Effect of instructions on selected self-care practices among type-1 diabetic children

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Background
Type 1 diabetes (T1D), which tends to develop in childhood, needs certain self-care practices to achieve optimal glycemic control.
Aim
The study aimed to evaluate the effect of instructions on selected self-care practices among T1D children.
Patients and methods
A quasi-experimental one-group design with pre–post assessment was used in this study, which was carried out in the Pediatric Diabetes and Endocrine Unit at El Monira University Pediatric Hospital, on a purposive sample of 100 diabetic children. The data were collected using a structured interview questionnaire and four observational checklists for self-care practices of insulin injection by syringe and by pen, blood glucose test, and foot care.
Results
Children's age ranged between 6 and 14 years, with female predominance. Their readiness for self-care was high, especially for insulin injection, and none of the children had adequate performance of any of the procedures before the intervention. At the postintervention phase, there were statistically significant improvements in all procedures, reaching 76% for insulin injection by syringe, 82 for injection by pen, 77% for blood glucose testing, and 58% for feet care ($P<0.001$). In total, 80% adequate performance after the intervention was detected ($P<0.001$). In multivariate analysis, the applied intervention was the main independent statistically significant positive predictor of the child's performance score, with child age and performance of exercise having a less but statistically significant influence. All children (100%) recommended the program for other diabetic children.
Conclusion
The study concluded that children's practice scores of self-care activities improved significantly after the intervention, and readiness of children plays an active role in improving these scores. The participation of parents, particularly with very young children, and more emphasis on foot care are needed. The study recommends that the intervention should be implemented in settings providing care to children with T1D. Feet care for children with T1D was done by parents until the children realize the importance of caring and examining their feet periodically. The impact of the program on glycemic control needs further research.

Keywords:
blood glucose test, feet care, insulin injection by syringe, pen, school-age children, selected instructions, self-care practices, type 1 diabetes

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Introduction

Type 1 diabetes (T1D) is an autoimmune disease with a strong genetic component. Although it may occur at any age, it tends to develop in childhood; hence, it has long been called juvenile diabetes (Noble and Erlich, 2012). According to the International Diabetes Federation (2015), more than half a million children are estimated to have T1D, and around 86 000 developed the disease worldwide in 2015. The rate is increasing by around 3% every year. In Eastern Mediterranean and Middle Eastern countries, the largest contribution to the total number of childhood T1D comes from Egypt, accounting for about a quarter of the region's total. The incidence varies between 1/100 000 per year (Pakistan) and 8/100 000 per year (Egypt) in children under the age of 15 years.

The T1D patients must follow certain self-care practices to achieve optimal glycemic control and prevent complications. Self-care in diabetes has

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been defined as a set of behaviors practiced by people with or at risk of diabetes for successful management of the disease on their own (Gopichandran *et al.*, 2012). These behaviors are well established; they involve regular physical activity, appropriate dietary regimen, daily foot care, and compliance with treatment (American Diabetes Association, 2010; Marques *et al.*, 2013). The first steps taught to the patient in diabetes self-management are the tasks of blood glucose monitoring and insulin injection (Hanna and Decker, 2010). Recent technological advances now make these tasks easier and less painful, such as the insulin pen (Rosa, 2013), insulin pumps, and jet injectors, although syringes remain the least expensive option as most insurance companies cover them (Morris, 2017). Nonetheless, many diabetic patients fail to practice self-care (Shrivastava *et al.*, 2013).

Children and adolescents with T1D need to learn to self-manage their disease early and gradually after diagnosis, and this should be integrated in their personal routines (Boman *et al.*, 2015). There might be some differences in self-care between pediatric and adult patients related to cognitive ability of children and emotional maturity in adolescents (Peters *et al.*, 2011). However, research demonstrated better glycemic control among children who practice self-monitoring of blood glucose (Svensson *et al.*, 2016; Weissberg-Benchell and Rychlik, 2017). Moreover, they showed good tolerance of the testing process (Hockenberry and Wilson, 2013). This would also help a smooth transition from pediatric to adult care for diabetes (Campbell *et al.*, 2016).

The role of the nurse in educating T1D children in self-care is essential (Kenny and Corkin, 2013). Patient education of self-care and the enhancement of the role of nurses in diabetes care leads to improvements in patient outcomes and the process of care. Nurses' responsibilities are numerous, educating the children to the best of their ability to understand their condition in such a way that they know enough about their management and self-care in order to change their lifestyle (Hockenberry and Wilson, 2013). However, there is a dearth of literature regarding self-care practices among children with T1D in Egypt, and most self-care practices such as insulin therapy, blood glucose monitoring, and foot care are performed by their mothers. Hence, this study is an attempt to fill a gap regarding self-care in the management of children with T1D in Egypt.

Aim

The study aimed to evaluate the effectiveness of instructions on selected self-care practices among T1D children.

The research hypothesis

Diabetic children who received the instructions will have adequate practice when compared with preapplication scores.

Operational definition of self-care practices

Self-care practices in this research include self-injection with the insulin pen and insulin syringe, blood glucose check by glucometer, and foot care.

Patients and methods

Research design and setting

A quasi-experimental one-group design with pre–post assessment was used in this study, which was carried out in the Pediatric Diabetes and Endocrine Unit at El-Monira Pediatric Hospital, affiliated to Cairo University hospitals. It is the largest hospital for children in Egypt, and it provides its services free of charge.

Patients

A non probability purposive sample of 100 diabetic children was recruited in the study sample according to the following inclusion criteria: children aged 6–18 years old, recently diagnosed with T1D, and treated by insulin syringe and pen. The exclusion criteria were having another endocrinal disorder or having attended a previous similar training.

Tools for data collection

These tools consisted of a structured interview questionnaire and an observation checklist. The interview questionnaire was developed by the researchers based on relevant literature. It included the child's personal data such as age, sex, educational level, residence, and parents' education. It also asked about the child's foot-care habits, practice of exercise, the most beneficiary part of the intervention, children recommendations to re-teach the content of the instructions to other diabetic children, and readiness for self-care.

For an observational checklists for self-care practices were adopted from Wilson and Hockenberry (2014). These checklists were for insulin injection by syringe (24 items), insulin injection by pen (13 items), blood glucose (glucometer) test (17 items), and foot care (17 items). Each step was to be checked as 'done' or

'not done.' These were scored 1 and 0, respectively. The scores of each checklist and for total performance were summed up and converted into percent scores. Adequate self-care practices were 60% or more and inadequate self-care practices were less than 60% of the total score of each observational checklist.

Tool validity

The tools were thoroughly reviewed by a panel of three experts in pediatric nursing and pediatric endocrinology for face and content validation. As per their opinions, no modifications were required.

Pilot study

A pilot study was carried out on 10 children representing 10% of the total sample to test study tools in terms of their clarity, applicability, and time required to fill. As no modifications were done, these children were included in the sample.

Study maneuver

Upon obtaining official permissions, the researchers met with the children and their parents for a clear and simple explanation of the aim and procedures of the study. Those who gave their consent/assent were interviewed individually in the education room of the inpatient diabetic and endocrine unit using the structured questionnaire sheet. Then, the instructions were delivered on three consecutive days for a group of four children through the following sessions:

(1) In the first session, each child was asked to carry out the selected self-care practices (insulin injection by syringe and pen, blood glucose check by glucometer, and then their knowledge and practice about feet care) as a pretest and was observed using the corresponding checklists.
(2) After completion of the pretest, the children were informed about the importance of the four selected self-care practices under study.
(3) Instructions about insulin injection by syringe and pen were explained and demonstrated by the researchers, and redemonstration was carried out by each child individually on a small doll.
(4) The second session, the researchers asked each child to redemonstrate insulin injection by syringe and pen, and the other three children were asked to act as peer evaluators. The researchers observed each child, and reassured the children if any mistake was committed, and the mistakes were discussed. Instructions about blood glucose check by glucometer were explained and demonstrated by performing the procedure on each child as a redemonstration.
(5) The third session, blood glucose check by glucometer was redemonstrated on each child to measure his/her blood glucose level, and then some items of feet care were done by the children on themselves using a mirror to see the bottom of his/her feet, check the color of his/her legs and feet and observe any abnormality, how to trim his/her nails straight across; the children and the researchers also inspect their shoes to check for appropriateness. The remaining items of feet care were discussed and then evaluated to give the children feedback about their performance.
(6) Then the final (postintervention) evaluation was done using the observational checklists. The researches tried to evaluate the child in his/her group of training because they became friends and had no problems making mistakes among themselves. After evaluation, the mistakes of all children were discussed again with them. The fieldwork was carried out from the beginning of May to the end of August 2016.

Ethical considerations

Ethical approval of the study protocol was obtained from the research Ethics Committee of the Faculty of Nursing, Cairo University. Informed consents were signed by parents after being informed about their rights to refuse and/or withdraw at any time without providing a reason and without any effect on the child's routine care. The children aged between 7 years and 12 years gave their oral assent to participate, whereas those aged between 13 years and 18 years provided their written consents. The participants were assured that their information would remain confidential.

Statistical analysis

Data entry and statistical analysis were done using SPSS 20.0 statistical software package (SPSS, Chicago, IL). Qualitative categorical variables were compared using chi-square or Fisher's exact test as appropriate. Spearman's rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of the performance score, multiple linear regression analysis was used and analysis of variance for the full regression models was done. Statistical significance was considered at *P*-value less than 0.05.

Results

Table 1 illustrates that the diabetic children's age ranged between 6 and 14 years, with slightly more girls (60%), and a majority of them were living in urban

areas (58%). The majority were at the primary phase of education (86%), and had educated mothers (67%) and fathers (69%). Their performance of foot care and exercise was low, 32 and 21%, respectively, whereas around two-thirds (68%) could properly choose their footwear. Their readiness for self-care was relatively high, especially regarding insulin injection (74%).

As shown in Table 2, none of the children had adequate performance of insulin injection by syringe before the intervention. At the postintervention phase, there were statistically significant improvements in all steps of this procedure, reaching 96% for the step of assembling the equipment properly. On the other hand, the lowest improvement was in the step of recording the date after opening the cartridge for the first use, which was performed by only 28% of them, and 30% disposed of used supplies appropriately. In total, 76% of the children had adequate performance after the intervention, compared with 0% before the intervention ($P<0.001$).

Table 1 Sociodemographic characteristics of children in the study sample and their practices and readiness for self-care before intervention ($n=100$)

	Frequency	%
Age		
<12	75	75.0
12+	25	25.0
Range		6.0–14.0
Mean±SD		9.6±2.2
Median		10.0
Sex		
Male	40	40.0
Female	60	60.0
Residence		
Urban	58	58.0
Rural	42	42.0
Educational level		
Primary	86	86.0
Preparatory	14	14.0
Mothers' formal education		
None	33	33.0
Educated	67	67.0
Fathers' formal education		
None	31	31
Educated	69	69.0
Performance of		
Foot care	32	32.0
Proper choice of footwear	68	68.0
Exercise	21	21.0
Proper action before exercise	12	57.1
Readiness for self-care in		
Blood sugar test	71	71.0
Insulin injection	74	74.0
Foot care	66	66.0

Table 3 demonstrates a statistically significant increase in the percentage of children having total adequate performance of insulin injection by pen from 0% before intervention to 82% after the intervention. The improvement was noticed in all steps, with the highest being for washing their hands with soap and water (93%). At the other extreme, only 19% of them disposed of used needle into a sharps container, but this was significantly higher compared with the preintervention level ($P<0.001$).

Concerning children's performance of blood glucose testing, Table 4 shows statistically significant improvements in all steps after the intervention ($P<0.001$). Around two-thirds or more of the children performed all steps. Meanwhile, only 21% of them disposed of used supplies appropriately. Overall, the percentage of children with total adequate performance of blood glucose testing increased from 1% before the intervention to 77% after the intervention ($P<0.001$).

As illustrated in Table 5, some steps of foot care were correctly performed by around one-fourth of the children before the intervention, such as cleaning a cut or scratch with a mild soap and water (22%) and properly washing their feet daily (25%). The postintervention phase demonstrated statistically significant improvements in all steps, reaching 95% for cleaning a cut or scratch with a mild soap and water. Conversely, only 29% of them used a mirror to see the bottom of their feet. In total, 58% of the children had adequate performance of feet care after the intervention ($P<0.001$). The table also shows that the total adequate performance increased from 0% before the intervention to 80% after the intervention ($P<0.001$).

Table 6 points to statistically significant relations between children' readiness for self-care related to blood sugar test ($P=0.004$), insulin injection ($P=0.001$), and foot care ($P=0.006$) and their practice of exercise ($P=0.006$) and their performance. It is evident that the percentages of children with adequate performance were higher among those having readiness and those practicing exercise.

Table 7 demonstrates statistically significant positive correlations among the scores of the four self-care performances. It also displays statistically significant positive correlations between these scores, as well as the total performance score, and children's age and

Table 2 Performance of insulin injection by syringe among children in the study sample before and after the intervention

	Time [*N* (%)]		χ^2-Test	*P*-value
	Before (*n*=100)	After (*n*=100)		
Wash hands thoroughly with soap and water	13 (13.0)	93 (93.0)	128.46	<0.001*
Check insulin's expiration date	0 (0.0)	65 (65.0)	96.30	<0.001*
Record the date after opening the cartridge for first use	0 (0.0)	28 (28.0)	32.26	<0.001*
Assemble equipment	6 (6.1)	96 (96.0)	160.07	<0.001*
For cloudy insulin only, gently mix/roll the insulin 10 times before use	0 (0.0)	66 (66.0)	98.51	<0.001*
Aspirate with syringe amount of air equal to insulin ordered	0 (0.0)	67 (67.0)	100.75	<0.001*
Inject the amount of aspired air in the insulin vial	0 (0.0)	69 (69.0)	105.34	<0.001*
Slowly pull the plunger, drawing correct amount of insulin, plus a little extra, into the syringe	0 (0.0)	74 (74.0)	117.46	<0.001*
Make sure that air bubbles are out	0 (0.0)	63 (63.0)	91.97	<0.001*
Check the correct amount for own dose	0 (0.0)	69 (69.0)	105.34	<0.001*
Inject air in the cloudy insulin vial equal to the unit of clear insulin unit (if mix cloudy with clear insulin)	0 (0.0)	70 (70.0)	107.69	<0.001*
Inject air in clear insulin vial equal to its unit	0 (0.0)	74 (74.0)	117.46	<0.001*
Aspirate clear insulin dose and then cloudy insulin dose in the syringe	0 (0.0)	84 (84.0)	144.83	<0.001*
Check the cleanness of hands, equipment, and injection site	0 (0.0)	71 (71.0)	110.08	<0.001*
Inject insulin intradermally at these sites (outer arms, abdomen, front and lateral thigh, back)	0 (0.0)	88 (88.0)	157.14	<0.001*
Rotate the site for each injection	0 (0.0)	75 (75.0)	120.00	<0.001*
Hold the skin between two fingers	0 (0.0)	80 (80.0)	133.33	<0.001*
Inject insulin at a 90^0 angle in the desired site	0 (0.0)	80 (80.0)	133.33	<0.001*
Inject all needle intradermally	0 (0.0)	80 (80.0)	133.33	<0.001*
Inject all of the insulin	0 (0.0)	84 (84.0)	144.83	<0.001*
Count to 10 before needle removal	0 (0.0)	60 (60.0)	85.71	<0.001*
Continue holding the skin until the end of injection and needle removal	0 (0.0)	58 (58.0)	Fisher's	<0.001*
Dispose of used supplies appropriately	0 (0.0)	30 (30.0)	Fisher's	<0.001*
Wash hands with soap and water	1 (1.0)	72 (72.0)	108.75	<0.001*
Total insulin injection (syringe)				
Adequate	0 (0.0)	76 (76.0)		
Inadequate	100 (100.0)	24 (24.0)	122.58	<0.001*

Table 3 Performance of insulin injection by pen among children in the study sample before and after the intervention

	Time [*N* (%)]		χ^2-Test	*P*-value
	Before (*n*=100)	After (*n*=100)		
Wash hands with soap and water	17 (17.0)	93 (93.0)	116.69	<0.001*
Check insulin's expiration date (manufacturer data and the date recorded after opening the cartridge)	10 (10.0)	57 (57.0)	49.58	<0.001*
Inspect insulin before each use	8 (8.0)	65 (65.0)	70.09	<0.001*
Rotate the site for each injection	3 (3.0)	81 (81.0)	124.88	<0.001*
Make sure that the injection site is free of bumps, cracks, or scarring	0 (0.0)	59 (59.0)	Fisher's	<0.001*
Use a new needle for each injection	0 (0.0)	41 (41.0)	Fisher's	<0.001*
Gently mix/roll insulin 25 times before use (for cloudy insulin), not shaking	0 (0.0)	60 (60.0)	85.71	<0.001*
Prime pen with 2 U before each use (for new cartridge, prime with 8–10 U)	0 (0.0)	73 (73.0)	114.96	<0.001*
Hold the injection for at least 6 s perpendicularly	0 (0.0)	79 (79.0)	130.58	<0.001*
Inject insulin at a 90^0 angle	0 (0.0)	89 (89.0)	160.36	<0.001*
Count to 20 before needle removal	0 (0.0)	69 (69.0)	Fisher's	<0.001*
Put used needle into a 'sharps' container	0 (0.0)	19 (19.0)	Fisher's	<0.001*
Wash hands with soap and water	0 (0.0)	81 (81.0)	Fisher's	<0.001*
Total insulin injection (pen)				
Adequate	0 (0.0)	82 (82.0)		
Inadequate	100 (100.0)	18 (18.0)	138.98	<0.001*

educational level. Meanwhile, the scores of performance of insulin injection by syringe, blood test, and total performance had statistically significant negative correlations with their mothers' education. No statistically significant correlations could be revealed with fathers' education.

Table 4 Performance of blood glucose testing among children in the study sample before and after the intervention

	Time [*N* (%)]		χ^2-Test	*P*-value
	Before (*n*=100)	After (*n*=100)		
Wash hands with soap and water	16 (16.0)	89 (89.0)	106.85	<0.001*
Assemble equipment	11 (11.0)	92 (92.0)	131.34	<0.001*
Place the lancet in the pen	3 (3.0)	74 (74.0)	106.45	<0.001*
Set up the glucometer	2 (2.0)	85 (85.0)	140.15	<0.001*
Be sure that the finger is dry before applying lancet	1 (1.0)	82 (82.0)	135.13	<0.001*
Turn the glucometer on	1 (1.0)	87 (87.0)	150.08	<0.001*
Apply the lancet to the side of the finger	1 (1.0)	69 (69.0)	101.63	<0.001*
Point the finger downward	1 (1.0)	73 (73.0)	111.20	<0.001*
Gently squeeze to get an adequate blood sample	1 (1.0)	65 (65.0)	92.63	<0.001*
Place the blood drop on the test strip	1 (1.0)	83 (83.0)	138.01	<0.001*
Wipe the finger with gauze pad and hold it in place	1 (1.0)	71 (71.0)	106.34	<0.001*
Apply gentle pressure until bleeding stops	1 (1.0)	64 (64.0)	90.46	<0.001*
Read the result	1 (1.0)	73 (73.0)	111.20	<0.001*
Record the result	1 (1.0)	69 (69.0)	101.63	<0.001*
Clean the equipment	1 (1.0)	66 (66.0)	94.83	<0.001*
Dispose of used supplies appropriately	0 (0.0)	21 (21.0)	Fisher's	<0.001*
Wash hands with soap and water	2 (2.0)	65 (65.0)	89.08	<0.001*
Total blood sugar test				
Adequate	1 (1.0)	77 (77.0)		
Inadequate	99 (99.0)	23 (23.0)	121.40	<0.001*

Table 5 Performance of foot care among children in the study sample before and after the intervention

	Time [*N* (%)]		χ^2-Test	*P*-value
	Before (*n*=100)	After (*n*=100)		
Check feet every day for cuts, cracks, bruises, blisters, sores, infections, or unusual markings	1 (1.0)	62 (62.0)	86.22	<0.001*
Use a mirror to see the bottom of the feet	0 (0.0)	29 (29.0)	Fisher's	<0.001*
Check legs and feet color	2 (2.0)	60 (60.0)	78.63	<0.001*
If there is swelling, warmth or redness, or pain, see a doctor or foot-care specialist right away	4 (4.0)	58 (58.0)	68.16	<0.001*
Clean a cut or scratch with a mild soap and water	22 (22.0)	95 (95.0)	109.75	<0.001*
Cover the cut with a dry dressing for sensitive skin	10 (10.0)	87 (87.0)	118.69	<0.001*
Trim nails straight across	7 (7.0)	92 (92.0)	144.51	<0.001*
Wash feet every day	25 (25.0)	93 (93.0)	95.58	<0.001*
Dry feet especially between toes	6 (6.0)	88 (88.0)	134.97	<0.001*
Apply a good skin lotion every day on heels and soles	0 (0.0)	66 (66.0)	97.76	<0.001*
Wipe off any excess lotion	0 (0.0)	55 (55.0)	75.25	<0.001*
Change socks every day	5 (5.1)	72 (72.0)	94.00	<0.001*
Wear a good supportive shoe	0 (0.0)	66 (66.0)	98.51	<0.001*
Choose shoes with low heels (under 5 cm high)	3 (3.0)	49 (49.0)	50.6	<0.001*
Buy shoes late afternoon (feet swell a little bit at that time)	0 (0.0)	36 (36.0)	Fisher's	<0.001*
Avoid extreme cold and heat (including the sun)	0 (0.0)	35 (35.0)	42.42	<0.001*
Exercise regularly	2 (2.0)	48 (48.0)	56.43	<0.001*
Total foot care				
Adequate	0 (0.0)	58 (58.0)		
Inadequate	100 (100.0)	42 (42.0)	81.69	<0.001*
Total performance				
Adequate	0 (0.0)	80 (80.0)		
Inadequate	100 (100.0)	20 (20.0)	133.33	<0.001*

Table 8 clarifies that in multivariate analysis the applied intervention was identified as the main independent statistically significant positive predictor of the child's performance score, with child age and performance of exercise having a less but statistically significant influence. The model

Table 6 Relations between children's performance and their characteristics

	Performance [*N* (%)]		χ^2-Test	*P*-value
	Adequate	Inadequate		
Age				
<12	58 (77.3)	17 (22.7)	1.33	0.25
12+	22 (88.0)	3 (12.0)		
Sex				
Male	32 (80.0)	8 (20.0)	0.00	1.00
Female	48 (80.0)	12 (20.0)		
Residence				
Urban	47 (81.0)	11 (19.0)	0.09	0.76
Rural	33 (78.6)	9 (21.4)		
Educational level				
Primary	66 (76.7)	20 (23.3)	Fisher's	0.07
Preparatory	14 (100.0)	0 (0.0)		
Mothers' formal education				
None	30 (90.9)	3 (9.1)	3.66	0.06
Educated	50 (74.6)	17 (25.4)		
Fathers' formal education				
None	26 (83.9)	5 (16.1)	0.42	0.52
Educated	54 (78.3)	15 (21.7)		
Ready for self-care in				
Blood sugar test				
No	18 (62.1)	11 (37.9)	8.21	0.004*
Yes	62 (87.3)	9 (12.7)		
Insulin injection				
No	15 (57.7)	11 (42.3)	10.93	0.001*
Yes	65 (87.8)	9 (12.2)		
Foot care				
No	22 (64.7)	12 (35.3)	7.53	0.006*
Yes	58 (87.9)	8 (12.1)		
Practice exercise				
No	59 (74.7)	20 (25.3)	Fisher's	0.006*
Yes	21 (100.0)	0 (0.0)		
Need information				
No	43 (76.8)	13 (23.2)	0.82	0.36
Yes	37 (84.1)	7 (15.9)		

*Statistically significant at $P<0.05$.

explains ~90% of the variation in performance score as shown by the R^2 value.

Table 9 illustrates that as regards program feedback the most beneficiary part in the intervention was insulin injection by syringe (74%) and by pen (72%), whereas the sugar test was the least (39%). Less than a half (44%) of the children expressed the need for more information, mainly about the nature of the disease (70.4%). All children (100%) recommended the program for other diabetic children.

Discussion

The study findings indicate no practice of self-care among children and adolescents with T1D. However, statistically significant improvements were revealed in their performance of the selected self-care practices after receiving related instructions. This leads to acceptance of the set research hypothesis.

The study results show that none of the children had adequate performance of insulin injection, either with the syringe or with the pen, before the instructions. This was also noticed regarding checking blood glucose and foot-care practices. This indicates total lack of patient education related to self-care in the setting. Moreover, the majority of the children expressed their readiness to perform self-care practices before receiving the instructions, which constitutes an unmet need. The finding underscores the urgent need for fostering nurses' role in this aspect. However, a similar lack of adequate self-care related to foot care among T1D children was found in a study in China, where the majority of participants reported having not examined their feet in the previous

Table 7 Correlation matrix of children's performance scores and their characteristics after the intervention

	Spearman's rank correlation coefficient				
	Insulin (syringe)	Insulin (pen)	Blood test	Foot care	Total performance
Performance					
Insulin injection (syringe)					
Insulin injection (pen)					
r	0.406**				
P	0.000				
Blood test					
r	0.535**	0.463**			
P	0.000	0.000			
Foot care					
r	0.352**	0.215*	0.364**		
P	0.000	0.032	0.000		
Characteristics					
Age					
r	0.513**	0.305**	0.393**	0.285**	0.471**
P	0.000	0.002	0.000	0.004	0.000
Educational level					
r	0.126	0.190	0.125	0.061	0.193
P	0.213	0.059	0.216	0.550	0.054
Mothers' education					
r	0.473**	0.260**	0.325**	0.279**	0.432**
P	0.000	0.009	0.001	0.005	0.000
Fathers' education					
r	−0.202*	−0.154	−0.273**	0.026	−0.220*
P	0.043	0.126	0.006	0.800	0.028

*Statistically significant at $P<0.05$; **Statistically significant at $P<0.01$.

Table 8 Best-fitting multiple linear regression model for children's performance score

	Unstandardized coefficients		Standardized coefficients	*t*-Test	*P*-value	95% confidence interval for B	
	B	SE				Lower	Upper
Constant	−85.95	4.49		19.147	<0.001	−94.80	−77.09
Intervention	68.27	1.66	0.94	41.035	<0.001	64.99	71.55
Age	2.04	0.38	0.12	5.329	<0.001	1.29	2.80
Practice exercise	4.24	2.08	0.05	2.037	0.043	0.14	8.35

r^2=0.896; Model analysis of variance: F=574.03, $P<0.001$.

Table 9 Information needs and program benefits as reported by children in the study sample (*n*=100)

	N (%)
Program benefits[a]	
Insulin injection	72 (74)
Insulin pen care	72 (72)
Foot care	46 (46)
Sugar test	39 (39)
Need more information	
No	56 (56)
Yes	44 (44)
Information needs (*n*=44)[a]	
Diet	26 (59.1)
Nature of the disease	31 (70.4)
Recommend program for others	100 (100)

[a]Not mutually exclusive.

seven days in spite of the simplicity of the procedure (Lin *et al.*, 2016).

After receiving the instructions, more than three-fourth of the children in the current study demonstrated adequate performance of insulin injection. The rate was higher for injection by pen compared with injection by syringe, which is quite expected given the easier use of the pen, its invisible needle, and the less discomfort after injection. In agreement with these findings, similar successes of interventions in improving T1D children' practices related to self-care were previously reported, such as Ali *et al.* (2014) in West Bank, Palestine, Karale (2014) in India, and Särnblad *et al.* (2016) in Sweden. Concerning the better performance in insulin injection by pen in the present study, the finding is in congruence with what Al-Ashry *et al.* (2015) demonstrated in a study in Egypt. This was attributed to its easier use and the possibility of its discrete use in social situations.

A similar success was revealed regarding children's performance of blood glucose testing using the glucometer in the present study. Thus, the majority had adequate performance after receiving the instructions. Actually, the researchers noticed that the children were very excited in using the glucometer, and it was simulated to a digital game. In this respect, Kamel Boulos *et al.* (2015) in a study in the UK stated that 'gamifying disease management' is an effective approach to improve self-management among children with chronic illness. In line with this present study result, Salehi *et al.* (2014) in a study in Iran reported that the children had very good performance in self-monitoring of blood glucose when exposed to teaching given in outpatient clinics. Nonetheless, some of the children in the current study, especially those of younger age, needed some help in the use of the lancet, and in reading the result in English; therefore, some support from parents is needed during this procedure.

Although the practice of foot care could be viewed as the easiest to perform among the four selected practices, the present study results indicated that it had the lowest percentage of adequate performance. Only less than two-thirds of the children demonstrated adequate performance of this self-care practice. This relatively low rate could be attributed to the assumption that children might be interested in learning a more technical process that satisfies their curiosity at this age compared with just checking their feet and footwear, which they see as a useless meticulous process. It could also be because of the fact that some of the steps of foot care were to be simulated, such as the choice of appropriate footwear, and managing scratches, cuts, or redness on the skin. Therefore, this task may need more involvement from parents until the child realizes its importance. The lack of adherence to regular foot care has been documented even among adults with diabetes (Mogre *et al.*, 2017).

Concerning the steps mostly missed or inadequately performed by the children in the present study, the results indicated that they were mostly related to infection control. This included washing hands and proper disposal of the waste at the end of the procedures. Their performance was also low in labeling the insulin bottle with the date of first use. The importance of such steps should be emphasized to the children whose attention is more drawn to the more interesting technical steps of the procedures. The findings could be explained by the generally low compliance to personal hygiene measures in developing countries, particularly in low-income communities (Diouf *et al.*, 2014; Al-Khatib *et al.*, 2015; Liao *et al.*, 2017).

According to the findings of the present study, the children having more readiness at the outset of the study and those practicing exercise demonstrated significantly higher performance after receiving the related instructions. This clarifies the importance of motivating children to increase their readiness to learn self-care practices. In congruence with this, Koller *et al.* (2015) highlighted the importance of assessment of diabetic children's acceptance for self-care, and this should be built up gradually to prepare them to assume this responsibility as they gain more confidence. In addition, research has demonstrated that school-aged children are capable of taking responsibility for self-management of their chronic diseases, with some support from their families, when they receive proper instructions and when health resources are available (Beacham and Deatrick, 2013).

The significant and independent positive effect of the instructions was confirmed through multivariate analysis, which identified it as the main positive predictor of the total performance score. This success could be attributed to more than one reason. First, the program content was easy to be assimilated to children and adolescents. Second, the process of instructions was in a friendly environment, with small groups acting as encouraging teams for each other. Last, each child was given full opportunity to practice the skill until mastered. Added to these factors is the positive attitude and psychological support provided by the healthcare providers in the study setting. In congruence with this, the benefits of peer-based interventions have been revealed in a recent systematic review (Kazemi *et al.*, 2016). Nonetheless, the best approaches in such educational interventions still need further research (Colson *et al.*, 2016).

The present study has also identified a positive and significant influence of children's age on their self-care performance score. This is quite expected given the increasing psychomotor abilities and the more eagerness to be self-dependent in adolescence. In agreement with this, Hockenberry and Wilson (2013) emphasized that as adolescents develop they are able to assume additional responsibility for their own health, including maintaining health practices, taking prescribed medications, keeping appointments, and

performing procedures when necessary. Thus, Scott (2013) stressed the importance of taking child's age and cognitive development into account in self-care instructional programs. In addition, in the present study, the history of practice of physical exercise seems to have a significant positive influence on children's performance score, which is plausible given its beneficial effect. Moreover, it reflects a higher level of health behavior as clarified by the New York State Department of Health (2012). Meanwhile, children's sex had no influence on their self-care performance score, which is in line with the results reported by Flora and Gameiro (2016).

The majority of the children in the present study expressed their satisfaction with the instructional program provided to them and with the associated gains in information and practical skills. Consequently, all of them recommended the program to be administered to all children having T1D. This high satisfaction could be attributed to the fact that their curiosity to know and practice was met in this program. Thus, they had fun while learning and gaining more control of their own health. In this respect, Pelicand *et al.* (2015) in France emphasized the importance of satisfying adolescents' need to gain autonomy in the management of their condition.

Conclusion and recommendations

Children with T1D can gain the self-care skills of insulin injection, blood glucose testing, and feet care through simple instructions associated with practical training. Therefore, the developed intervention should be implemented in settings providing care to children with T1D. This should be started immediately upon diagnosis. The participation of parents, particularly with very young children, and more emphasis on foot care are needed. The nurses should be trained in administering such programs. The impact of the program on glycemic control needs further research.

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Conflicts of interest

There are no conflicts of interest.

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