Published by v|b|z

ORIGINAL INVESTIGATION

Effects of structured diabetes education program on diabetes knowledge and metabolic control in insulin-treated diabetes patients from the Republic of Macedonia

Tatjana Milenkovic[1], Ivica Smokovski[1], Nadica Bozhinovska[1], Dario Rahelic[2], Sasha Jovanovska Misevska[1], Iskra Bitovska Mileva[1], Irfan Ahmeti[1]

[1]University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Skopje, Republic of Macedonia
[2]Department of Endocrinology, Diabetes and Metabolic Disorders, Clinical Hospital Dubrava, Zagreb, Croatia

Corresponding author:
Prof. Tatjana Milenkovic, Medical Faculty "St. Cyril and Methodius" Clinic of Endocrinology, Diabetes and Metabolic Disorders, Vodnjanska 17, 1000, Skopje Macedonia,
Telephone: +38970359073,
e-mail: milenkovic.tatjana@yahoo.com

DOI: 10.21040/eom/2017.3.1.1

Received: January 10th 2017
Accepted: February 26th 2017
Published: March 30th 2017

Funding: None.
Conflict of interest statement: The authors declare that they have no conflict of interest.
Data Availability Statement: All relevant data are within the paper.

Abstract

Background and Aims: We aimed to compare the diabetes knowledge and metabolic control between insulin-treated diabetes patients who completed structured and those who completed unstructured diabetes education at diagnosis and to evaluate the effects of structured diabetes education program (SDEP) on diabetes knowledge and metabolic control.
Subjects and Methods: Prospective, observational study of 59 insulin-treated diabetes patients invited for SDEP at University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Skopje, in the period from March 2013 to December 2014 and divided into two groups if they completed SDEP at diagnosis. Patients were tested for their diabetes knowledge (scale of 0 to 100 points) before SDEP and immediately after SDEP and evaluated for their metabolic control. Patients were invited 1 year after completion of SDEP for evaluation of their diabetes knowledge and metabolic parameters.
Results: Groups were not significantly different in diabetes knowledge before SDEP (67.3 ± 11.1 vs. 68.0 ± 13.1 points, P = 0.835), and results improved in both groups after completion of SDEP (Group 1: 19.6 ± 8.9 points, P < 0.001; Group 2: 16.9 ± 7.8 points, P < 0.001) with no significant difference between groups. Diabetes knowledge 1 year after SDEP was significantly higher in Group 2 (82.9 ± 7.8 vs. 76.6 ± 11.1 points, P = 0.014). Significant reduction in glycated hemoglobin was obtained 1 year after SDEP within both groups with no significant difference between groups.
Conclusion: Continuous SDEP results in sustainable increase in diabetes knowledge and improved glycemic control, thus avoiding or delaying diabetes complications, and reducing the burden on the society.

Key words: Structured diabetes education; diabetes knowledge; metabolic control

1. Introduction

Diabetes mellitus poses a huge health care and socioeconomic threat to the Republic of Macedonia, with a national prevalence of 12%, being the fourth highest in Europe, and a comparative (age-adjusted) prevalence of 10.3%, being the third highest in Europe [1,2]. A considerable increase in calories per capita per day, a sedentary lifestyle, transition society-related stress, and a high national smoking rate are the main reasons for the dramatic rise of type 2 diabetes in the past 25 years [2].

As a result, numerous activities have been undertaken to tackle the rising prevalence of diabetes, such as its inclusion in the Law on Healthcare as a specifically designated medical condition, National Diabetes Guidelines were published in the Official Journal of the Republic of Macedonia (where laws and by-laws are published), and a National Diabetes Committee was established to oversee the implementation of diabetes care guidelines. In addition, public awareness programs were developed highlighting the importance of nutrition, physical activity and smoking cessation, and diabetes-specific patient data were integrated into the National eHealth System [2].

Structured diabetes education is widely recognized as a crucial part of diabetes care, that could certainly be referred to as the "sine qua non" in diabetes treatment [3]. Numerous studies have demonstrated that structured diabetes education programs (SDEPs) result in improved diabetes care, reduced hospitalizations, and are cost-effective in the long term [4-6].

National Diabetes Guidelines recommend that every diabetes patient and/or caregiver be offered structured education at the time of diagnosis or later and repeated at least annually, followed by testing of acquired diabetes knowledge [7]. Such Guidelines are in line with SDEP recommendations from other widely accepted international guidelines [8].

In addition, National Diabetes Guidelines recommend that patients with diabetes be informed that structured education is an integral part of their diabetes treatment. Group education is generally preferred; however, for those not able or not willing to participate, alternative methods of SDEPs should be offered [7].

Although recent diabetes care initiatives in the Republic of Macedonia were acknowledged by relevant international authorities [2,9], it was also recognized that some SDEP recommendations in the National Diabetes Guidelines were not fully implemented, and many patients with both type 1 and type 2 diabetes were not offered SDEPs, neither at the time of diagnosis nor later during the course of the disease [9]. SDEPs were mainly available in diabetes care facilities in larger cities, and a lack of SDEP resources was recognized as a reason for the paucity in diabetes education in the country [9].

There are no national studies reported so far comparing the effect of SDEPs on the level of diabetes knowledge and metabolic control in insulin-treated patients if provided at the time of diagnosis or later during the course of diabetes. In addition, the 1-year sustainability of SDEP and its effect on diabetes knowledge and metabolic control is unknown.

The aim of our study was to compare the diabetes knowledge, as measured by the diabetes knowledge test results, between insulin-treated diabetic patients from the Republic of Macedonia that completed a structured versus unstructured diabetes education at the time of diagnosis, and to evaluate the effects of SDEP on their diabetes knowledge immediately after the SDEP and 1 year later.

In addition, metabolic parameters (glycated hemoglobin [HbA1c] and lipid profile) were compared in both groups at baseline and 1 year after SDEP, and correlations between changes in diabetes knowledge and glycemic control (HbA1c) before and after SDEP were evaluated.

2. Methods

This prospective, observational study included 59 patients with type 1 or type 2 diabetes treated at the University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Skopje. Participants were divided into 2 groups according to whether or not they completed an SDEP at the time of diabetes diagnosis: Group 1 consisted of patients who completed SDEP and Group 2 of patients who were offered unstructured education at the time of diagnosis. None

of the study patients was offered continuous structured diabetes education during the course of diabetes and before study inclusion. All 59 patients were insulin-treated and received additional treatment for concomitant diseases when indicated.

Both groups were invited to SDEPs at the University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Skopje, from March 2013 to December 2014; Group 1 patients were offered re-education through SDEP, and Group 2 patients completed SDEP for the first time.

An SDEP was defined as an interactive educational program lasting 5 consecutive days, 3 h per day, provided by a team of diabetologists, 2 diabetes nurses, nutritionist, and psychologist. The program was offered as group education, and all invited patients were divided into teams of 5-10.

Before any SDEP activities, patients were tested for their diabetes knowledge through a standardized diabetes knowledge test, prepared according to the American Association of Clinical Endocrinologists recommendations [10]. The test consisted of 44 questions: 11 about diabetes mellitus, 14 about nutrition, 5 about physical activity, 9 about self-control, and 5 about pharmacological treatment. Test results were presented on a scale of 0-100 points, and diabetes knowledge was categorized as adequate if patients scored 75 or above. In addition, patients were evaluated for the type and duration of diabetes, systolic and diastolic blood pressure, self-reported regular physical activity, body mass index (BMI), smoking, and acute and chronic diabetes complications. Laboratory tests were performed to determine glycemic control (HbA1c, fasting plasma glucose [FPG]) and lipid profiles (low-density lipoprotein [LDL] cholesterol, triglycerides [TG]).

Day 1 of SDEP was dedicated to mechanisms leading to diabetes and treatment of diabetes; day 2 to nutrition, including basic and advanced carbohydrate counting; day 3 to acute diabetes complications and their treatment, including adjustments of insulin doses related to diet, physical activity, the common cold, or other infections; day 4 to chronic diabetes complications and the diabetic foot; day 5 was reserved for the summary of knowledge gained. Patients were tested for their diabetes knowledge immediately after the SDEP completion on day 5, by using the same diabetes knowledge test as on day 1.

One year after completing the SDEP, patients were re-invited to take the same diabetes knowledge test, as described above. In addition, laboratory samples were taken for HbA1c and lipid parameters (LDL and TG).

Statistical methods used in the study were the ANOVA test, Chi-square test, paired samples t-test, Pearson's correlation, regression, and $P < 0.05$ was considered as significant.

3. Results

Patient characteristics of Groups 1 and 2 are presented in Table 1.

There were 24 patients (40.7%) in Group 1 and 35 patients (59.3%) in Group 2. Group 1 was characterized by significantly more females (74.3% vs. 45.8%, $P = 0.026$), an older population (62.4 ± 5.4 vs. 38.8 ± 12.5 years, $P < 0.001$), a longer duration of diabetes (20.4 ± 1.7 vs. 5.0 ± 2.3 years, $P < 0.001$), and fewer patients with type 1 diabetes (2.9% vs. 45.8%, $P < 0.001$). Furthermore, Group 1 patients had significantly higher systolic (139.8 ± 17.5 vs. 125.0 ± 14.5 mmHg, $P = 0.001$) and diastolic blood pressure (83.6 ± 9.2 vs. 77.9 ± 10.3 mmHg, $P = 0.031$) and had fewer smokers (14.3% vs. 37.5%, $P = 0.041$). There were no significant differences in BMI (29.4 ± 5.0 vs. 27.7 ± 4.7 kg/m^2, $P = 0.193$), self-reported regular physical activity (25.7% vs. 29.2%, $P = 0.499$), FPG (10.0 ± 2.9 vs. 9.9 ± 3.2 mmol/l, $P = 0.856$), HbA1c (9.9 ± 2.7% vs. 9.2 ± 1.7%, $P = 0.287$), and lipid profile (LDL: 3.9 ± 0.9 vs. 3.9 ± 0.8 mmol/l, $P = 0.906$; TG: 2.4 ± 1.6 vs. 2.6 ± 1.3 mmol/l, $P = 0.673$) between the groups. In addition, there were significantly more patents in Group 1 with non-proliferative retinopathy (54.3% vs. 4.2%, $P < 0.001$), chronic kidney disease (42.9% vs. 12.5%, $P = 0.012$), and neuropathy (37.1% vs. 12.5%, $P = 0.034$), while there was no significant between-group difference in proliferative retinopathy, nephropathy, autonomic neuropathy, coronary artery disease, cerebrovascular disease, peripheral artery disease, hypoglycemic events, severe hypoglycemic events, hypoglycemic coma, hospitalizations or diabetic ketoacidosis.

Table 1. Characteristics of the study population

Parameter	Group 1 (N=24)	Group 2 (N=35)	P
Female gender n (%)	18 (75.0)	16 (45.8)	0.026
Age (years)*	62.4±5.4	38.8±12.5	<0.001
Diabetes duration (years)*	20.4±1.7	5.0±2.3	<0.001
Diabetes type 1 n (%)	1 (4.2)	16 (45.8)	<0.001
BMI (kg/m^2)*	29.4±5.0	27.7±4.7	0.193
Smoking n (%)	3 (12.5)	13 (37.1)	0.041
Self-reported regular physical activity n (%)	6 (25.0)	10 (28.6)	0.499
Systolic blood pressure (mmHg)*	139.8±17.5	125.0±14.5	0.001
Diastolic blood pressure (mmHg)*	83.6±9.2	77.9±10.3	0.031
Fasting plasma glucose (mmol/l)*	10.0±2.9	9.9±3.2	0.856
Non-proliferative retinopathy n (%)	13 (54.2)	1 (2.9)	< 0.001
Proliferative retinopathy n (%)	1 (4.2)	4 (11.4)	0.323
Chronic kidney disease n (%)	10 (41.7)	4 (11.4)	0.012
Neuropathy n (%)	9 (37.5)	4 (11.4)	0.034
Autonomic neuropathy n (%)	3 (12.5)	3 (8.6)	0.530
Coronary artery disease n (%)	1 (4.2)	0 (0.0)	0.593
Cerebrovascular disease n (%)	0 (0.0)	0 (0.0)	NA
Peripheral artery disease n (%)	4 (16.7)	3 (8.6)	0.285
HbA1c (%)*	9.9±2.7	10.6±2.4	0.287
LDL (mmol/l)*	3.9±0.9	3.9±0.8	0.906
TG (mmol/l)*	2.4±1.6	2.6±1.3	0.673
Hypoglycemic events per year (n)*	1.1±2.0	1.5±2.9	0.530
Severe hypoglycemic events per year (n)*	0.2±0.03	0	0.412
Hypoglycemic coma per year (n)*	0	0	NA
DKA per year (n)*	0.1±0.4	0.2±0.5	0.843
Hospitalizations per year (n)*	0.5±0.6	0.6±0.6	0.587
HbA1c after 1 year (%)*	9.0±1.3	9.2±1.7	0.605
Change in HbA1c after 1 year (pp)*	−1.4±1.9	−0.9±1.9	0.327**
LDL after 1 year (mmol/l)*	3.7±0.9	3.5±0.6	0.564
Change in LDL after 1 year (mmol/l)*	−0.2±0.9	−0.4±0.8	0.504**
TG after 1 year (mmol/l)*	1.1±0.2	1.1±0.3	0.814
Change in TG after 1 year (mmol/l)*	−1.4±1.4	−1.3±1.7	0.765**

BMI-Body mass index, LDL-Low-density lipoprotein, HbA1c-Glycated hemoglobin, TG-Triglycerides, DKA-Diabetic ketoacidosis, NA-Not applicable, pp-Percentage points, SD-Standard deviation. *Mean±SD, **Between-group difference

Despite the significant reduction in HbA1c obtained 1 year after the SDEP within both groups (Group 1: −1.4 ± 1.9%, P = 0.002; Group 2: −0.9 ± 1.9%, P = 0.009), no significant difference between the groups was observed (9.0 ± 1.3% vs. 9.2 ± 1.7%, P = 0.605).

A significant reduction in LDL was also obtained 1 year after the SDEP within Group 2 (Group 1: −0.2 ± 0.9 mmol/l, P = 0.245; Group 2: −0.4 ± 0.8 mmol/l, P = 0.04), whereas no significant difference between groups was observed (3.7 ± 0.9 vs. 3.5 ± 0.6 mmol/l, P = 0.564). In addition, TG values were significantly reduced within groups (Group 1: −1.4 ± 1.4 mmol/l, P < 0.001; Group 2: −1.3 ± 1.7 mmol/l, P = 0.002) with no significant between-group difference (1.1 ± 0.2 mmol/l vs. 1.1 ± 0.3 mmol/l, P = 0.814).

Diabetes knowledge test results are presented in Table 2.

Groups were not significantly different in diabetes knowledge test results before SDEP (67.3 ± 11.1 vs. 68.0 ± 13.1 points, P = 0.835). Results in both groups were significantly improved after completion of SDEP at day 5 (Group 1: 19.6 ± 8.9 points, P < 0.001; Group 2: 16.9 ± 7.8 points, P < 0.001); however, no significant difference was observed between groups (87.0 ± 6.5 vs. 84.7 ± 11.3 points, P = 0.323).

As expected, diabetes knowledge test results deteriorated 1 year after SDEP; nonetheless, the results were significantly higher in Group 2 (82.9 ± 7.8 vs. 76.6 ± 11.1 points, P = 0.014), resulting in a significantly smaller change in Group 2 test results 1 year after SDEP (−4.1 ± 4.0 vs. −8.0 ± 5.2 points, P = 0.002). Comparing the change of test results 1 year after SDEP and before SDEP, there was a significant improvement in Group 2 versus Group 1 (15.6 ± 9.5 vs. 9.0 ± 8.7 points, P = 0.011).

A negative correlation was observed in the total population between the change in HbA1c 1 year after SDEP and the change between diabetes knowledge test results before and after SDEP (r = −0.3, P = 0.029). Such a negative correlation resulted from the negative correlation observed in Group 1 between the change in HbA1c 1 year after SDEP and the change between diabetes knowledge test results before and after SDEP (r^2 = −0.5, P = 0.01), whereas no significant negative correlation was obtained in Group 2 (r^2 = −0.2, P = 0.282) (Figure 1a-c).

One year after SDEP, a negative correlation was also observed in Group 1 between change in HbA1c and SDEP and the change in diabetes knowledge test results before and 1 year after SDEP (r^2 = −0.4, P = 0.045), whereas no significant negative correlation was obtained in Group 2 (r^2 = −0.2, P = 0.365). No significant negative correlation was observed in the total population between change in HbA1c 1 year after SDEP and the change in diabetes knowledge test results before and 1 year after SDEP (r^2 = −0.2, P = 0.114) (Figure 2a-c).

4. Discussion

SDEPs are an integral part of diabetes care, and one of the key elements in the National Diabetes Guidelines, which recommend these programs to every diabetes patient or

Table 2. Diabetes knowledge test results

Variable	Group 1	Group 2	P
Test results before SDEP (points)*	68.0±13.2	67.3±11.1	0.835
Test results after SDEP (points)*	84.9±11.4	87.0±6.5	0.323
Change of test result after SDEP versus before SDEP (points)*	16.9±7.8	19.6±8.9	0.244**
Test results 1 year after SDEP (points)*	76.6±11.1	82.9±7.8	0.014**
Change of test result 1 year after SDEP versus after SDEP (points)*	−8.0±5.2	−4.1±4.0	0.002**
Change of test result 1 year after SDEP versus before SDEP (points)*	9.0±8.7	15.6±9.5	0.011**

*Mean±SD. **Between-group difference. SD-Standard deviation

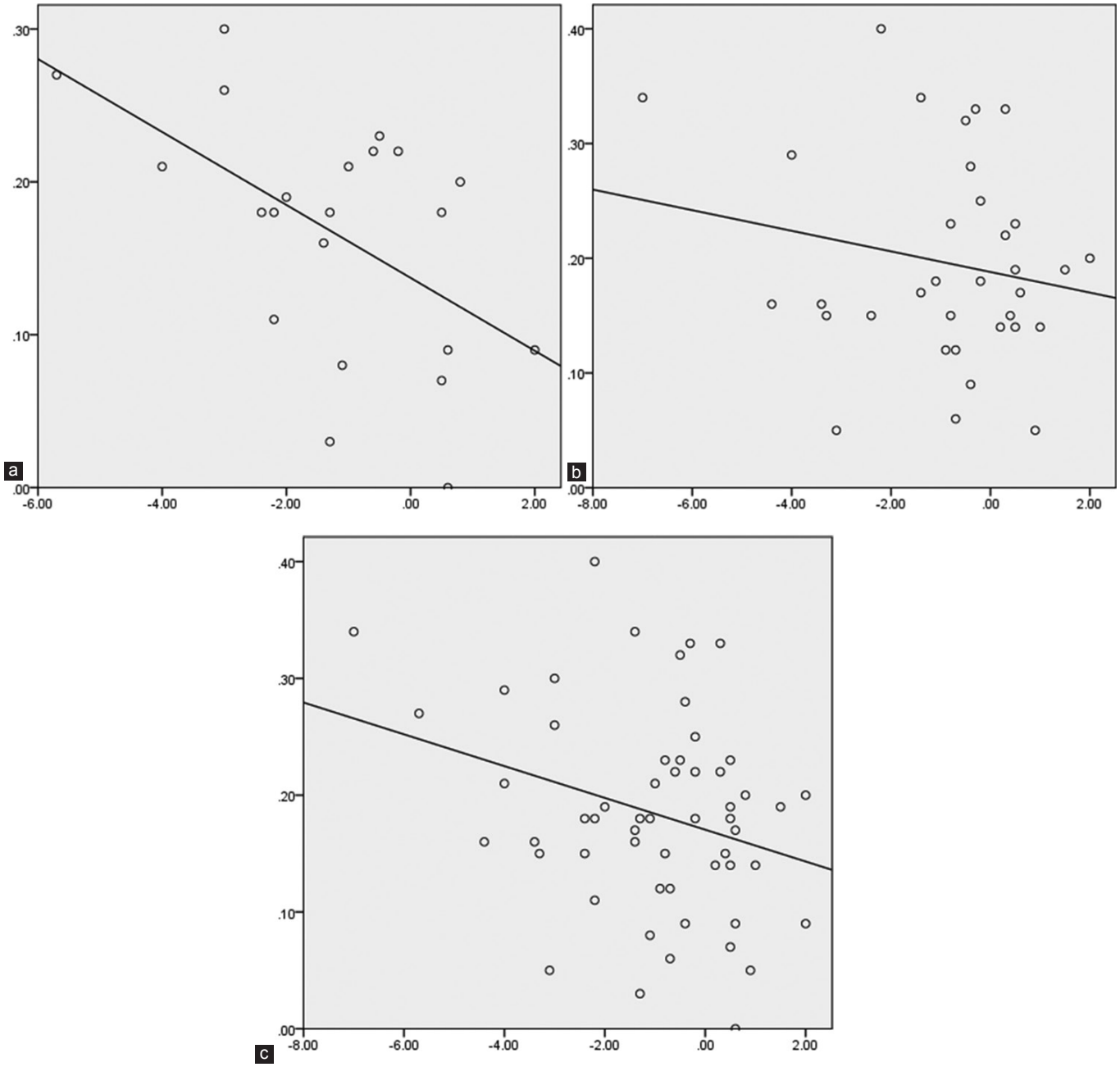

Figure 1. Correlation between change in glycated hemoglobin 1 year after structured diabetes education program (SDEP) (x-axis) and change in diabetes knowledge test results before and after SDEP (y-axis) in Group 1 (r = –0.5, P = 0.01) (a), Group 2 (r = –0.2, P = 0.282) (b) and in the entire study population (r = –0.3, P = 0.029) (c)

caregiver at the time of diagnosis or later, and recommend repeat education, as well as testing of diabetes knowledge acquired on a yearly level [7].

This was the first study to compare diabetes knowledge between insulin-treated diabetic patients from the Republic of Macedonia who completed structured or unstructured diabetes education at the time of diagnosis, with no continuous diabetes education afterward, and to evaluate the sustainable effects of SDEP on diabetes knowledge and metabolic control after 1 year. The University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Skopje, is the largest (out of 41) diabetes care facility in the Republic of Macedonia, providing care for 1/5 of all insulin-treated patients in the country, and is currently the only tertiary diabetes care institution in the Republic of Macedonia.

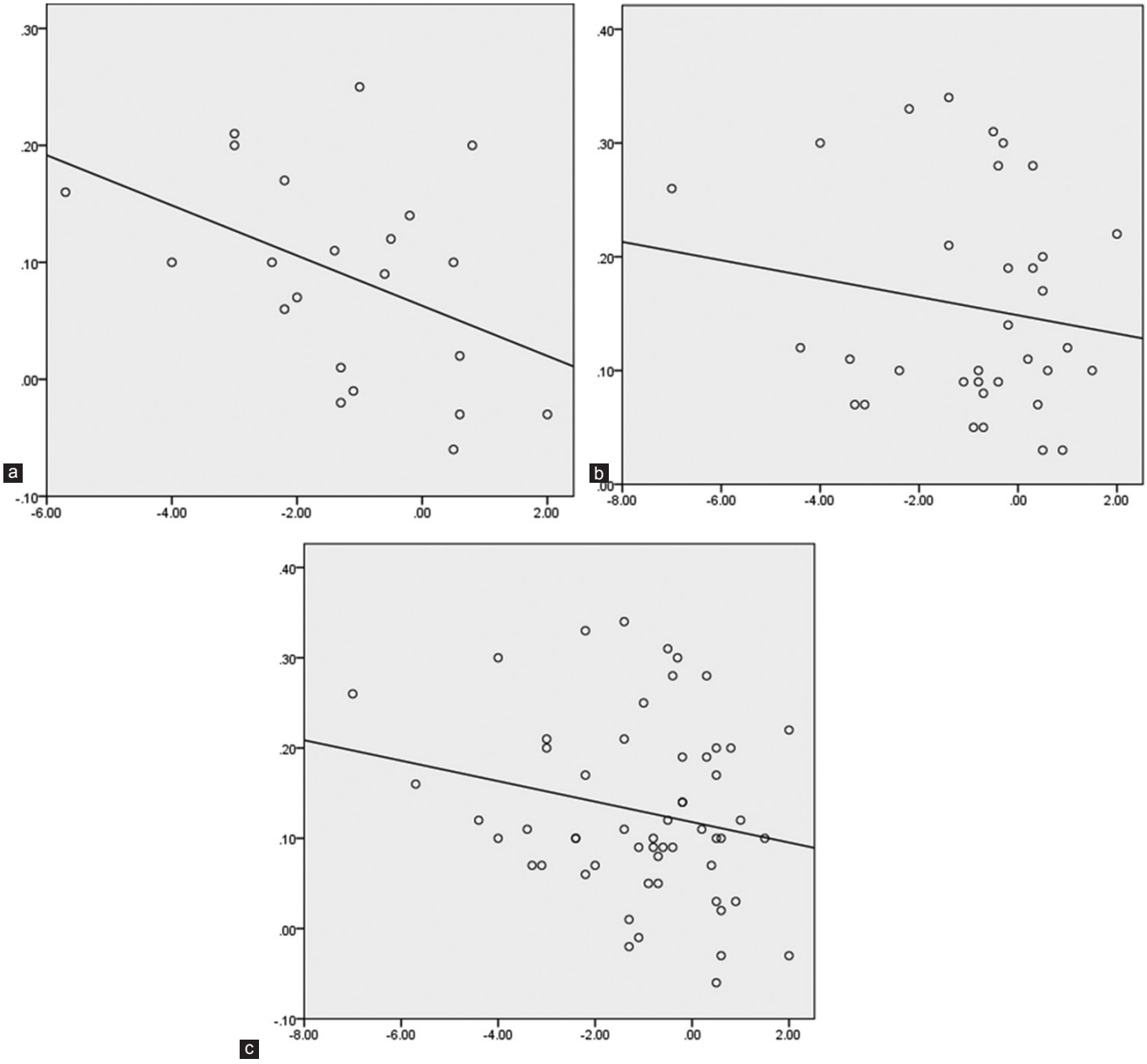

Figure 2. Correlation between change in glycated hemoglobin 1 year after structured diabetes education program (SDEP) (x-axis) and change in diabetes knowledge test results before and 1 year after SDEP (y-axis) in Group 1 (r = –0.4, P = 0.045) (a), Group 2 (r = –0.2, P = 0.365) (b) and in the entire study population (r = –0.2, P = 0.114) (c)

At study baseline, the study patients demonstrated inadequate diabetes knowledge (test score below 75), and there was no difference in the previously acquired diabetes knowledge between the groups, regardless if patients were offered SDEP or unstructured diabetes education at the time of diagnosis not followed by any diabetes education afterward. Such findings at baseline demonstrate the need to implement the National Diabetes Guidelines' recommendations and offer SDEP at least annually and test diabetes knowledge acquired [7].

Additional reasons for inadequate results could be due to the longer duration of diabetes and more advanced age in Group 1 despite the fact that they were offered SDEP at the time of diagnosis. A significantly higher proportion of patients with diabetic complications - such as retinopathy, chronic kidney disease or neuropathy - could also be

attributed to the features in Group 1 as listed above, including the higher values of systolic and diastolic blood pressure.

On the other hand, almost half of Group 2 patients had type 1 diabetes and were more capable of exploiting modern means of online diabetes education and social media networking, although they were not offered SDEP at the time of diagnosis. Sadly, this younger population was also characterized by more smokers, in line with the exceptionally high national smoking rate [2], thus multiplying the risk for future deleterious outcomes [11,12].

At study baseline, patients from both groups, although insulin-treated, demonstrated poor glycemic control and inadequate lipid control that resulted in diabetic complications at study baseline, in particular in Group 1, further demonstrating the necessity SDEP at specialized diabetes care facilities [7,11].

As anticipated, diabetes knowledge was significantly improved in both groups after 5 days of SDEP, passing the pre-defined threshold of 75 points in both groups with no between groups' differences in terms of diabetes knowledge test results.

When the same diabetes knowledge test was taken after 1 year, as expected, lower results were observed in both groups compared to the results obtained on day 5 after completion of SDEP. Nonetheless, these results were significantly higher than the results obtained before SDEP at day 1, indicating the sustainable effect of SDEP on diabetes knowledge after 1 year. In addition, both groups presented with adequate diabetes knowledge (score of 75 points or above) even 1 year after SDEP.

Test results were significantly higher in Group 2 after 1 year, demonstrating a more sustainable effect of SDEP in this group of patients, even though they completed SDEP for the first time a year before. This can be explained by the younger age and increased motivation to acquire diabetes knowledge, improve metabolic control, and prevent diabetes complications in these patients.

However, the deterioration of diabetes knowledge 1 year after SDEP once again confirms the need for annual re-education, accompanied by testing of diabetes knowledge as recommended by the National Diabetes Guidelines [7].

In addition, lower HbA1c values were measured in both groups after 1 year, with no between-group difference in HbA1c reduction. No reduction in LDL was demonstrated at this time, and there was a significant lowering of TG in both groups. Such improved metabolic control could also be attributed to the increase in diabetes knowledge after 1 year; however, even the improved glycemic control, as measured by HbA1c, was well above the recommended targets [7,11]. Inadequate glycemic control achieved 1 year after SDEP additionally supports the recommendations from the National Diabetes Guidelines to repeat the education and testing of diabetes knowledge at least annually [7]. The level of metabolic improvement 1 year after SDEP, as well as the positive effects of SDEP on diabetes knowledge, is in accordance with results from other studies [13-17].

The negative correlation observed between the change in HbA1c 1 year after SDEP and the change in diabetes knowledge test results before and after SDEP emphasizes the importance of SDEP and the diabetes knowledge acquired, since better diabetes knowledge tends to be correlated with better glycemic control as measured by lower HbA1c. Negative correlations between the change in HbA1c 1 year after SDEP and the change between diabetes knowledge test results before and after SDEP, as well as between change in HbA1c 1 year after SDEP and the change in diabetes knowledge test results before and 1 year after SDEP observed in Group 1 could mainly be attributed to higher absolute improvement of HbA1c in Group 1, although no statistically significant between-group difference in HbA1c was achieved.

Limitations of our study include a small sample size and relatively short follow-up period of only 1 year. It would be of interest to further evaluate the sustainability of SDEP and its effect on diabetes knowledge and metabolic control for a period longer than 1 year in diabetes care facilities throughout the Republic of Macedonia, and to establish the optimal frequency and content of SDEP for each patient within the national recommendations.

This study was conducted before the National Diabetes Guidelines came into effect; nevertheless, it demonstrated

that it is critical to fully implement the Guidelines' recommendations on continuous SDEP.

Unfortunately, despite recommendations in the National Diabetes Guidelines, standardized SDEPs are currently not widely available to diabetes patients in the Republic of Macedonia. It is recommended that SDEP be provided at the time of diagnosis; however, our study demonstrated that sustainable effects of SDEP are observed even if provided later during the course of diabetes, in line with the National Diabetes Guidelines on SDEPs [7]. The integration of online diabetes tools should strongly be considered as an alternative to group education, especially for younger patients, to make SDEP more appealing to this age group.

Our study also demonstrated that structured diabetes re-education should be routinely offered to patients with both type 1 and type 2 diabetes, aiming for continuous SDEP for all diabetic patients. Recording of successful completion of SDEP and the accompanying diabetes knowledge test results should be made available in the diabetes electronic health-care records that have already been integrated into the National e-Health System in the Republic of Macedonia [2,18].

SDEPs should be appropriate for patients in terms of cultural, linguistic needs or level of literacy, and adequate resources need to be secured for diabetes educators, who should be qualified, competent and adequately trained. As part of the patient-centric healthcare system, patients should also be encouraged to take an active role in the creation and implementation of SDEPs.

Diabetes education remains the cornerstone of diabetes care; thus, diabetes care facilities in the country and elsewhere should routinely provide continuous SDEP as an integral part of diabetes care, through an experienced and highly qualified team consisting of diabetologists, nurses specialized in diabetes, nutritionists, and psychologists. Such continuous SDEP could result in a sustainable increase in diabetes knowledge attained by patients with diabetes, as well as their empowerment, and ultimately, to improved glycemic control, thus avoiding or delaying diabetes complications, and reducing the burden diabetes imposes on society.

Author Contributions

All listed authors have equally contributed in the conduct of the study, statistical analysis, and preparation of publication and gave their final approval.

References

1. International Diabetes Federation. IDF Diabetes Atlas. 7th ed. Brussels, Belgium: International Diabetes Federation; 2015.
2. Smokovski I, Milenkovic T, Trapp C, Mitov A. Diabetes care in republic of Macedonia: Challenges and opportunities. Ann Glob Health 2015;81:792-802. https://doi.org/10.1016/j.aogh.2015.12.017.
3. American Diabetes Association. Standards of care. Diabetes Care 2016;39 Suppl 1:s23-35.
4. Balamurugan A, Ohsfeldt R, Hughes T, Phillips M. Diabetes self-management education program for Medicaid recipients: A continuous quality improvement process. Diabetes Educ 2006;32:893-900. https://doi.org/10.1177/0145721706294787.
5. North SL, Palmer GA. Outcome analysis of hemoglobin A1c, weight, and blood pressure in a VA diabetes education program. J Nutr Educ Behav 2015;47:28-35. https://doi.org/10.1016/j.jneb.2014.07.006.
6. Boren SA, Fitzner KA, Panhalkar PS, Specker JE. Costs and benefits associated with diabetes education: A review of the literature. Diabetes Educ 2009;35:72-96. https://doi.org/10.1177/0145721708326774.
7. International Diabetes Federation. Guideline on healthcare related to the treatment and control of Type 2 diabetes. Off J Repub Maced 2015;40:15-34.
8. National Institute for Health and Care Excellence. Type 2 Diabetes in Adults: Management. Available from: http://www.nice.org.uk/guidance/ng28. [Last accessed on 2016 Sep 24].
9. International Diabetes Federation. Diabetes in Europe policy puzzle. The State We Are In. 4th ed. Brussels, Belgium: International Diabetes Federation; 2014.
10. Milenkovic T, Gavrilovic S, Percan V, Petrovski G. Influence of diabetic education on patient well-being and metabolic control. Diabetol Croat 2004;33:91-6. https://doi.org/10.2337/dc14-2441.
11. Inzucchi S, Bergenstal R, Buse J, Diamant M, Ferrannini E, Nauck M, et al. Management of hyperglycemia in Type 2 Diabetes, 2015: A patient-centered approach: Update to a position statement of the American diabetes association and the European association for the study of diabetes. Diabetes Care 2015;38:140-9. https://doi.org/10.2337/dc14-2441.
12. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, et al. 2016 European guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J 2016;37:2315-81. https://doi.org/10.1093/eurheartj/ehw106.
13. Ko SH, Song KH, Kim SR, Lee JM, Kim JS, Shin JH, et al. Long-term effects of a structured intensive diabetes education programme (SIDEP) in patients with Type 2 diabetes mellitus - A 4-year

follow-up study. Diabet Med 2007;24:55-62. https://doi.org/10.1111/j.1464-5491.2007.02013.x.
14. Deakin TA, Cade JE, Williams R, Greenwood DC. Structured patient education: The diabetes X-PERT Programme makes a difference. Diabet Med 2006;23:944-54. https://doi.org/10.1111/j.1464-5491.2006.01906.x.
15. Speight J, Holmes-Truscott E, Harvey DM, Hendrieckx C, Hagger VL, Harris SE, et al. Structured Type 1 diabetes education delivered in routine care in Australia reduces diabetes-related emergencies and severe diabetes-related distress: The OzDAFNE program. Diabetes Res Clin Pract 2016;112:65-72. https://doi.org/10.1016/j.diabres.2015.11.002.
16. Pieber TR, Brunner GA, Schnedl WJ, Schattenberg S, Kaufmann P, Krejs GJ. Evaluation of a structured outpatient group education program for intensive insulin therapy. Diabetes Care 1995;18:625-30. https://doi.org/10.2337/diacare.18.5.625.
17. Khunti K, Gray LJ, Skinner T, Carey ME, Realf K, Dallosso H. et al. Effectiveness of diabetes education and self-management program (DESMOND) for people with newly diagnosed Type 2 diabetes mellitus: Three year follow-up of a cluster randomized controlled trial in primary care. BMJ 2012;344:e2333. https://doi.org/10.1136/bmj.e2333.
18. Velinov G, Jakimovski B, Lesovski D, Ivanova Panova D, Frtunik D, Kon-Popovska M. EHR system MojTermin: Implementation and initial data analysis. Stud Health Technol Inform 2015;210:872-6.