Changes Induced by Recreational and Educational Activities in Children With Diabetes

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Children with diabetes face numerous daily challenges that are completely different from those of other children their age. Dealing with those issues successfully requires that children with diabetes and their families acquire knowledge and develop skills and attitudes to overcome those challenges through a process of continuous education. Such a process simultaneously promotes the development of healthy behavioral changes and the consequent active and effective participation in the control and treatment of the disease.[1–7]

Therapeutic education should start at diabetes diagnosis and should include the child and family members. Contents, pedagogical methodology, language, and didactic material should adapt to the age and maturity of the child.[8–10] Psychosocial, cultural, and economic factors should also be considered to achieve the therapeutic and educational goals.[11–15]

In this educational context, residential camps for children and youth with diabetes worldwide[16–25] appear to be a suitable education strategy because *1*) the teaching-learning process is enhanced by a recreational, motivating, and safe environment; *2*) the presence of other children and staff members with diabetes give them the opportunity to be in the majority and not an exception; *3*) formal education sessions are accompanied by observation, imitation, practice, and exchange of opinions and experience; *4*) group creative and innovative didactic methods are useful to convey and consolidate knowledge, self-management, and problem-solving skills concerned with diabetes control instead of the traditional passive attitude of the unidirectional educational model;[26–28] and *5*) children and their families have the opportunity to integrate and exchange experiences about living with a chronic disease.

Evidence in the literature has demonstrated the positive effect of camps for children and youth with diabetes on their specific knowledge, self-management skills, and self-esteem.[16,18,20,21,23–25] However, only a few studies have reported their clinical and metabolic benefits in the post-camp period.[16,18,21,25] Therefore, the aim of this study was to evaluate in campers the effect of educational activities on diabetes knowledge, self-management skills, and glycemic control during and after the camp and in family members how the implementation of post-camp activities affects their knowledge about diabetes control and treatment.

METHODS

The educational program consisted of a 7-day camp for children with diabetes and a family weekend for these children and their relatives, organized by Centro de Endocrinología Experimental y Aplicada (CENEXA) in Argentina.

Study Sample and Camp Program

The sample included 37 children of both sexes with type 1 diabetes (age range 7–13 years); children attending two or more camps were ineligible. The 4-month follow-up included 19 children who had attended the camp and 19 adult family members who participated in the family weekend. Written informed consent from parents and/or guardians was required to attend both the camp and the family weekend. Public and private institutions provided support to campers and families who needed financial assistance.

The organization, development, and supervision of both activities was led by an experienced interdisciplinary team that included two pediatric endocrinologists, two nutritionists, a diabetes educator, two physical education teachers, eight counselors with diabetes (one counselor for every five children), and campsite staff in charge of cooking and cleaning.

The daily camp and family weekend programs included sports, athletic, and recreation activities, arts and crafts, and educational activities related to diabetes control and treatment. The program included four main meals, two snacks, and at least four daily times for self-monitoring of blood glucose (SMBG) before each meal, performed in small groups (four to six children) and supervised by two counselors. Glycosuria and ketonuria were also measured when blood glucose values were ≥ 250 mg/dl. Insulin dose preparation and self-injection were supervised by members of the interdisciplinary team. During the camp and family weekend, the campers' home insulin regimens were individually adjusted based on blood glucose level, physical activity load, and carbohydrate intake. During the family weekend, children together with the camp medical staff and family members decided on these insulin dose adjustments.

Educational Model

The goal was to consolidate and reinforce the diabetes learning process that the camping experience facilitates and to motivate both children and adults to enhance implementation of knowledge and use of practical skills in problem-solving and daily self-care.

At camp, daily educational sessions (45–60 minutes each) were performed at morning hours and main meals. During the family weekend, adults participated in educational sessions also performed during the morning, main meals, and in the afternoon, while children participated in two sessions related to nutrition and problem-solving skills. For the rest of the day, children and adults shared recreational activities.

In special cases (use of visual rather than digital test strips for SMBG, limited access to a balanced diet because of socioeconomic reasons, association of diabetes with other pathologies such as celiac disease), the daily educational sessions were complemented with two individual or small-group educational sessions during both the camp and the family weekend.

Educational and objective content was divided into five major areas, including *1*) importance of metabolic control, to identify situations that modify glycemia, correctly perform self-monitoring of blood/urine glucose techniques, record and interpret results, and recognize and handle hypo- and hyperglycemia and ketoacidosis episodes; *2*) insulin therapy, to correctly perform insulin dose preparation and self-injection techniques and insulin dose adjustments according to SMBG values, immediately estimate carbohydrate intake and physical activity practice, recognize the importance of injection-site rotation, and identify different insulin types and their action times; *3*) carbohydrate selection and counting, to identify foods that modify glycemia and quantify carbohydrates in different food supplies; *4*) identification of nutrients, to interpret food labels to optimize food choices and identify different type of carbohydrates; and *5*) prevention of chronic complications, to recognize the role of appropriate glycemic control in preventing the development and progression of complications and the importance of periodical clinical and laboratory controls.

Educational techniques included problem-based learning and role-playing implemented through didactic games divided into five rotating stations (small groups of seven to eight children [camp] or three to four adults [family weekend] coordinated by staff members). Each game dealt with one category of educational content and was designed and adapted (language, style) to mixed age-groups; their implementation was always supervised by the pediatricians, the nutritionist, and the diabetes educator. Results were evaluated and discussed by health care staff members, children, and parents.

Source and Type of Information

The data analyzed were collected from the following sources:

- **Camp and family weekend registration forms**, recording personal data, level of education, health coverage, diabetes history, height and weight, type of treatment and control, habits (extracurricular physical activity and meal plan), and skills (clinical and metabolic self-monitoring, insulin dose preparation, self-injection, and site rotation). We also recorded characteristics of the insulin treatment, values and frequencies of SMBG (the week before and after the camp and the week before the family weekend), and A1C (10 days before the camp/family weekend).
- **Individual follow-up forms**, with daily record of insulin schedules, blood/urine glucose and ketonuria values, intensity and type of physical activity performed, and amount and daily distribution of carbohydrates.
- **Self-management assessment forms**, to evaluate the correct performance of the different steps of blood and urine glucose self-monitoring techniques, insulin dose preparation, and self-injection technique; site rotation; and food selection (identification of amount and type of carbohydrates in food). Copies of these two forms were mailed to parents and the family doctor of each participating child at the end of the camp/family weekend.
- **Knowledge questionnaire (for both children and adults)**, consisting of 20 multiple-choice questions regarding diabetes definition, normal blood glucose values, meal plan, physical activity, insulin therapy, symptoms of hypo- and hyperglycemia, and SMBG.

To evaluate the changes induced by the camp and the family weekend, we compared the results of the different parameters recorded during the study period as follows:

Knowledge level (number of correct answers from a total of 20 points) was assessed on the first and the last day of the camp and 4 months after camp. Knowledge was assessed 1 week before the family weekend for children and parents who did not participate in this activity; for those who participated, data were recorded on arrival (children and parents) and at the end of the family weekend (parents).

Self-management skills (number) to perform correctly the different technique steps, to identify the amount and type of carbohydrates in food (% children), and injection site rotation (number) were assessed by camp medical staff and diabetes educator on the first and the last day of the camp and 4 months after camp (during the same days as knowledge evaluation).

In the case of injection site rotation, we considered 1, 2, and > 2 injection sites, regardless of the site used. Each site represented two areas of the body for insulin injection. Due to their specificity and impact on metabolic control, injection site rotation and food selection were assessed independently of the other four self-management skills. All the data from the different time periods and different sources were recorded by our staff members.

Educational techniques and the multiple-choice questionnaire had been previously tested and validated by our team in 16 independent groups of children with diabetes attending camps organized by CENEXA, of the same age

Table 1. Characteristics of Campers

	Total	With coverage	With partial coverage
n	37	22	15
Age (years)	10.8 ± 1.6	10.8 ± 1.6	10.8 ± 1.7
Sex (% female)	51	50	53
Primary school attendance (grade)	5.3 ± 1.6	5.4 ± 1.6	5.3 ± 1.7
Diabetes history (years)	3.4 ± 2.8	3.1 ± 2.8	3.9 ± 2.9
Extracurricular physical activity (%)	70.3	77.3	60
Knowledge (number of correct answers)			
Children	16 ± 3	16 ± 3	16 ± 3
Family members	18 ± 2.1	19 ± 2	17 ± 2
BMI SD score	+0.63 ± 1.18	+0.50 ± 1.12	+0.82 ± 1.29
Height SD score	+0.27 ± 1.05	+0.35 ± 1.01	+0.15 ± 1.14
A1C (%)	10.3 ± 2.3	10.1 ± 2.4	10.7 ± 2.3
Treatment (units/day)			
Total insulin dose	44 ± 27	47 ± 31	40 ± 19
Prolonged-acting insulin dose	39 ± 23	40 ± 27	37 ± 18
Rapid-acting insulin dose	6 ± 8	8 ± 10	3 ± 2
Number of injections/day*	2 ± 1	3 ± 1	2 ± 1
SMBG tests/day**	3 ± 1	3 ± 1	2 ± 1

Results are means ± SD, percentages, and frequencies. BMI and height SD score reference value: ± 1.8.
** P < 0.02 children with versus without partial coverage. **P < 0.001 children with versus without partial coverage.*

and social level as those currently studied.

Metabolic Control Indicators
A1C was assessed with the DCA 2000 method (Bayer, Buenos Aires, Argentina); reference value, up to 6.0%) before camp and 4 and 7 months after camp. SMBG (mg/dl; frequency and daily mean values) was determined with glucose meters and test strips (Onetouch-Ultra, Johnson & Johnson Medical, Pilar, Buenos Aires, Argentina) at least four times each camp day and in staggered timetables 7 days before and after the camp. The number of mild and moderate hypoglycemic episodes during the camp and the weeks before and after the camp was also recorded.

Treatment Indicators
Type (rapid-, intermediate- and long-acting insulins or analogs), amount of insulin (unit/dose/day) and number of injections/day the weeks before, during, and after camp were assessed.

Statistical Analysis
Data were incorporated into an ad hoc database and analyzed with Statgrafic software. Analysis of variance (95% CI), Student's *t* test, Tukey's test, and χ^2 test were used. The level of significance was defined as $P < 0.05$.

RESULTS
Of the total children participating, 59.5% had health insurance coverage, and the remaining 40.5% depended on the public-sector program (Diabetes Program, Ministry of Health of the Province of Buenos Aires—PRODIABA) that provides partial health coverage (Table 1).

Free insulin provision was optimal in both groups; conversely, children with coverage received an average 110 ± 27 strips/month for SMBG with glucose meters, whereas children with partial coverage received ~ 33 strips/month of visual (color) comparison method. In the latter case, only four families reported to have additionally bought 25 strips of similar characteristics, thus resulting in 44 ± 23 strips/month. Therefore, the number of strips and of daily SMBG measurements was significantly lower in children with partial coverage (1–2 times; 73%) compared to those with coverage (4 times; 64%) ($P < 0.001$) (Table 1).

Eleven children (30%) were on intensified insulin therapy (three or more daily injections); 9 of them (82%) belonged to the group of children with coverage. The remaining 26 children (70%) were on conventional insulin therapy (one to two injections/day), 9 of which (50%) had partial coverage.

Nineteen children (51%), comprising 11 children with coverage

Table 2. Characteristics of Treatment Before, During, and After Camp

	Before (n = 37)	During (n = 37)	After (n = 36)	P value
Total insulin dose (units/day)	44 ± 27	41 ± 21	41 ± 24	NS
Intermediate-/long-acting insulin dose (units/day)	39 ± 23	36 ± 22	35 ± 21	NS
Rapid-acting insulin dose (units/day)	6 ± 8	5 ± 4	7 ± 7	NS
Injections/day	2 ± 1	2 ± 1	2 ± 1	NS
SMBG tests/day	3 ± 1	4 ± 1	3 ± 1	< 0.001
Mean number of hypoglycemia events (day/child)	0.1 ± 0.2	0.7 ± 0.6	0.1 ± 0.2	< 0.001
Glycemia (mg/dl)	178 ± 59.5	137.4 ± 33.7	177.5 ± 44.1	< 0.001

Results are means ± SD. NS, not significant (P > 0.05).

(58%) and 8 with partial coverage (42%), and 19 adult family members (16 mothers, 3 fathers) attended the family weekend. Mean age, diabetes duration, and percentage of girls were similar to those recorded among camp attendees.

Knowledge and Self-Management Skills

The number of correct answers increased significantly on the last day of the camp (18 ± 2; P < 0.01) and 4 months after camp (18 ± 2; P < 0.04) compared to when assessed on arrival (16 ± 3). The number of correct answers on the first day of the camp was significantly higher in older (10–13 years) than in younger (7–9 years) children (17 ± 2 vs. 13 ± 3; P < 0.001). This difference in favor of older children was also observed in the values recorded on the last day of the camp (17 ± 3 vs. 19 ± 2 and 18 ± 2, respectively; P < 0.02). However, no differences were observed 4 months after camp.

The number of skills was also significantly higher at the end (4 ± 1; P < 0.01) and at 4 months after camp (4 ± 1; P < 0.009) compared to the beginning of the camp (3 ± 1).

Concerning food selection and insulin site rotation, 76% of children used > 2 injection sites before the camp; this percentage increased to 100% (P < 0.005) at the end of the camp, and decreased to 89% by 4 months after camp. On the first day of the camp, only 38% of children could identify the amount and type of carbohydrates in food; this percentage increased to 73% (P < 0.01) on the last day and was 68% (P < 0.03) at the post-camp evaluation.

There were no significant differences between knowledge and skills when comparing first-time campers and children attending the camp for the second time. At post-camp evaluation (4 months), the number of skills and correct answers was not significantly associated with age of the children, diabetes duration, or health coverage, nor were their differences between children who participated in the family weekend and those who did not.

The number of correct answers recorded 4 months after camp were higher, but not significantly, in the 22 family members of children with health coverage than in the 15 family members of children with partial coverage. Such a difference between groups was not recorded in the 19 adults who participated in the family weekend. Similarly, no significant differences were recorded 4 months after camp between parents who participated in the family weekend and those who did not.

Metabolic Indicators and Treatment Variables

The number of daily SMBG tests was 1.16 times higher during the camp compared to that recorded the week before the camp (P < 0.001) and 0.58 times higher than that assessed the week after the camp (P < 0.005). The total mean daily insulin dose (rapid-, intermediate-, and long-acting) and the number of daily insulin injections were similar the week before, during, and the week after camp (Table 2).

The mean blood glucose value during the camp was significantly lower than those recorded the weeks before and after camp (–41 and –40 mg/dl, respectively; P < 0.001). The mean number of daily mild-to-moderate hypoglycemic episodes during the camp was significantly higher than levels recorded the weeks before and after the camp (0.7 ± 0.6 vs. 0.1 ± 0.2; P < 0.001) (Table 2). No severe hypoglycemic or ketoacidosis episodes were recorded during the camp or at the family weekend.

On arrival at camp, BMI and height SD scores were similar in both groups of children and within the normal range according to reference values for the Argentine population.[29]

Before the camp, all the children had comparable A1C levels (above recommended goals), suggesting that both groups had a similarly poor degree of glycemic control regardless of whether they had partial or total health coverage (Table 3).

Four months after the camp, the mean A1C values of the 37 campers decreased significantly with respect to the previous period (P < 0.001). Significantly lower values were recorded at this time only in children with total health coverage (Table 3).

Seven months after the camp, the whole group mean A1C went up to almost pre-camp values (9.5 ± 2.5 vs. 10.3 ± 2.3%); however, children with total health coverage who attended the family weekend maintained the low value attained at 4 months (7.2 ± 1 vs. 7.4 ± 0.9%). The mean A1C value of children with total health coverage who did not attend the fam-

Table 3. A1C Values (%)

	Children With Family Weekend (*n* = 19)		Children Without Family Weekend (*n* = 18)		All Children (*n* = 37)
	With coverage (a) (*n* = 11)	With partial coverage (b) (*n* = 8)	With coverage (c) (*n* = 11)	With partial coverage (d) (*n* = 7)	
Before camp	9.1 ± 1.9	10.4 ± 2.5	11.0 ± 2.5	11.0 ± 2.3	10.3 ± 2.3
Camp					
4 months after camp	7.4 ± 0.9	9.8 ± 1.7	8.3 ± 1.7	10.4 ± 1.3	8.8 ± 1.8
Family Weekend					
7 months after camp	7.2 ± 1.0	10.9 ± 2.1	9.1 ± 2.1	12.1 ± 2.1	9.5 ± 2.5
P value	0.004	NS	0.001	NS	< 0.001

Results are means ± SD. NS, not significant.
P *values:*
- *Before camp versus 4 months after camp: (a) 0.002, (b) NS, (c) < 0.001, (d) NS.*
- *Before camp versus 7 months after camp: (a) 0.001, (b) NS, (c) 0.006, (d) NS.*
- *4 months after camp: a versus b, < 0.001; a versus c, NS; b versus d, NS; c versus d, 0.002.*
- *7 months after camp: a versus b, < 0.001; a versus c, 0.002; b versus d, NS; c versus d, < 0.001.*

ily weekend, although still below the initial value, registered a not significant increment of A1C in relation to values at 4 months (8.3 ± 1.7 vs. 9.1 ± 2.1%) (Table 3).

An A1C of 8.0% was selected as a realistic goal for this age-group, considering that above this value there is a markedly increased risk of developing complications.[30–33] Before the camp, only 16%[6] of the children had an A1C ≤ 8%. This percentage increased significantly to 40% (15 children) at 4 months after the camp and to 30% (11 children) 7 months after the camp. Of these, 93 and 100% had health coverage, respectively.

When we compared the A1C levels recorded after the camp to the frequency of SMBG and insulin regimen performed, mean A1C values > 9% were recorded in children with < 2 insulin injections/day and testing 1–2 times/day (66% with partial coverage); 82% of children with coverage and 33% of children with partial coverage ($P < 0.001$) performed ≥ 3 SMBG tests/day and were on > 2 injections/day of insulin. Mean A1C values in the latter group were significantly lower than in the former at both 4 ($P < 0.005$) and 7 ($P < 0.001$) months after the camp. The lowest A1C values were observed 4 and 7 months after camp in children performing ≥ 4 SMBG tests/day (59% with coverage) (Table 4).

DISCUSSION

Our study reports significant improvements in diabetes knowledge and self-management skills that were sustained after the camp; this fact suggests that the camp recreational and educational model is effective to promote behavioral changes that can positively affect clinical indicators and lead to improved metabolic control. We have also shown that the improvement of the initial A1C values maintained after the camp was related to the degree of health insurance coverage and participation in the family weekend. Furthermore, greater A1C decreases corresponded to children with a higher daily frequency of SMBG testing and those taking > 2 insulin injections/day (80% with coverage) and to those with coverage attending the family weekend with their parents. The latter maintained A1C values < 8% up to the time when evaluations were performed, whereas those values increased in children with partial coverage.

Our data suggest that *1)* the economic factor per se does not guarantee better metabolic control given that before-camp A1C values were similarly high in children with full and partial coverage; *2)* the impact of the therapeutic education program, assessed through incremented knowledge and skills, resulted in either attainment of A1C levels recommended by reference values for children with type 1 diabetes or a significant decrease of A1C levels; and *3)* the long-term beneficial effects of the camp educational model depend in part on both the health coverage (total vs. partial) and the continuity of the educational process (attendance vs. nonattendance at family weekend).

The degree of health coverage and the continuity of the educational process would affect the accessibility to the appropriate number of strips for SMBG and the adoption of a successful therapeutic regimen. To test this hypothesis, it should be necessary to verify whether the free provision of a greater number of strips and glucose meters, together with a continuous educational program,

Table 4. Daily Frequency of SMBG, Number of Daily Insulin Injections, and Metabolic Control After Camp

Number of SMBG tests/day	1	2	3	> 4	*P* value
With partial coverage (*n* = 15)	3	7	4	1	—
With coverage (*n* = 22)	—	4	5	13	—
Number of insulin injections/day	1 ± 1	2 ± 0.4	2 ± 1	3 ± 1	0.006
A1C (%) 4 months after camp	10.9 ± 1.1	9.3 ± 2.1	8.3 ± 1.4	8.2 ± 1.5	0.006
A1C (%) 7 months after camp	11.7 ± 2.1	10.8 ± 2.7	9.5 ± 2.7	8.0 ± 1.6	< 0.001

Results are expressed as mean ± SD and frequency.

improves the frequency of SMBG and the children's glycemic control. In support of this assumption, Haller et al.[17] reported that, in a group of 229 children and youth, lower A1C values before camp correlated significantly with the frequency of SMBG. This association between frequency of SMBG and A1C levels has been extensively confirmed.[34,35]

However, the number of SMBG tests or of insulin injections per se is not enough to improve metabolic control unless children and family members learn to translate results into appropriate insulin dose adjustements, carbohydrate intake, and physical activity load.[7] On the other hand, short- and medium-term improvement in metabolic control after diabetes camps has been shown in some studies.[16,18,21] One study showed an improvement in A1C levels only in children who also followed up at monthly meetings with their parents for 3 months after the camp.[21] Similarly, we have observed sustained A1C < 8% until the end of the study in children with health coverage and whose family members participated in the family weekend.

We have to accept some limitations to our conclusions, namely, *1*) the small sample size could limit its applicability, and *2*) other factors not included in our study, such as structural and functional characteristics of the family, socioeconomic and cultural environment, and eating habits, could also affect the achievement of the therapeutic goals.[12,13,15] Thus, new studies using a similar methodology, a larger number of children, and a long-term follow-up period are required to confirm our results.

In summary, our study shows that an educational program implemented during a camp for children with diabetes followed by a family weekend optimizes the use of diabetes management and therapeutic tools and improves glycemic control of attendees. The sustainability of these beneficial effects, however, partly depends on continuous education and appropriate accessibility to treatment and management devices.

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