Rocz Panstw Zakl Hig 2020;71(2):197-206
http://wydawnictwa.pzh.gov.pl/roczniki_pzh/ https://doi.org/10.32394/rpzh.2020.0117

ORIGINAL ARTICLE

INFLUENCE OF TWO DIFFERENT METHODS OF NUTRITION EDUCATION ON THE QUALITY OF LIFE IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES MELLITUS – A RANDOMIZED STUDY

Karolina Dłużniak-Gołaska[1], Mariusz Panczyk[2], Agnieszka Szypowska[3], Beata Sińska[4], Dorota Szostak-Węgierek[1]

[1]Department of Clinical Dietetics, Faculty of Health Sciences, Medical University of Warsaw, Warsaw, Poland
[2]Department of Education and Research in Health Sciences, Faculty of Health Sciences, Medical University of Warsaw, Warsaw, Poland
[3]Department of Pediatrics, The First Faculty of Medicine, Medical University of Warsaw, Warsaw, Poland
[4]Department of Human Nutrition, Faculty of Health Sciences, Medical University of Warsaw, Warsaw, Poland

ABSTRACT

Background. Nutrition education is one of the most important factors determining the effectiveness of treatment and maintaining an adequate quality of life (QoL) in children and adolescents with type 1 diabetes.

Objective. The primary objective was to compare the influence of two methods of nutrition education on the QoL. The secondary objective was to identify other determinants of the QoL.

Material and Methods. A randomized single-blind study was conducted between October 2017 and April 2019 at the Children's Clinical Hospital in Warsaw. The study included 170 patients (aged 8-17) with at least 1-year history of type 1 diabetes, treated with insulin pumps. The participants were randomly divided into two groups: a control group (C) – traditional/ informative education methods, and an experimental group (E) – modern/interactive methods. PedsQL Diabetes Module 3.0 questionnaire was used in the assessment of the QoL. Total PedsQL score was the primary outcome. The secondary outcomes included the results obtained in five subscales of the questionnaire. The relationships between selected variables and changes in scores were also verified.

Results. Data obtained from 136 patients were analyzed. In both groups no significant changes regarding total PedsQL were noted 6 months after the intervention. However, a significant reduction occurred as regards the scores of 'Communication' subscale in group C. Analyzing other determinants of the QoL, significant dependencies were observed between: the level of physical activity and a change in 'Diabetes symptoms' subscale, and the level of parents' education and a change in 'Treatment barriers' subscale.

Conclusions. Both methods of nutrition education exerted a comparable influence on the total QoL. However, modern methods were more effective in terms of the improvement in the aspect of communication. Additionally, moderate physical activity and parents' tertiary education constituted valid determinants of various aspects of the QoL in children and adolescents with type 1 diabetes.

Keywords: *quality of life, education, type 1 diabetes mellitus*

STRESZCZENIE

Wprowadzenie. Edukacja żywieniowa stanowi jeden z najważniejszych elementów warunkujących skuteczność leczenia oraz utrzymanie odpowiedniej jakości życia dzieci i młodzieży z cukrzycą typu 1.

Cel badań. Głównym celem badania było porównanie wpływu dwóch metod edukacji żywieniowej na jakość życia. Cel drugorzędny stanowiło zidentyfikowanie pozostałych czynników determinujących jakość życia.

Materiał i metody. Przeprowadzono badanie randomizowane, pojedynczo zaślepione. Badanie było realizowane od października 2017 r. do kwietnia 2019 r. w Dziecięcym Szpitalu Klinicznym w Warszawie. Do badania zakwalifikowano 170 pacjentów (w wieku 8-17 lat) z cukrzycą typu 1 rozpoznaną przynajmniej rok wcześniej, leczonych za pomocą pomp insulinowych. Uczestnicy zostali losowo podzieleni na dwie grupy: kontrolną (C), w której zastosowano tradycyjne/informacyjne metody edukacji oraz eksperymentalną (E), w której wdrożono metody nowoczesne/interaktywne. Do oceny jakości życia wykorzystano kwestionariusz PedsQL Diabetes Module 3.0. Pierwszorzędowy punkt końcowy stanowiła całkowita punktacja uzyskana w kwestionariuszu. Do drugorzędowych punktów końcowych należały rezultaty osiąg-

Corresponding author: Karolina Dłużniak-Gołaska, Department of Clinical Dietetics, Faculty of Health Sciences, Medical University of Warsaw, Erazma Ciolka 27, 01-445 Warsaw, Poland, phone number: +48 22 57 20 931, e-mail address: kdluzniak@wum.edu.pl

nięte w pięciu podskalach kwestionariusza. Zweryfikowano również występowanie zależności pomiędzy wybranymi zmiennymi a zmianami w punktacji.
Wyniki. Przeanalizowano dane 136 pacjentów. Po upływie 6 miesięcy od zastosowanej interwencji w obydwu grupach nie odnotowano istotnych zmian w zakresie całkowitej punktacji. W grupie C stwierdzono jednak znamienne pogorszenie wyników w podskali „Komunikacja". Analizując inne determinanty jakości życia pacjentów, zaobserwowano znamienne zależności pomiędzy: poziomem aktywności fizycznej a zmianą w podskali „Objawy cukrzycy" oraz stopniem wykształcenia rodziców a zmianą w podskali „Bariery związane z leczeniem".
Wnioski. Obydwie metody edukacji żywieniowej miały porównywalny wpływ na ogólną jakość życia. Metody nowoczesne były jednak skuteczniejsze w zakresie poprawy aspektu komunikacji. Co więcej, umiarkowany stopień aktywności fizycznej oraz wyższe wykształcenie rodziców stanowiły istotne determinanty różnych aspektów jakości życia dzieci i młodzieży z cukrzycą typu 1.

Słowa kluczowe: *jakość życia, edukacja, cukrzyca typu 1*

INTRODUCTION

According to the International Society for Pediatric and Adolescent Diabetes (ISPAD) recommendations, patient education, including nutrition education, is the key element to successful diabetes management [19, 22]. However, the purpose of education should not only include transmission of knowledge, but, mostly, supporting patients in overcoming barriers, strengthening their motivation and enabling the acquisition of practical skills [23]. It is worth emphasizing that the diagnosis of type 1 diabetes affects all the aspects of patient functioning, including their quality of life (QoL) [16]. It is particularly visible in adolescents for whom the modification of previous lifestyle is an exceptional challenge, as it requires the independent management of nutrition, physical activity and insulin adjustment. Biological changes occurring during puberty may additionally impede their adaptation to the new situation [1, 10]. Therefore, conducting education in the group of children and adolescents with type 1 diabetes requires a special approach [5]. Education should be participant-oriented and tailored to their needs [22]. The methods used should be interactive, motivating, practical and focused on solving specific problems. Moreover, the topics discussed should be interesting, useful and understandable for the participants [4]. It it also recommended to use digital technologies during education (e.g. carbohydrates counting applications for smartphones). The benefits of providing technology-based education include improving patient confidence, QoL, and self-management [19]. It seems that education based solely on informative methods does not meet the above assumptions, and is also less effective in terms of improving metabolic control in adolescent patients with type 1 diabetes [8]. It should be noted that the acquisition of adequate skills to control the diabetes effectively is of high importance as regards the effectiveness of the treatment process and achieving appropriate QoL [11,15]. Notably, the deterioration of the QoL may result in neglecting daily self-control, and, as a consequence, increasing the risk of developing complications of the disease [3]. It should be also emphasized that there is a paucity of studies on the assessment of the effectiveness of various nutrition education methods in the contex of the QoL in young patients with type 1 diabetes treated with insulin pumps.

Therefore, the primary objective of the study was to compare the influence of two different methods of nutrition education on the QoL in children and adolescents with type 1 diabetes. The secondary objective was to identify other determinants of their QoL.

MATERIAL AND METHODS

A randomized single-blind study was conducted between October 2017 and April 2019 at the Children's Clinical Hospital in Warsaw. The study design was accepted without reservations by the Bioethics Committee of the Medical University of Warsaw (approval no AKBE/188/17 issued on the 10th of October 2017). All the procedures were consistent with ethical standards and the Declaration of Helsinki as of 1964 as amended. All the participants and their parents or legal guardians expressed informed consent for participation in the study. They obtained detailed information concerning the aim and course of the study, encoding all data and the possibility of resigning at any moment.

The participants were recruited during their hospitalization at the Department of Pediatric Diabetology and Pediatrics between October 2017 and June 2018. The study enrolled a group of patients aged 8-17. The inclusion criteria were as follows: at least 1-year history of type 1 diabetes, implementation of treatment with an insulin pump and the absence of concomitant chronic diseases which might affect the QoL (e.g. celiac disease). The exclusion criteria were as follows: a diagnosis of a different type of diabetes or a concomitant chronic disease, a history of type 1 diabetes below a year, or a different treatment modality (e.g. insulin pen injections). The lack of informed consent for participation in the study from

the patient or a parent/legal guardian also constituted an exclusion criterion.

The patients were randomly assigned to two groups using 1:1 technique. Simple randomization was performed using a random number generator with uniform distribution from the STATISTICA package (DIEHARD certificate). Randomization was the basis for distinguishing two groups: the control group (C) in which traditional education methods (a lecture) were used, and the experimental group (E) in which modern methods (an interactive quiz/multimedia application) were additionally used.

The randomization was presented in detail in Figure 1. The patients were not aware which group they had been assigned to by the educator (single-blind trial).

All the patients participated in a nutrition training during the hospitalization. The training was conducted in small (3-5 people each) groups by an appropriately prepared educator – a dietician. Patient education in the control group (C) was realized in the form of a 30-minute lecture. The aim was to convey theoretical knowledge concerning the most important issues of nutrition in diabetes. The content of the lecture was based on current recommendations of Diabetes Poland [2]. Moreover, the educator tackled the issue of calculating carbohydrate (CE) and protein-fat exchanges (PFE). The same lecture was also conducted in the experimental group (E). However, the educator focused on practical implementation and consolidating the theoretical knowledge acquired in this group. Therefore, after the lecture, the present authors' 'true-false quiz' was used. It included such elements as photographs and examples of correctly or incorrectly balanced meals, labels of healthy and unhealthy foods. The participants were supposed to decide (true or false) and justify their choice when sharing their opinion during a discussion. The quiz also included selected photographs of products and dishes for which the exchanges were to be calculated by the participants. Finally, they could verify their answers with VitaScale multimedia application (produced by TARGET IT, under a Freeware license) for diabetics which is designed for calculating exchanges [25]. Therefore, education implemented in group E lasted 60 minutes longer.

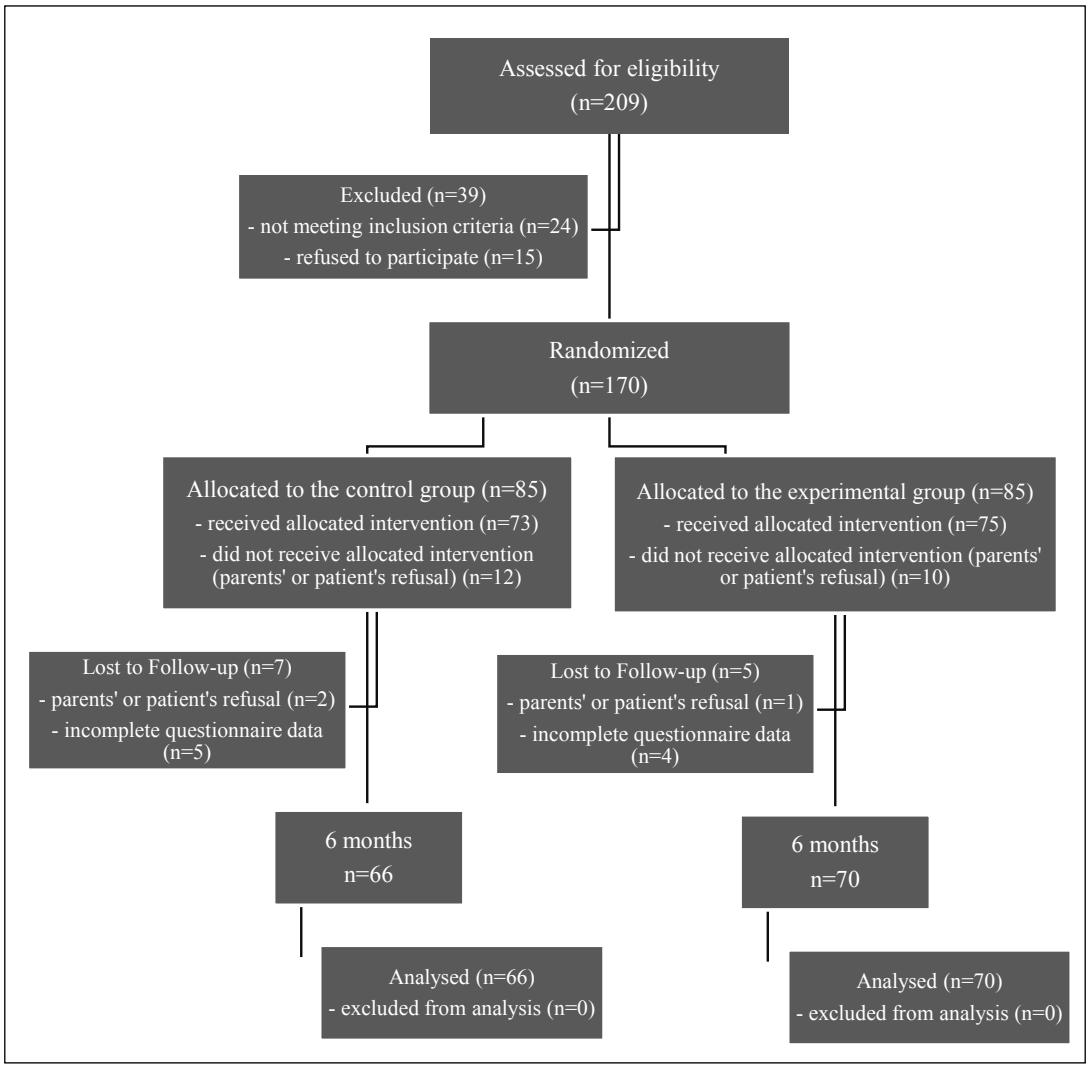

Figure 1. Flow diagram

Outcome Measures

All relevant information was collected during individual interviews with the patients and their parents or legal guardians during the hospitalization. Patients' QoL was assessed with Pediatric Quality of Life Inventory (PedsQL) – Diabetes Module 3.0 for the following age groups: 8-12 and 13-18 years [24]. The full package was downloaded in the Polish version via Mapi Research Trust.

The questionnaires were completed by patients independently at baseline and after 6 months during a follow-up visit. In case of problems with understanding questions in the group of younger children additional explanations were offered by the interviewer. Patients completed the questionnaires in the presence of the interviewer, thanks to which they had the opportunity to ask for clarification of difficult terms contained in the questions (e.g. long-term complications of diabetes). However, the interviewer's role was limited to providing a comprehensive explanation without suggesting an answer.

Both versions of the questionnaire were composed of 28 statements divided into five subscales: 'Diabetes symptoms', 'Treatment barriers', 'Treatment adherence', 'Worry' and 'Communication'. Initially, each statement was assessed on a 5-grade scale (0 – never, 1 – almost never, 2 – sometimes, 3 – often, 4 – almost always). In order to conduct further analyses, raw data described on the scale from 0 to 4 were converted into standardized data on the scale from 0 to 100 (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0). Finally, mean scores were calculated for the whole questionnaire (total PedsQL) and for each subscale individually for each patient. Ultimately, it was possible to obtain from 0 to 100 points in the whole questionnaire and each subscale. Higher scores should be interpreted as higher QoL.

Total PedsQL score was the primary outcome. The secondary outcomes included scores obtained in individual subscales of PedsQL questionnaire: 'Diabetes symptoms', 'Treatment barriers', 'Treatment adherence', 'Worry' and 'Communication'. Outcome data were collected at baseline and after 6 months.

In addition, other data (e.g. sociodemographic data) necessary to characterize patients were also collected at the beginning of the study. Anthropometric data and the most recent glycated hemoglobin (HbA1c) concentration was completed on the basis of patients' medical records. Each patient had the Body Mass Index (BMI) value calculated according to the formula: BMI = body weight [kg]/body height [m]^2. BMI value was interpreted with the use of growth charts for the Polish population [13], while HbA1c concentration was assessed on the basis of ISPAD recommendations according to which target values for children, adolescents and adults younger than 25, who have access to comprehensive care should be lower than 7.0% [7].

Statistical Analysis

Sample size was estimated based on the primary outcome. The study was designed with 80% power to detect medium (0.50) effect size for the difference in total PedsQL score between the experimental and control groups at 6 months. Power calculations were based on a sample size of 128 participants completing the study with 2-sided significance level of 0.05. Sample size was calculated using G*Power version 3.1.9.2 (Universität Kiel, Germany) [9].

Differences between baseline characteristics of patients from groups C and E were assessed with t-Student test, Fisher's exact test or Fisher-Freeman-Halton exact test. Data were presented with descriptive statistics as the mean (M) and standard deviation (SD) for metric variables and as the number (N) and frequency (%) for non-metric variables.

The effect of the intervention on the change of the primary and secondary outcomes was assessed with matched-pairs t-test and mixed-design analysis of variance, and presented together with their 95% confidence intervals. Multiple linear regression was used to assess changes of the primary and secondary outcomes for variables including: intervention (C/E), gender (F/M), age (8-12/13-18), place of residence (village/town/city), parents' level of education (vocational/secondary/tertiary), duration of the disease (<5/≥5 years), physical activity (low/moderate/high), BMI (underweight, normal weight/overweight, obese), and HbA1c concentration (<7.0/≥7.0%). The regression model was fitted to the empirical data by the Ordinary Least Squares (OLS) method. All variables were introduced to the model at the same time. The model statistics were calculated for each variable. The vector and intensity of significant relationships were interpreted by determining β standardized regression coefficients with their 95% confidence intervals.

Data were analysed using STATISTICA version 13.3 (Tibco Software Inc., Palo Alto, California, United States). P-value lower than 0.05 was considered to indicate statistical significance.

RESULTS

Patient characteristics

The authors decided to recruit a group which was 1/3 larger than the estimated sample size because of expected difficulties with obtaining the consent for participation in the study from the parents or legal guardians and a high percentage of patients who are lost to follow-up in this kind of studies. The participants were randomly assigned to groups C (traditional education) and E (modern education).

A total of 12 individuals were excluded throughout the study due to incomplete data in PedsQL questionnaire and the withdrawal of patients or their guardians from participation. Finally, data of 136 patients were analyzed (Figure 1). Baseline comparison of both subgroups showed no significant differences in any of the variables except scores obtained in 'Communication' subscale, in which group C scored higher than group E (Table 1 and Table 2).

Changes in the primary and secondary outcomes

Six months after the intervention we compared the results to the baseline scores obtained in PedsQL questionnaire. No significant discrepancies were observed as regards the total PedsQL score. However, a significant deterioration of results was noted in group C for 'Communication' subscale (-5.68, P=0.038). Such a deterioration was not found in group E. The intergroup difference was statistically significant (P=0.007). No other significant changes were observed (Table 3).

Table 1. Baseline characteristics of patients

Variable	Variant	All Patients (n = 136)		Group C (n = 66)		Group E (n = 70)		P-value
		n	%	n	%	n	%	
Sex								
	Male	56	41.2	33	50.0	23	32.9	0.055[a]
	Female	80	58.8	33	50.0	47	67.1	
Place of residence								
	Village	35	25.7	16	24.2	19	27.1	0.746[b]
	Town	54	39.7	25	37.9	29	41.4	
	City	47	34.6	25	37.9	22	31.4	
Parents' education								
	Vocational	15	11.0	7	10.6	8	11.4	0.711[b]
	Secondary	61	44.9	32	48.5	29	41.4	
	Tertiary	60	44.1	27	40.9	33	47.1	
Physical activity								
	Low	28	20.6	15	22.7	13	18.6	0.808[b]
	Moderate	70	51.5	34	51.5	36	51.4	
	High	38	27.9	17	25.8	21	30.0	
BMI interpretation								
	Underweight/ Normal	105	77.2	52	78.8	53	75.7	0.688[a]
	Overweight/ Obese	31	22.8	14	21.2	17	24.3	

Abbreviations: BMI – Body Mass Index, group C – control group, group E – experimental group
[a] 2-sided *Fisher's* exact test; [b] *Fisher-Freeman-Halton* exact test

Table 2. Baseline characteristics of patients

Variable	All Patients (n = 136)		Group C (n = 66)		Group E (n = 70)		t	P- value [a]	d (95% CI) [b]
	M	SD	M	SD	M	SD			
Age	13.72	2.27	13.44	2.10	13.99	2.40	-1.410	0.161	0.24 (-0.09; 0.58)
HbA1c	8.23	1.81	7.93	1.58	8.51	1.97	-1.861	0.065	0.32 (-0.02; 0.66)
Duration of the disease	5.58	3.71	5.28	3.60	5.87	3.82	-0.928	0.355	0.16 (-0.18; 0.50)
Total PedsQL	64.04	12.05	65.94	9.53	62.24	13.85	1.801	0.074	-0.31 (-0.65; 0.03)
Diabetes symptoms	59.86	12.67	62.02	11.54	57.82	13.42	1.949	0.053	-0.34 (-0.67; 0.01)

Treatment barriers	62.13	20.55	62.59	17.76	61.70	22.99	0.254	0.800	-0.04 (-0.38; 0.29)
Treatment adherence	71.56	18.49	73.38	16.88	69.85	19.86	1.114	0.267	-0.19 (-0.53; 0.15)
Worry	59.44	20.95	58.96	19.90	59.88	22.04	-0.254	0.800	0.04 (-0.29; 0.38)
Communication	68.93	23.86	74.37	20.11	63.81	26.04	2.635	0.009	-0.45 (-0.79; -0.11)

Abbreviations: M – mean, SD – standard deviation, HbA1c – glycated hemoglobin, CI - confidence interval, group C – control group, group E – experimental group
[a] t-test; [b] *Cohen's* coefficient

Table 3. Changes in scores obtained in PedsQL questionnaire from baseline to 6 months

Variable	Group C (N = 66)			Group E (N = 70)			F	P-value [a]
	M	SD	Mean change (95% CI) [b]	M	SD	Mean change (95% CI) [b]		
Total PedsQL								
baseline	65.94	9.53	-1.85 (-4.52; 0.82)	62.24	13.85	-0.36 (-3.14; 2.43)	0.596	0.441
6 months	64.08	14.23		61.89	12.20			
Diabetes symptoms								
baseline	62.02	11.54	-1.65 (-5.06; 1.76)	57.82	13.42	-1.92 (-5.04; 1.21)	0.013	0.910
6 months	60.37	16.11		55.91	13.36			
Treatment barriers								
baseline	62.59	17.76	-0.57 (-4.36; 3.22)	61.70	22.99	-2.05 (-7.04; 2.94)	0.220	0.640
6 months	62.03	19.53		59.64	20.65			
Treatment adherence								
baseline	73.38	16.88	-2.38 (-6.43; 1.67)	69.85	19.86	1.28 (-2.69; 5.24)	1.658	0.200
6 months	71.00	16.73		71.12	18.38			
Worry								
baseline	58.96	19.90	0.76 (-4.77; 6.29)	59.88	22.04	-0.83 (-6.08; 4.41)	0.174	0.677
6 months	59.72	23.69		59.05	20.10			
Communication								
baseline	74.37	20.11	-5.68[c] (-11.05; -0.31)	63.81	26.04	4.29 (-0.64; 9.21)	7.487	0.007
6 months	68.69	25.11		68.10	25.77			

Abbreviations: M – mean, SD – standard deviation, CI – confidence interval, group C – control group, group E – experimental group
[a] Mixed-design analysis of variance; [b] Matched-pairs t-test; [c] $P<0.05$

Analysis of other determinants of the QoL

A relationship between selected variables and the delta (difference between baseline and final values) of scores obtained in PedsQL questionnaire was assessed with regression analysis. No significant dependencies were revealed for total PedsQL and 'Treatment adherence' and 'Worry' subscales.

However, a significant relationship was observed between the level of physical activity and the change in 'Diabetes symptoms' scores. Patients characterized by undertaking moderate physical activity scored higher compared to those with low physical activity profile (β=0.27, P=0.008). A similar relationship was not observed in case of high levels of physical activity (Table 4).

A dependence between the level of education of one of the parents and the change in 'Treatment barriers' score was found to be on the border of statistical significance. Patients with at least one parent with completed tertiary education achieved a higher

Table 4. Multiple linear regression analyses between the delta of scores obtained in selected subscales of PedsQL and selected variables

Variable	Variant	'Diabetes symptoms' (delta)	'Treatment barriers' (delta)	'Communication' (delta)
		ß (95% CI)	ß (95% CI)	ß (95% CI)
Method of education/ group	Traditional/C			
	Modern/E	0.01 (-0.17; 0.18)	-0.04 (-0.22; 0.13)	0.22[a] (0.05; 0.40)
Sex	Female			
	Male	0.14 (-0.04; 0.33)	-0.02 (-0.20; 0.17)	0.00 (-0.19; 0.19)
Age (years)	8-12			
	13-18	-0.13 (-0.30; 0.05)	0.12 (-0.06; 0.30)	-0.08 (-0.26; 0.10)
Place of residence	Village			
	Town	-0.06 (-0.25; 0.13)	-0.05 (-0.24; 0.14)	0.02 (-0.17; 0.21)
	City	0.14 (-0.06; 0.33)	0.14 (-0.05; 0.34)	0.05 (-0.15; 0.25)
Parent's level of education	Vocational			
	Secondary	-0.09 (-0.27; 0.09)	0.06 (-0.12; 0.24)	-0.08 (-0.26; 0.10)
	Tertiary	0.05 (-0.13; 0.22)	0.17[c] (-0.01; 0.35)	0.01 (-0.17; 0.19)
Disease duration (years)	<5			
	≥5	0.10 (-0.08; 0.28)	0.08 (-0.10; 0.26)	0.03 (-0.15; 0.21)
Physical activity	Low			
	Moderate	0.27[b] (0.07; 0.46)	0.10 (-0.09; 0.30)	-0.03 (-0.23; 0.17)
	High	-0.11 (-0.30; 0.08)	-0.09 (-0.28; 0.11)	0.11 (-0.08; 0.30)
BMI interpretation	Underweight/ Normal			
	Overweight/ Obese	0.12 (-0.05; 0.29)	-0.08 (-0.26; 0.09)	0.03 (-0.15; 0.20)
HbA1c (%)	<7.0			
	≥7.0	-0.01 (-0.20; 0.17)	0.04 (-0.15; 0.22)	-0.02 (-0.21; 0.16)

Abbreviations: CI – confidence interval, group C – control group, group E – experimental group, BMI – Body Mass Index, HbA1c – glycated hemoglobin

[a] P<0.05; [b] P<0.01; [c] P=0.062

improvement in the scores compared to those whose parents completed vocational programs (β=0.17, P=0.062). A similar relationship was not observed for secondary education (Table 4).

Finally, a marked dependence was demonstrated between the type of intervention and the change in 'Communication' scores. Patients from group E, in whom modern methods of training were implemented, achieved a more marked improvement in the results (β=0.22, P=0.014) compared to group C, educated with traditional methods (Table 4).

DISCUSSION

The authors of the present study attempted to compare the impact of two different methods of nutrition education on the QoL in patients with type 1 diabetes. In addition, attempts were made to identify the remaining QoL determinants in this group. It should be emphasized that there is a paucity of studies on the assessment of the effectiveness of various nutrition education methods in the contex of the QoL in children and adolescents with type 1 diabetes treated with insulin pumps. With the use of randomization the participants were assigned to group C, in which a traditional training (a lecture) was conducted, or to group E, in which modern methods of education (a quiz + multimedia application) were additionally used.

The analysis of changes after 6 months following the intervention showed a significant deterioration of results in group C and a simultaneous improvement in group E as regards 'Communication' subscale. It is worth emphasizing that at baseline group E was characterized by a significantly lower QoL in terms of 'Communication' aspect compared to group C, which may have impeded the improvement. No other significant changes were noted as regards the total PedsQL score and scores in other subscales. As a comparison, in Kids in Control of Food (KICk–OFF) study conducted in a group of 396 children and adolescents with type 1 diabetes the researchers assessed the effectiveness of a 5-day educational course. The QoL of the participants and the control group was verified after 6, 12 and 24 months following the intervention. Interestingly, after 6 months a significant improvement was observed for 'Diabetes symptoms'. At the same time, a slight deterioration of results was noted in the control group. However, after 24 months the scores obtained in both groups returned to baseline values. A significant change was also observed after 12 and 24 months for 'Treatment adherence'. Notably, a significant improvement achieved by the control group was higher than in the group of course participants in both measurements. However, no significant changes were noted for 'Diabetes Total Score' and other subscales at any stage of the study [20]. It is worth mentioning results obtained in *DEPICTED* study, in which the effectiveness of a special Talking Diabetes exercise programme was assessed. The programme was designed to improve the communication skills in pediatric diabetes teams. Subsequently, the researchers assessed changes in the QoL in a group of children and adolescents with type 1 diabetes who interacted with the personnel who had undergone the training and personnel without such a training. In both groups of patients a significant improvement of the QoL was noted for 'Treatment barriers' and 'Treatment adherence' (on the border of statistical significance) [21].

The analysis of factors determining individual aspects of the QoL demonstrated that physical activity was a significant determinant of the QoL. Patients characterized by moderate activity obtained a marked improvement as regards the QoL for 'Diabetes symptoms' compared to those whose activity was described as low. It seems understandable, because 'Diabetes symptoms' subscale tackled such topics as experiencing fatigue, irritability, or sleep problems. Interestingly, a similar relationship was not observed in patients characterized by high physical activity. It may be associated with the subjective assessment of the level of physical activity by the patients. Conversely, excessive physical exercise may increase the risk of hypoglycemia in patients with type 1 diabetes [14]. Nevertheless, a positive effect of physical activity on the mental health of patients with type 1 diabetes was also documented in other studies [6,17]. However, it is worth emphasizing that the health status of children and adolescents with type 1 diabetes may frequently contribute to lowering the level of physical activity [17].

The level of parents' education was another determinant of the QoL in the study group. It was demonstrated that patients with at least one parent who had completed tertiary education achieved a higher improvement in the QoL for 'Treatment barriers' compared to those whose parents had completed vocational education (the result was very close to the border of statistical significance). It may be associated with the development of technologies (especially as regards insulin pumps, mobile applications and continuous glucose monitoring systems) which facilitates more effective disease management, but may be too complicated for some individuals [12]. Therefore, it seems that parents who had completed tertiary education may be more eager to use modern technologies, which translates into an improvement of the QoL. However, no studies were found to analyze the relationship between the parents' level of education and the QoL in children suffering from type 1 diabetes. Notably, the lack of agreement between parents and children as regards diabetes management

was one of the elements of 'Treatment barriers' subscale. Diabetes-specific family conflict appeared to be an undeniably strong factor which influenced the QoL in young patients [12]. Unquestionably, appropriate attitude of parents plays a very important role in daily functioning of their children with type 1 diabetes. When adolescents go through puberty, they are determined to achieve independence and do not need excessive care from the parents. However, commitment and cooperation based on support provided by the parents has a positive influence on the QoL of children [18].

Finally, the type of educational intervention also constituted a significant determinant of the QoL. Patients from group E, who had been educated using modern methods (a quiz/multimedia application), achieved a considerable improvement in the QoL for 'Communication' compared to patients from group C, whose education had only involved participation in a lecture. Seemingly, the interactive form of education (a discussion conducted on the basis of a quiz, encouraging asking questions by the participants, problem solving by the group) in group E had a positive impact on communication skills of the participants.

The results of the present study are not free from limitations. Primarily, baseline significant intergroup difference as regards scores obtained in 'Communication' subscale and a relatively large number of participants who did not receive the allocated intervention or 'lost to follow-up' could have a potential impact on the further results and conclusions. Another limitation is the wide age range of the participants. However, the average age in both groups was very similar. Moreover, it seems that a relatively short duration of observation might be insufficient to assess long-term changes and the effect of the intervention on the QoL of patients. Ultimately, we may not exclude the impact of additional patient-related factors, such as intelligence quotient (IQ) or predisposition to acquire knowledge and new skills, as well as the level of motivation and commitment.

CONCLUSIONS

The present results indicate a comparable effect of both methods of nutrition education on the general QoL of the study group of children and adolescents with type 1 diabetes. However, they also confirm a higher effectiveness of modern methods of nutrition education in terms of the improvement in the aspect of communication. Basing on the obtained results it may be stated that the following factors constitute important determinants of various aspects of the QoL in the analyzed group of patients: interactive training methods, moderate level of physical activity and tertiary education completed by the parents. Observation period extension and the analysis of the influence of additional factors which may influence the QoL are necessary to assess long-term intervention effects.

Acknowledgements
The authors have nothing to declare.

REFERENCES

1. *Abolfotouh M.A., Kamal M.M., El-Bourgy M.D., Mohamed S.G.:* Quality of life and glycemic control in adolescents with type 1 diabetes and the impact of an education intervention. Int J Gen Med. 2011;4:141–152. doi:10.2147/IJGM.S16951.
2. *Araszkiewicz A., Bandurska-Stankiewicz E., Budzyński A., Cypryk K., Czech A., Czupryniak L., ... Zozulińska-Ziółkiewicz D.:* 2019 Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019;8(1):15-18. doi:10.5603/DK.2019.0001.
3. *Baraz S., Zarea K., Shahbazian H.B.:* Impact of the self-care education program on quality of life in patients with type II diabetes. Diabetes Metab Syndr. 2017;11(Suppl2):S1065-S1068. doi:10.1016/j.dsx.2017.07.043.
4. *Calle-Bustos A.M., Juan M.C., García-García I., Abad F.:* An augmented reality game to support therapeutic education for children with diabetes. PLoS One. 2017;12(9):e0184645. doi:10.1371/journal.pone.0184645
5. *Chaney D.:* Structured diabetes education for children and adolescents. Nurs Stand. 2012;27(6):41-47. doi:10.7748/ns.27.6.41.s55.
6. *Chimen M., Kennedy A., Nirantharakumar K., Pang T.T., Andrews R., Narendran P.:* What are the health benefits of physical activity in type 1 diabetes mellitus? A literature review. Diabetologia. 2012;55(3): 542–551. doi:10.1007/s00125-011-2403-2.
7. *DiMeglio L.A., Acerini C.L., Codner E., Craig M.E., Hofer S.E., Pillay K., Maahs D.M.:* ISPAD Clinical Practice Consensus Guidelines 2018: Glycemic control targets and glucose monitoring for children, adolescents, and young adults with diabetes. Pediatr Diabetes. 2018;19(Suppl27):105–114. doi:10.1111/pedi.12737.
8. *Dłużniak-Gołaska K., Panczyk M., Szypowska A., Sińska B., Szostak-Węgierek D.:* Interactive Nutrition Education Is More Effective in Terms of Improved Levels of Glycated Hemoglobin in Adolescent Patients with Poorly Controlled Type 1 Diabetes - A Randomized Study. Diabetes Metab Syndr Obes. 2019;12:2619-2631. doi: 10.2147/DMSO.S229246.
9. *Faul F., Erdfelder E., Lang A.G., Buchner A.:* G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175-191. doi:10.3758/bf03193146.
10. *Faulkner M.S.:* Quality of life for adolescents with type 1 diabetes: parental and youth perspectives. Pediatr Nurs. 2003;29(5):362-368.
11. *Guo J., Whittemore R., Jeon S., Grey M., Zhou Z.G., He G.P., Luo Z.Q.:* Diabetes self-management, depressive

symptoms, metabolic control and satisfaction with quality of life over time in Chinese youth with type 1 diabetes. J Clin Nurs. 2015;24(9-10):1258–1268. doi:10.1111/jocn.12698.

12. *Jaser S.S.:* Family interaction in pediatric diabetes. Curr Diab Rep. 2011;11(6):480–485. doi:10.1007/s11892-011-0222-y.
13. *Kułaga Z., Różdżyńska-Świątkowska A., Grajda A., Gurzkowska B., Wojtyło M., Góźdź M., Świąder-Leśniak A., Litwin M.:* Siatki centylowe dla oceny wzrastania i stanu odżywienia polskich dzieci i młodzieży od urodzenia do 18 roku życia [Percentile charts for growth and nutritional status assessment in Polish children and adolescents from birth to 18 year of age]. Standardy medyczne/Pediatria. 2015;12:119-135. (in Polish).
14. *Metcalf K.M., Singhvi A., Tsalikian E., Tansey M.J., Zimmerman M.B., Esliger D.W., Janz K.F.:* Effects of moderate-to-vigorous intensity physical activity on overnight and next-day hypoglycemia in active adolescents with type 1 diabetes. Diabetes Care. 2014;37(5):1272–1278. doi:10.2337/dc13-1973.
15. *Mohammadi H., Valiee S., Nouri B., Fallahi A., Zehni K.:* The effect of self-care education through social networks on the patients' quality of life with type 1 diabetes in Sanandaj City, Iran. Creative Education. 2018;9:322-332. doi:10.4236/ce.2018.92022.
16. *Murillo M., Bel J., Pérez J., Corripio R., Carreras G., Herrero X., Mengibar J.M., Rodriguez-Arjona D., Ravens-Sieberer U., Raat H., Rajmil, L.:* Health-related quality of life (HRQOL) and its associated factors in children with type 1 diabetes mellitus (T1DM). BMC Pediatr. 2017;17(1):16. doi:10.1186/s12887-017-0788-x.
17. *Mutlu E.K., Mutlu C., Taskiran H., Ozgen I.T.:* Association of physical activity level with depression, anxiety, and quality of life in children with type 1 diabetes mellitus. J Pediatr Endocrinol Metab. 2015;28(11-12):1273–1278. doi:10.1515/jpem-2015-0082.
18. *Nordfeldt S., Ängarne-Lindberg T., Nordwall M., Krevers B.:* Parents of adolescents with type 1 diabetes - their views on information and communication needs and internet use. A qualitative study. PLoS One. 2013;8(4):e62096. doi: 10.1371/journal.pone.0062096.
19. *Phelan H., Lange K., Cengiz E., Gallego P., Majaliwa E., Pelicand J., Smart C., Hofer S.E.:* ISPAD Clinical Practice Consensus Guidelines 2018: Diabetes education in children and adolescents. Pediatr Diabetes. 2018;19(Suppl27):75-83. doi: 10.1111/pedi.12762.
20. *Price K.J., Knowles J.A., Fox M., Wales J.K., Heller S., Eiser C., Freeman J.V., KICk-OFF Study group.:* Effectiveness of the Kids in Control of Food (KICk–OFF) structured education course for 11–16 year olds with Type 1 diabetes. Diabet Med. 2016;33(2):192–203. doi:10.1111/dme.12881.
21. *Robling M., McNamara R., Bennert K., Butler C.C., Channon S., Cohen D., Crowne E., Hambly H., Hawthorne K., Hood K., Longo M., Lowes L., Pickles T., Playle R., Rollnick S., Thomas-Jones E., Gregory J.W.:* The effect of the Talking Diabetes consulting skills intervention on glycaemic control and quality of life in children with type 1 diabetes: cluster randomized controlled trial (DEPICTED study). BMJ. 2012;344:e2359. doi:10.1136/bmj.e2359.
22. *Smart C.E., Annan F., Higgins L.A., Jelleryd E., Lopez M., Acerini C.L.:* ISPAD Clinical Practice Consensus Guidelines 2018: Nutritional management in children and adolescents with diabetes. Pediatr Diabetes. 2018;19(Suppl 27):136-154. doi: 10.1111/pedi.12738.
23. *Snoek F.J., Visser A.:* Improving quality of life in diabetes: how effective is education?. Patient Educ Couns. 2003;51(1):1–3. doi:10.1016/s0738-3991(03)00204-0.
24. *Varni J.W., Burwinkle T.M., Jacobs J.R., Gottschalk M., Kaufman F., Jones K.L.:* The PedsQL in type 1 and type 2 diabetes: reliability and validity of the Pediatric Quality of Life Inventory Generic Core Scales and type 1 Diabetes Module. Diabetes Care. 2003;26(3):631-637. doi:10.2337/diacare.26.3.631.
25. VitaScale Kalkulator kalorii i wymienników [VitaScale Calories and exchanges calculator]. Available https://vitascale.pl/ (Accessed 13 April 2020). (in Polish).

Received: 16.04.2020
Accepted: 09.05.2020