Environmental factors affecting management of type 1 diabetes in children below the age of 10

Czynniki środowiskowe wpływające na wyrównanie metaboliczne dzieci poniżej 10 roku życia chorujących na cukrzycę typu 1

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Abstract
Introduction. The way parents manage diabetes of their small children and environmental influence are crucial for maintaining glycemic control. **The aim of the study** was to assess environmental factors affecting metabolic control of young children with T1D treated with insulin pumps. **Material and methods.** Parents of children with T1D under the age of 10 years completed: General Self-Efficacy Scale, Parental Diabetes Quality of Life Questionnaire, Beck Depression Inventory and a questionnaire on socioeconomic factors. **Results.** There were analyzed 165 questionnaires. 66% of children achieved HbA1c <7.5% (<58mmol/mol). Factors associated with HbA1c≥7.5% (≥58mmol/mol) in the multiple logistic regression: single-parent families (p=0.003), low income <250EURO (p=0.017), parental education (p<0.05), snacking without parents' permission (p=0.0006) and in parents of children ≥6 year of age – quality of life (p=0.037). In families of children <6 year of age, parents had higher self-efficacy than parents of children ≥6 year of age (p=0.046). **Conclusions.** Parents of young children are not homogeneous group and face different challenges. Young children of parents withlower education level and living in single-parent families are at high risk of poor diabetes management. More attention should be paid to the problem of young children snacking without parents' permission.
Abbreviations: BDI – Beck Depression Inventory, CI–Confidence Intervals, GSES – General Self-Efficacy Scale, HbA1c – glycated hemoglobin, OR- Odds Ratio, PDQOLQ – Parental Diabetes Quality of Life Questionnaire, T1D – type 1 diabetes
Key words
depression, quality of life, self-efficacy, insulin pump

Streszczenie
Wstęp. Wyrównanie metaboliczne małych dzieci chorujących na cukrzycę typu 1 (T1D) zależy od rodziców i środowiska, w jakim dziecko funkcjonuje. **Celem pracy** jest ocena czynników środowiskowych wpływających na wyrównanie metaboliczne małych dzieci chorujących na T1D leczonych przy pomocy pompy insulinowej. **Materiały i metody.** Rodzice dzieci poniżej 10 roku życia wypełniali kwestionariusze: Skalę uogólnionej własnej skuteczności, Miarę jakości życia pacjenta z cukrzycą–wariant dla rodzica, Skalę depresji Becka oraz kwestionariusz oceniający czynniki socjoekonomiczne. **Wyniki.** Zanalizowano 165 kwestionariuszy. U 66% dzieci stwierdzono HbA1c<7.5% (<58mmol/mol). W regresji logistycznej wykazano następujące czynniki związane z HbA1c ≥7.5% (≥58mmol/mol): niepełna rodzina (p=0.003), niski dochód <250EURO (p=0.017), wykształcenie rodzica (p<0.05), podjadanie (p=0.0006), u rodziców dzieci ≥6 roku życia jakość życia (p=0.037). U rodziców dzieci <6 roku życia stwierdzono wyższy poziom własnej skuteczności w porównaniu do rodziców dzieci ≥6 roku życia (p=0.046). **Wnioski.** Rodzice małych dzieci nie są jednorodną grupą. Niższy poziom wykształcenia i samotne rodzicielstwo stanowi ryzyko gorszego wyrównania metabolicznego. Więcej uwagi należy zwrócić na problem podjadania.
Skróty: BDI – Skala Depresji Becka, CI–przedział ufności, GSES – Skala Uogólnionej Własnej Skuteczności, HbA1c – hemoglobina glikowana, OR- iloraz szans, PDQOLQ –Miara jakości pacjenta z cukrzycą-wariant dla rodzica, T1D – cukrzyca typu 1
Słowa kluczowe
depresja, jakość życia, własna skuteczność, pompa insulinowa

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Introduction

The incidence of childhood type 1 diabetes across Europe increases by an average of approximately 3–4% per year with most remarkable rise observed among the youngest age groups. Researchers predict a doubling of new cases in children younger than 5 years of age by 2020 [1].

Diabetes management of preschool and early school children is markedly different from the care of teenagers as parents assume the whole responsibility for all diabetes care. According to earlier investigations, family functioning (for example: diabetes-specific family conflicts, parental involvement, shared responsibilities) accounts for 34% of the variance in metabolic control (compared to only 10% for adherence) [2]. Socioeconomic factors such as parental education, a family structure (a single-parent family) and parenting style influence metabolic control in children [3]. Previous studies also show that parental self-efficacy and mood disorders affect diabetes management [4, 5].

Although diabetes therapy has been intensified by means of the insulin pumps, improved devices for self-control and continuous glucose measurement, some children still do not reach the metabolic goal [6]. Little is known about environmental factors affecting metabolic control of preschool and prepubertal children. Of so far available study results, populations were not homogenous, and outcomes were limited by small parent populations of children below 10 years of age [7, 8].

The purpose of this study was to assess environmental factors affecting metabolic control of children with T1D under the age of 10 years treated with insulin pumps.

Material and methods

Parents of children under the age of 10 years, with T1D of at least 1-year duration, treated with insulin pump, completed a set of questionnaires during control visit in the Outpatient Clinic of the Department of Pediatrics at the Medical University Hospital of Warsaw: General Self-Efficacy Scale (GSES), Parental Diabetes Quality of Life Questionnaire (PDQOLQ), Beck Depression Inventory (BDI) and the questionnaire on socioeconomic factors, specially designed for this study.

GSES, developed by M. Jaruselem and R. Schwarzer [9], consists of 10 items assessing optimistic self-beliefs related to coping with a variety of difficult demands in life. Higher scores on this measure indicate higher levels of General Self-Efficacy. Too high score may indicate overestimation of problem-solving ability. Negative coefficients were found with depression, anxiety, stress, burnout and health complaints [10].

PDQOLQ is a 59-item questionnaire based on DCCT Diabetes Quality of Life Scale for Adults [11]. It measures different aspects of life as a parent of a child with T1D. The total score was used as the assessment of general life satisfaction related to illness. Cronbach's alpha coefficient was measured to assess internal consistency of the PDQOLQ in this study, and it was 0.92.

BDI is a 21-item, self-report rating inventory, one of the most widely used tools to screen for symptoms of depression. The score of 19 was a cut off point for depression. Higher scores suggest more severe depressive symptoms [12].

At the same time, we collected some socioeconomic, demographic and disease related data, which could contribute to difficulties with diabetes management (table I and II). Following the Central Statistical Office of Poland, the low income was defined as earnings of less than 250EURO per month per each family member [13].

Glycated hemoglobin (HbA1c) level was measured using a high-pressure liquid chromatography method; with a range for subjects without diabetes of 4.1%–6.4% to assess diabetes control.

There were 186 parents participated in the study after giving a written informed consent. Only 165 (88.7%) fully completed questionnaires were analyzed; 21 questionnaires were excluded from the study due to insufficient responses.

Parents were stratified into two groups regarding children's age (<6 years of age – preschool children and ≥6 years of age – early school children) and their metabolic control, following the International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines: group A with HbA1c<7.5% and group B with HbA1c≥7.5% (≥58mmol/mol) [14].

Statistical analysis was performed with Statistica 10 (Stat-Soft, Inc, Tulusa, USA) software. The assumption that data was sampled from population that follows Gaussian distributions was tested using the Kolmogorov and Smirnov methods. Comparisons between groups were performed using a Student t-test (unpaired, 2-tailed) or in case of non-parametric data with Mann-Whitney U test or Fisher's exact test. Logistic regression analysis was performed to evaluate factors affecting HbA1c ≥7.5% (≥58 mmol/mol). The Odds Ratio (OR) was calculated with 95% confidence intervals (CI). P-values less than 0.05 were considered as significant.

Characteristic of study participants stratified by children's HbA1c is shown in table II.

Results

In our sample 66% (109/165) of children achieved HbA1c<7.5%. Factors significantly associated with HbA1c≥7.5% in logistic regression are shown in table III.

There were no statistically significant differences between the groups in parents' depressive symptoms (p=0.934), self-efficacy (p=0.492), economic status (p=0.114), quality of life (p=0.137), the number of episodes of hypoglycemia in children(without seizure and loss of consciousness), reported by parents and requiring their assistance (group A: 13 episodes vs. group B: 10 episodes; p=0.349) or the number of episodes of hyperglycemia with ketonuria without hospitalization (group A: 21 episodes vs. group B: 16 episodes; p=0.239).

Characteristics of children <6 years of age are shown in table IV. In the whole group 57% of children attended kindergarten. Only 12% children had single parented families and there

Environmental factors affecting management of type 1 diabetes in children...
Czynniki środowiskowe wpływające na wyrównanie metaboliczne dzieci...

Pediatr Endocrinol Diabetes Metab 2017;23,1:23-29

Table I. Parents responses on questionnaire evaluating factors affecting management of T1D of children
Tabela I. Odpowiedzi rodziców na pytania zawarte w kwestionariuszu oceniającym czynniki wpływające na wyrównanie metaboliczne dzieci chorujących na cukrzycę typu 1

Factor [number of responses] (%)	Group A HbA1c <7.5% N=109 (65%)	Group B HbA1c ≥7.5% N=56 (45%)	p
Lack of time	28 (26%)	10 (18%)	0.252
Poor material conditions	22 (20%)	16 (28%/72%)	0.330
Fear of hypoglycemia	55 (50%)	22 (39%)	0.189
Counting exchanges difficulties	16 (15%)	4 (7%)	0.210
Stress related pain	39 (36%)	22 (39%)	0.737
Frequent blood monitoring	26 (24%)	14 (25%)	1.000
Shame of diabetes	7 (6%)	2 (3.5%)	0.720
Snacking without parent's permission	19 (17%)	24 (43%)	0.0008
Diabetes misunderstanding	25 (23%)	20 (36%)	0.101
Frequent infections	26 (24%)	13 (23%)	1.000
Estimation of food difficulties	25 (23%)	16 (28%)	0.570
Eating many meals	20 (18%)	16 (28%)	0.168
Taking care of other children	19 (17%)	9 (16%)	0.831
Parents' tiredness	55 (50%)	31 (55%)	0.744
Problems with care at kindergarten/school	35 (32%)	21 (37%)	0.605

were only 4 divorces reported (8%). Parents of children with HbA1c≥7.5% complained more often about "diabetes misunderstanding by other people" (47% vs. 13% of families, respectively; p=0.018).

Characteristics of children ≥6 years of age are shown in Table IV. Compared to participants with HbA1c<7.5%, children with HbA1c≥7.5% were significantly more often parented in single-parent families (p=0.018) and more divorces were noted in these families (19% vs. 2.5%, respectively; p=0.036). These parents had lower education level (mothers p=0.040; fathers p=0.0002). In families of children with HbA1c≥7.5% the problem of snacking without parent's permission occurred more often (p=0.022) and more parents complained about "eating many meals" (p=0.011). Factors significantly associated with HbA1c≥7.5% are shown in table III.

Comparison between children <6 and ≥6 years of age. We included 116 children ≥6 years of age with mean age 8.1±1.1 years and 49 children <6 years of age with mean age 4.6±0.9 years. There was no statistical difference between both groups regarding HbA1c (7.1±0.9% vs. 7.2±0.9%, respec-

tively; p=0.472) and daily insulin dose (0.74±0.27U/kg vs. 0.70±0.19U/kg, respectively; p=0.463). Families of children <6 years of age had higher self-efficacy compared to parents of children ≥6 years of age (Chi-square = 6.2, p=0.046).

Discussion

Our study concentrated on environmental factors, which may affect metabolic control of the youngest group of children with diabetes. To our knowledge, it is the first analysis of parental functioning of preschool and early school children with relatively well controlled type 1 diabetes. The average HbA1c, even in the groups not following ISPAD guidelines, was close to the recommended cut off point of 7.5%. Judging by the number of daily blood glucose measurements, we may assume that it is a group of parents motivated to achieve the best results in diabetes care of their children. Parents did not report problems with carbohydrate counting or insulin dosing, what suggests their diabetes education is sufficient. Nevertheless, in our study

Table II. Characteristic of study participants stratified by children's HbA1c
Tabela II. Charakterystyka uczestników badania, podział wg HbA1c dzieci

All participants	Group A HbA1c <7.5% N=109 (66%)	Group B HbA1c ≥7.5% N=56 (34%)	p
Parents (male/female) [n]	89/20 (82%/18%)	47/9 (84%/16%)	0.830
Children (male/female) [n]	54/55 (50%/50%)	33/23 (59%/41%)	0.253
Age of children [years]	6.8±2.0	7.5±1.7	0.077
Diabetes duration [years]	3.0±1.8	3.4±2,2	0.321
HbA1c [%]	6.6±0.6	8.1±0.6	-
Insulin [IU/kg/day]	0.7±0.3	0.7±0.2	0.527
Comorbid conditions [n]	27 (25%)	12 (21%)	0.701
Place of residence: village/town/city [n]	32/32/45 (29.5%/29.5%/41%)	10/23/23 (18%/41%/41%)	0.124
Maternal education level: primary and secondary/higher [n]	41/68 (38%/62%)	33/23 (59%/41%)	0.006
Paternal education level: primary and secondary/higher [n]	58/51 (53%/47%)	40/16 (71%/29%)	0.003
Maternal profession: manual worker/office worker and pensioner [n]	33/76/5 (30%/65%/5%)	24/31/1 (43%/55%/2%)	0.312
Paternal profession: manual worker/office worker/pensioner [n]	52/54/3 (48%/50%/2%)	36/19/1 (64%/34%/2%)	0.108
Each family member income per month: <250 Euro/250-500 Euro/>500 Euro [n]	35/41/33 (32%/38%/30%)	28/13/15 (50%/23%/27%)	0.114
Marital status: full family/single parent family [n]	101/8 (93%/7%)	42/14 (75%/25%)	0.003

we found some distinguishing factors, which affect metabolic control.

Our study confirmed the results obtained by other authors [15] that parents raising children without the support of a partner more often have difficulties with management and achievement of recommended HbA1c levels. Levine et al showed that children of single parents had significantly higher HbA1c levels than children of 2-parent families did [16]. Tsiouli et al. reported that single parents were more susceptible to diabetes related stress and had more problems with achieving good metabolic control in their children [17]. Single parenting is still an understudied problem, not only in the care of children with diabetes as Brown et al. reported [18], and rising number of divorces may require additional addressing in the development of support and intervention programs.

Although low income <250EURO had an impact on diabetes management, parents did not report lower satisfaction with life. These findings are not consistent with other studies, where researches report correlations between socioeconomic status, quality of life and metabolic control [19, 20]. However, we should consider this effect in relation to the health system and the type of insurance available to a patient, which is an indication of socioeconomic status in other countries [21]. In Poland, families of children with diabetes are not obliged to have higher insurance – most insulin types, pens, insulin pumps etc. are reimbursed.

Although parental depression is implied as a factor directly affecting metabolic control of children with reciprocal influence [2], parents participating in our study did not present any depressive symptoms or lower satisfaction with life. Similarly,

Environmental factors affecting management of type 1 diabetes in children...
Czynniki środowiskowe wpływające na wyrównanie metaboliczne dzieci...

Pediatr Endocrinol Diabetes Metab 2017;23,1:23-29

Table III. Results of multiple logistic regression
Tabela III. Wyniki regresji logistycznej wieloczynnikowej

	All participants			Children <6 years of age			Children ≥6 years of age		
	OR	95%CIi	p	OR	95%CI	p	OR	95%CI	p
Single-parent families	4.42	1.65–11.86	0.003	7.71	0.78–77.75	0.079	1.36	1.36—3.9	0.017
Low income<250Euro/each family member/month	0.43	0.22–0.86	0.017	0.74	0.22–2.56	0.639	0.93	0.39–0.18	0.023
Paternal education	0.29	0.15–0.61	0.001	0.93	0.27–3.22	0.907	0.17	0.07–0.42	0.03
Maternal education	0.3	0.12–0.74	0.008	0.31	0.06–1.49	0.145	1.19	0.10–0.89	0.03
Snacking without parent's permission	3.58	1.73–7.42	0.0006	2.99	0.98–9.08	0.017	2.9	1.23–6.9	0.015
PDQOLQ	1.01	0.99–1.03	0.121	0.99	0.96–1.02	0.531	1.02	1.00–1.03	0.037
Conflicts in families	1.01	0.99–1.03	0.121	1.40	0.54–3.65	0.485	2.44	0.98–6.05	0.056
GSES	0.96	0.88–1.05	0.351	0.91	0.33–2.53	0.855	1.26	0.61–2.63	0.535
BECK	1.05	0.97–1.14	0.240	0.59	0.10–3.39	0.553	0.9	0.48–1.67	0.740

OR – odds ratio, CI – confidence interval

Table IV. Characteristic of study participants stratified by children's age (<6 years of age and ≥ 6 years of age) and HbA1c
Tabela IV. Charakterystyka uczestników badania, podział wg wieku dzieci (<6 roku życia i ≥ 6 roku życia) i HbA1c

	<6 years of age (49 children)		p	≥6 years of age (116 children)		p
	HbA1c<7.5% (30 children, 61%)	HbA1c≥7.5% (19 children, 39%)		HbA1c<7.5% (79 children, 68%)	HbA1c≥7.5% (37 children, 32%)	
HbA1c [%]	6.6±0.5	8.1±0.6	–	6.7±0.6	8.2±0.6	-
Age of children [years]	4.7 ± 1.0	4.5 ± 0.8	0.314	8.1± 1.1	8.1 ± 1.1	0.824
Diabetes duration [years]	2.7 ± 1.5	2.9 ± 1.9	0.764	3.2 ± 1.9	3.5 ± 2.1	0.356
Daily insulin dosage [IU/kg]	0.69 ± 0.21	0.72±0.18	0.741	0.73 ± 0.3	0.75 ± 0.2	0.500
Basal insulin/total insulin [%]	24.8 ± 12.9	31.8 ± 12.1	0.051	32.4 ± 18.8	28.4 ± 20.7	0.061

Grey showed that maternal symptoms of anxiety and depression were not related to higher HbA1c level [22]. It is a surprising result as parenting stress and depressive symptoms in parents of young children with diabetes type 1 are high [23]. We may only hypothesise that treating children with insulin pumps from the diabetes onset and relatively good metabolic control, contributed to psychological well-being of parents.

We found association between parents' level of education and metabolic control of their children. Results of other studies assessing parents' education level and children's HbA1c are inconclusive [24, 25]. While results of Gesuita et al. show that metabolic control depends on the number of mother's years of education [3], in our study paternal education seems to play a more important role, although mothers usually spend more time with children and diabetes care is mainly their responsibility. These results may be an effect of sharing responsibility for the diabetes management if fathers are present in family life.

More parents of children with HbA1c≥7.5% reported a problem of snacking without parental permission. We may speculate about different factors affecting these results. Young children are often left in grandparents' care. In Poland grandparents are on the one hand very important caregivers, while on

the other they are not very keen on taking part in diabetes education. The need to compensate illness, the feeling of sorrow for the child and conflicts between parents and grandparents may play an important role in poor adherence to treatment. Parents of children ≥6 years of age attending schools may face another problem: an access to snacks without their control: school shops selling snacks, peers sharing their sweets, etc.. Current studies researching problems of children with diabetes at schools usually concentrate on the access to diabetes care support and diabetes management but not on children functioning in the school environment [26]. Moreover, parents of children ≥6 years of age with poor metabolic control complained more often about "eating many meals". Considering children's family situation we should reflect upon the possibility that snacking is a coping strategy for these patients.

When we examined groups divided by the age of children and their metabolic control, we found even more interesting results. First of all, it is clear that parents of children below 10 year of age are not homogeneous group, facing different challenges. Parents of younger children had higher self-efficacy compared to parents of children ≥6 years of age. Streisand et al. presented that parents with lower self-efficacy for the diabetes regimen reported more parenting stress, which had an impact on child-health outcomes [27]. School children who did not achieve recommended level of metabolic control were more often parented in single parent families with more divorces noted there. Their parents had lower education and lower income. They reported on the verge of significance more family conflicts affecting diabetes management. It was also the only group where we found the parental quality of life was associa-

ted with worse metabolic control. However, current knowledge based mostly on studies carried out on adolescents and their families shows that family functioning plays a great role in the child health outcomes [28]. Young children brought up in families with low socioeconomic status are more often admitted to hospitals [29]. Family functioning has an impact not only on present health but also in adulthood. Roustit et al. found the association between a negative family social environment in childhood and poor self-perceived health in adulthood [15]. Furthermore, parental socioeconomic status has great impact on chances of longer survival: Berhan et al. found that low socioeconomic status experienced in childhood by patients with childhood-onset diabetes type 1 increases the risk of mortality after the age of 18 [30].

We have to acknowledge some limitations of our study. Our data is based on self-report questionnaires without further interviews to clarify doubts about participants' answers or to verify information.

Conclusion

Parents of children with HbA1c≥7.5% are more often single-parents, have lower income and lower education level. Parents of young children (up to the age of 10) are not homogeneous group. They face different challenges and therefore they should by analyzed in smaller, age dependent groups. More attention should be paid to the problem of snacking without parent's permission and feeding by other family members.

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Environmental factors affecting management of type 1 diabetes in children...
Czynniki środowiskowe wpływające na wyrównanie metaboliczne dzieci...

Pediatr Endocrinol Diabetes Metab 2017;23,1:23-29

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