurring in developed and developing countries are a significant problem for public health. This manuscript aims to demonstrate the relationship between the increase in the incidence of diabetes in Poland and the increasing socioeconomic costs incurred for the treatment of chronically diseased children and adolescents. Such correlations have also been confirmed in many European countries, where similar studies and analyses have been performer [18].

The most recent statistics in the 10th edition of the IDF Diabetes Atlas for European countries indicated that 294,9 thousand children and adolescents aged 0-19 years had type 1 diabetes mellitus in 2021. The new cases accounted for 31 thousand, while the size of the European population of children and adolescents in the year under review was 221,8 million [19].

Detailed analysis of T1DM reimbursement was carried out in the Netherlands based on an analysis of a three-year nationwide observational study between 2009-2011 in children with type 1 diabetes aged 0-18 years. E. A. J. M. Spaans and the other researchers analysed the hospitalisation of 6710 children and adolescents from 81 hospitals, six of which were university hospitals and the rest general hospitals. Based on their analyses, an average reimbursement cost of 8326 € for a paediatric patient was estimated. The study indicated that the largest impact on the cost of reimbursement came from expenditure incurred on specialist consultations, medical supplies and pharmaceuticals [20].

The analysis of the cost of treatment of 89 children and adolescents with type I diabetes in Greece by F. Karachaliou and co-authors differs significantly from the Dutch study in terms of population size. The manuscript concentrates the analysis exclusively on the basic ranges of costs incurred in diagnosis and treatment in the public health sector. The average annual cost of a paediatric patient with type I diabetes was significantly lower at 2712 € [21].

In contrast, J. López-Bastida's work analysed the costs of T1DM in a study population sample of 249 people aged 0-17 years in Spain. The estimated average direct healthcare costs incurred due to the disease were 4070 €. In addition, costs were shown to vary according to the level of glycated haemoglobin (HbA1c) and the presence of T1DM complications and comorbidities. In terms of HbA1c < 7,5 %, a 23,2 % lower average cost incurred was found in relation to patients with HbA1c ≥ 7,5 % [22].

An analysis of the d irect costs of T1DM in paediatric patients in Andalusia aged 2-16 years was conducted by M. Álvarez Casaño and co-authors. The observational study was conducted for six months from February to July 2018 and included a total of 178 patients from 6 hospitals in the Andalusia region. The average annual patient cost was 4720 €. The amount, however, included the costs of tests and pharmaceuticals resulting from both inpatient and outpatient treatment [23].

As far as the analysis of Polish data is concerned, the average annual cost of health services in the public system per patient in 2019, converted at the average exchange rate set by the National Bank of Poland of 4,29 PLN per 1 €, amounted to 868,6 €. The scientific research from other European countries cited in this discussion included many more factors than just the

cost of health services alone, hence there is a significant difference in the comparative scope of the research [24].

Undoubtedly, differences in the functioning of individual health care systems in European countries and the resulting standards of diabetes treatment, as well as reimbursement options, make a uniform comparison of costs across countries impossible. In addition, the development of modern methods for continuous glucose monitoring systems is costing the healthcare system money. In terms of the availability and ability of the health system to fund these methods, not every paediatric patient is included in such measurement uses.

Some of the studies discussed did not specify the detailed types and ranges of health care costs incurred, which does not make it possible to unequivocally state the correspondence in costs between only procedures directly related to the treatment of diabetes or the overall annual treatment of a patient diagnosed with diabetes. The studies in question are also characterised by different numbers, ages of patients and duration. There is also an unquestionable cost impact of co-morbidities in patients that lead to complications and thus generate additional costs. The cited studies did not detail the disease characteristics of individual patients.

In addition to the public healthcare system, many countries also have a very well-developed commercial healthcare system that is successfully used by paediatric diabetic patients. The possibility of benefiting from such an arrangement depends on the economic status of the family. In addition, commercial medical services are not often included in system cost analyses in individual countries.

Based on the results of a study evaluating people with type one diabetes, J. Spencer pointed out that there is a significant glycemic control problem among young people in the UK. The problem has been shown to be multifaceted as poorly controlled glycemia conditions more frequent use of health care services to properly stabilize the disease. This determines the increase in costs incurred per patient. At the same time, the important role of the family in supporting the sick child in the disease learning how to conduct regular glycemic control and learning proper dietary patterns has been demonstrated. Introducing long-term changes and reorganizing existing eating habits is quite a difficult task to implement in the initial phase of the disease, just after its diagnosis [25].

JP Catherine and co-authors conducted an analysis of factors influencing the incidence of type 1 and type 2 diabetes in children in England and Wales. On the basis of this analysis they pointed out the association of social factors affecting the incidence of diabetes, according to which the degree of poverty had a significant impact on the incidence of type 2 diabetes.

It was shown that 45% of patients came from the poorest backgrounds. Significantly poor socioeconomic conditions appeared to be associated with negative values of duration in the disease and proper treatment. This successively resulted in the occurrence of complications that required additional diagnosis, hospitalization and treatment. These resulted in increased per-patient expenditures associated with stabilizing the disease and its complications. Clinically it was shown that patients living in areas of limited poverty had an average of 0.5% lower HbA1c levels compared to patients living in areas of significant poverty. Undoubtedly living conditions affect the quality of treatment. Caucasian ethnicity and residence in areas of higher economic status appeared to be associated with more frequent use of modern technology in diabetes treatment, which had a favorable effect on improving diabetes control among ill patients. The disproportion in the use of diabetes therapy with the use of insulin pumps accounted for 13.5% of the difference between patients with a higher economic status and patients living in poverty [26].

An extremely interesting study was conducted in France by H. Mellerio and co-authors, who assessed the long-term impact of type 1 diabetes revealed in childhood on quality of life. They indicated that the psychosocial burden of living with diabetes is a major problem for patients, which can result in a deterioration of normal self-care behaviors. This in turn stimulates a decrease in quality of life. In the aspect of this study the authors indicated greater fatigue and abandonment of sports and higher alcohol consumption compared to the general population. In addition to this, frequent dissatisfaction with sexuality resulting from attitudes toward the disease, especially among the female sex [27].

At the national level, there are legal acts dealing with issues of disease prevention, such as the Law on Public Health. It indicates tasks in the field of public health, which include, among others: monitoring and evaluation of the health status of the population, health risks and the quality of life associated with the health of the population; health education tailored to the needs of different groups of the population, especially children, adolescents and the elderly; health promotion; disease prevention; creation of health and social attitudes conducive to the prevention of risky behavior. The reliable conduct of phase III education and prevention activities among patients at different levels of social units can significantly influence the formation of attitudes in the management of one's disease, which will translate sequentially into increased self-management of current civilization diseases [28].

Scientists from Turkey, led by S. Karahan, conducted a study on the impact of diabetes on a family with a child suffering from T1DM. The study included 121 parents of children aged 6-12 years, with whom a questionnaire survey consisting of 35 questions was conducted to

collect sociodemographic data, the child's disease and the impact of diabetes on the family using the DFIS scale. It showed a correlation in terms of higher values of the diabetes impact index among low-income families. The child's illness disrupts the home and represents a real fear on the part of carers of possible complications. By lacking the financial stability that can undoubtedly provide an adequate level of medical care in the event of diabetes-related health problems, the family undoubtedly experiences many more quality-of-life issues and its functioning along with the child's disease [29].

A systematic review of parents' experiences of caring for a young child up to 8 years old with type 1 diabetes by B. Kimbell's team identified aspects of incessant worry about the child's health situation resulting from the need for constant control and over-vigilance over the condition. Childcare responsibilities also affect other aspects of the parents' lives through which they make choices that are good for the child, limiting their own [30].

Summary

It is appropriate to continue the analysis of data on the prevalence of type 1 diabetes among children and adolescents in Poland. The prevention and health education should be the core of the management of insulin-dependent diabetes in children and adolescents, thus reducing the cost of subsequent medical procedures in the later, more advanced stages of the disease. The correct formation of habits will help to adapt to life with the disease and partly reduce the inefficiencies. As part of primary prevention, early detection of type 1 diabetes should be carried out in children in the asymptomatic period.

It would be advisable to further extend aspects of the analyses to measure the social costs of T1DM for children and adolescents, including an interdisciplinary approach to the problem of diabetes as a chronic disease with an assessment of the state of family functioning with the disease.

Data Availability Statement

All relevant data are within the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

Funding for the manuscript was provided under contract PCN-2-050/N/1/Z for the research work of a young scientist at the Medical University of Silesia in Katowice.

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