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The impact of blood glucose and HbA_{1c} goals on glycaemic control in children and adolescents with Type 1 diabetes

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Abstract

Aims—To evaluate parents' goals and parents' perceptions of physicians' goals for blood glucose and HbA_{1c} in children and adolescents with type 1 diabetes.

Methods—In a cross-sectional observational assessment, parents (80% mothers) of 153 children/adolescents (56% female), aged 12.9 ± 2.3 years (range 8–16 years) with Type 1 diabetes for 6.3 ± 3.5 years, completed surveys regarding their goals and their perceptions of physicians' goals for their child's blood glucose and HbA_{1c} levels.

Results—Children/adolescents had a mean HbA_{1c} of 69 ± 16 mmol/mol ($8.4 \pm 1.4\%$) and blood glucose levels checked 3.8 ± 1.2 times/day; 23% received pump therapy. Almost half of parents reported a blood glucose goal of 130 (80–180) mg/dl [7.2 (4.4 – 10) mmol/l]; 75% of parents reported a HbA_{1c} goal of 42–64 mmol/mol (6–8%). The HbA_{1c} level was significantly lower when parents reported HbA_{1c} goals ≤ 64 mmol/mol ($\leq 8\%$) vs. > 64 mmol/mol ($> 8\%$) [67 ± 14 mmol/mol ($8.3 \pm 1.2\%$) vs. 76 ± 20 mmol/mol ($9.1 \pm 1.8\%$), respectively, $P = 0.02$]. Parents' blood glucose and HbA_{1c} goals were tightly linked with parents' perceptions of physicians' blood glucose and HbA_{1c} goals (69% concordant, $P < 0.0001$; 88% concordant, $P < 0.0001$, respectively).

Conclusions—There was a significant association between lower parent HbA_{1c} goals and lower child/adolescent HbA_{1c}. Further, parents appear to set glycaemic goals based upon their perceptions of physician goals. Future studies should assess the relationship between parents' perceptions of health-care providers' goals and health-care providers' actual goals and the impact of unified family/provider goal-setting on glycaemic control.

Introduction

Goal-setting theory predicts that specific goals will lead to better performance compared with no goal-setting [1]. In paediatric Type 1 diabetes, this applies to treatment goals aimed at normalizing growth and development and preventing complications by optimizing HbA_{1c} levels [2]. For children/adolescents with Type 1 diabetes, blood glucose (BG) and HbA_{1c} goals should be realistic and attainable, otherwise it is unlikely that such goals will be achieved [3, 4].

The International Society for Pediatric and Adolescent Diabetes (ISPAD) recommends an HbA_{1c} < 58 mmol/mol ($< 7.5\%$) for children/adolescents ≥ 18 years old [5]. The American Diabetes Association (ADA) recommends age-specific HbA_{1c} targets: ages 0–6 years,

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Competing interests

Nothing to declare.

HbA_{1c} < 69 mmol/mol (< 8.5%); ages 6–12 years, < 64 mmol/mol (< 8%); ages 13–19 years, < 58 mmol/mol (< 7.5%) [6]. Studies suggest that HbA_{1c} may vary according to health-care providers' recommendations [7] and parents' glycaemic goals [8].

Parent support and involvement are associated with better adherence for children/adolescents with Type 1 diabetes [9–12]. Therefore, we sought to assess the impact of parents' glycaemic goals on HbA_{1c} in children/adolescents with Type 1 diabetes. We also assessed parents' perceptions of physicians' goals. We hypothesized that more optimal parent glycaemic goals would be associated with more optimal glycaemic outcomes in their children.

Patients and methods

Participants were children/adolescents (ages 8–16 years) with Type 1 diabetes (duration 6 months and daily insulin requirements 0.5 units/kg) and their parents/guardians. Patients with major psychiatric disorders (e.g. major depression) were excluded. The study protocol was approved by the Institutional Review Board and written informed consent/assent were obtained from parents/youths.

We aimed to enrol around 150 participants. Over 4 months, we approached 174 eligible patients during routine clinic visits; 154 (89%) agreed to participate. One participant was excluded after further review uncovered MODY. Twenty patients declined participation (no time, $n = 10$; no interest, $n = 8$; confidentiality concerns, $n = 2$). Those who declined were similar to participants in age and duration of diabetes. The final sample consisted of 153 children/adolescents.

Study visits occurred on clinic appointment days. Parents completed a paper survey that included the following questions: What is your goal for your child's blood sugar? What is your goal for your child's HbA_{1c}? What is your doctor's goal for your child's blood sugar? What is your doctor's goal for your child's HbA_{1c}? A multidisciplinary team of paediatric endocrinologists, psychologists, nurses and research staff with expertise in paediatric diabetes developed the questions (see Table 2, later, for response options).

Children/adolescents provided a blood sample for Diabetes Control and Complications Trial (DCCT)-standardized HbA_{1c} assay [reference range 20–42 mmol/mol (4.0–6.0%); Tosoh 2.2]. Medical data (height/weight) and diabetes management data (insulin regimen, blood glucose monitoring frequency) were obtained from the medical record. The blood glucose monitoring frequency was based on clinician report using meter download or logbook review.

Data analysis

Statistical analyses were conducted with SAS (v9.2, SAS Institute, Cary, NC, USA) and included *t*-tests, ANOVA, correlations and chi-square tests.

Results

Participant characteristics appear in Table 1. The younger group had shorter duration of diabetes, received less insulin, and checked BG levels more frequently than the older group (Table 1).

Blood glucose goals

Almost half (49%) of parents reported a blood glucose goal of 130 (80–180) mg/dl [7.2 (4.4–10) mmol/l]; 29% had higher goals and 22% had lower goals (Table 2a). Only 3% of

parents reported blood glucose goals ≤ 180 mg/dl (≤ 10 mmol/l). Parent reports of physicians' blood glucose goals were similarly distributed (Table 2a). Mean HbA_{1c} was almost the same in the lower three parent blood glucose goal groups. However, HbA_{1c} was higher [86 mmol/mol (10.0%)] when parents reported goals ≤ 180 mg/dl. Similarly, HbA_{1c} was higher when parents reported physicians' goals ≤ 180 mg/dl or when parents did not know physicians' goals, compared with when parents reported physicians' goals < 180 mg/dl. Neither comparison was significant, likely owing to small numbers reporting these responses.

HbA_{1c} goals

Three-quarters of parents reported HbA_{1c} goals of 42–64 mmol/mol (6–8%); 21% reported goals > 64 mmol/mol ($> 8\%$) or no specific goal; only 4% reported goals < 42 mmol/mol ($< 6\%$) (Table 2b). Similarly, most parents (75%) reported physicians' HbA_{1c} goals of 42–64 mmol/mol (6–8%). Surprisingly, 16% were unaware of their physician's goal (Table 2b). The HbA_{1c} level was significantly lower when parents reported goals ≤ 64 mmol/mol (8%) (67 ± 14 mmol/mol, $8.3 \pm 1.2\%$) vs. > 64 mmol/mol (8%) or unawareness of goals (76 ± 20 mmol/mol, $9.1 \pm 1.8\%$) ($P < 0.02$). The HbA_{1c} level was also lower, although not significantly, when parents reported physicians' goals ≤ 64 mmol/mol (8%) (67 ± 14 mmol/mol, $8.3 \pm 1.2\%$) vs. > 64 mmol/mol (8%) or unawareness of goals (74 ± 20 mmol/mol, $8.9 \pm 1.9\%$) ($P < 0.06$).

Blood glucose and HbA_{1c} goals according to age, duration of diabetes and blood glucose monitoring frequency

Age was significantly associated with glycaemic goals. A greater proportion (62%) of parents in the younger group (< 12) reported the widest blood glucose range (80–180 mg/dl, 4.4–10 mmol/l) as their goal, compared with parents in the older group (≥ 12 ; 41%, $P = 0.01$). Similarly, 57% of parents in the younger group reported the widest blood glucose range as their physician's goal, compared with 41% of parents in the older group ($P = 0.06$). With respect to HbA_{1c} goals, 88% of parents in the younger group reported HbA_{1c} goals $\leq 8\%$, compared with 73% of parents in the older group ($P = 0.02$). A similar, although non-significant, pattern emerged for parents' reports of physicians' HbA_{1c} goals.

Duration of diabetes was not related to glycaemic goals. Frequency of blood glucose monitoring was not related to blood glucose goals but was related to HbA_{1c} goals. The monitoring frequency was significantly higher when parents reported HbA_{1c} goals $\leq 8\%$ vs. $> 8\%$ (3.9 ± 1.2 vs. 3.4 ± 1.0 times/day, $P = 0.03$) and when parents reported physicians' HbA_{1c} goals $\leq 8\%$ vs. $> 8\%$ (3.9 ± 1.2 vs. 3.5 ± 1.0 times/day, $P = 0.04$).

Concordance of parent goals and parent perceptions of physicians' goals

Most parents' goals matched parents' perceptions of physicians' goals for both blood glucose (69% agreement) and HbA_{1c} (88% agreement) (both $P < 0.0001$). There was no difference by age group for blood glucose goal concordance (younger, 67% agreement; older, 70% agreement) or HbA_{1c} goal concordance (younger, 85% agreement; older, 89% agreement).

Discussion

We aimed to evaluate the relationship between parents' glycaemic goals and their children's glycaemic control. the HbA_{1c} level was modestly associated with parents' blood glucose goals; it was higher, although not significantly, only at the highest blood glucose goal ≤ 180 mg/dl. However, HbA_{1c} was associated with parents' HbA_{1c} goals and parents' perceptions of physicians' HbA_{1c} goals. Youth HbA_{1c} was lower when parents reported HbA_{1c} goals

64 mmol/mol (8%) (67 ± 14 mmol/mol, $8.3 \pm 1.2\%$) vs. > 64 mmol/mol (8%) (76 ± 20 mmol/mol, $9.1 \pm 1.8\%$). However, owing to the cross-sectional study design, we do not know if parents set glycaemic goals based upon their child's actual HbA_{1c} rather than recommended targets; longitudinal studies are needed to determine directionality of this relationship. It was also notable that about one in six parents (16%) were unaware of their physician's HbA_{1c} goal.

More frequent blood glucose monitoring was associated with both lower parent HbA_{1c} goals and parent perceptions of physicians' HbA_{1c} goals. After controlling for age, these associations maintained a trend toward significance ($P = 0.07$). Previous studies have confirmed a tight inverse relationship between blood glucose monitoring frequency and HbA_{1c} levels [12–15]. Notably, blood glucose goals and monitoring frequency were unrelated. One might expect families that encourage frequent blood glucose monitoring in order to self-correct their child's out-of-range glucose levels to observe substantial glucose variability, leading the parents to target a wider blood glucose range.

Although diabetes duration was not related to blood glucose and HbA_{1c} goals, age of children/adolescents was associated with both parents' goals and parents' perceptions of physicians' blood glucose and HbA_{1c} goals. Parents of children < 12 years old reported a wider blood glucose goal range and a lower HbA_{1c} goal than parents of adolescents ≥ 12 years old. Parents of younger children are more likely to observe fluctuations in their child's blood glucose levels than parents of adolescents, as teens may be more likely to self-monitor, leading parents of younger children to report a wider blood glucose range [16]. However, adolescents tend to have higher HbA_{1c} levels than younger children [17, 18], which, in turn, likely leads parents of adolescents to report a higher HbA_{1c} goal than parents of younger children. Our data support this premise as 90% of parents of children < 12 years compared with 75% of parents of adolescents ≥ 12 years reported HbA_{1c} goals ≤ 64 mmol/mol (8%). Nonetheless, we are encouraged that parents likely are seeking glycaemic improvements for their children and may perceive lower HbA_{1c} goals than may be attainable in the short-term.

Our study has several limitations. The cross-sectional study design does not allow assessment of causal relationships. The survey response options did not allow for reporting of more specific or narrower goals. Also, the questions asked only about parents' perceptions of physicians' goals and not about parents' perceptions of goals of other health-care providers (e.g. certified diabetes educators). Parents' blood glucose and HbA_{1c} goals were highly concordant with their perceptions of physicians' blood glucose and HbA_{1c} goals, respectively, but we did not assess the physicians' goals or children/adolescents' goals. It is likely that health-care providers individualize glycaemic targets. For example, an HbA_{1c} goal of 75 mmol/mol (9%) is usually considered higher than recommended targets but it may be an appropriate goal for a patient with an HbA_{1c} > 86 mmol/mol ($> 10\%$).

This observational study suggests a need for more research on goal-setting in paediatric Type 1 diabetes. Previous research supports the importance of unified goals by diabetes health-care team members in order to achieve glycaemic targets [19]. Future studies should assess the relationship between parents' perceptions of health-care providers' goals and health-care providers' actual goals, and the impact of unified family/provider goal-setting on glycaemic control in children/adolescents with Type 1 diabetes.

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Table 1

Participant characteristics

	All participants (n = 153)	< 12 years (n = 60)	12 years (n = 93)	P
Age (years)	12.9±2.3 (8.2–16.5)	10.4±1.1	14.4±1.2	< 0.0001
Duration of diabetes (years)	6.3±3.5 (0.8–14.3)	4.6±2.7	7.4±3.6	< 0.0001
z-BMI (SDS)	0.8±0.7 (–1.1–2.4)	0.8±0.8	0.8±0.7	
Blood glucose monitoring frequency (times/day)	3.8±1.2 (1–9)	4.1±1.2	3.7±1.2	0.04
Insulin dose (u/kg.day)	1.0±0.3 (0.3–1.8)	0.9±0.3	1.0±0.2	0.03
HbA _{1c} (mmol/mol)	69±16 mmol/mol (41–133 mmol/mol)	68±12 mmol/mol	69±18 mmol/mol	
HbA _{1c} (%)	8.4±1.4% (5.9–14.3%)	8.3±1.1%	8.5±1.6%	
Sex (% female)	56	53	58	
Insulin therapy (%)				
Pump	23	17	27	
MDI	62	62	62	
BDI	15	22	11	
Parents (% mothers)	80	83	77	
Race/ethnicity (% non-white)	10	7	12	

Values are reported as mean±SD (range) or percent.

Table 2

A. Blood glucose goals				
Blood glucose goal category*		Parents' goals		Parents' perceptions of physicians' goals
mg/dL	mmol/L	% of Parents	Child HbA1c	% of Parents
100(80–120)	5.6(4.4–6.7)	22	69±18 mmol/mol (8.5±1.6%)	20
130(80–180)	7.2(4.4–10)	49	68±14 mmol/mol (8.3±1.3%)	47
150(120–180)	8.3(6.7–10)	26	69±14 mmol/mol (8.4±1.3%)	24
180 / Don't know	10 / Don't know	3**	86±34 mmol/mol (10.0±3.1%)	9

B. HbA1c goals				
HbA1c goal category		Parents' goals		Parents' perceptions of physicians' goals
mmol/mol	%	% of Parents	Child HbA1c	% of Parents
<42	<6	4	64±15 mmol/mol (8.0±1.4%)	2
42–64	6–8	75	67±14 mmol/mol (8.3±1.2%)	75
>64	>8	10	77±18 mmol/mol (9.2±1.6%)	7
Don't know	Don't know	10	75±23 mmol/mol (9.0±2.1%)	16

* Pre-prandial goals

** All parents reported a blood glucose goal

* The HbA1c levels of the 3 children whose parents reported a physician HbA1c goal <6% were 7.1%, 8.0%, and 10.8%.