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Predictors of deteriorations in diabetes management and control in adolescents with type 1 diabetes

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Abstract

Introduction—Deteriorating type 1 diabetes management and control are common among adolescents, yet clinical evidence suggests that individual trajectories can vary. The aim of this study was to examine patterns and predictors of blood glucose monitoring (BGM) frequency and glycemic control (A1c).

Methods—Prospective data analysis spanning 18–24 months with 150 adolescent-parent pairs. Latent group-based trajectory modeling identified subgroups and determined medical, demographic, psychological, and family predictors of subgroup membership.

Results—Three subgroups emerged, representing diabetes management and control that is "meeting treatment targets" (40%; A1c at baseline= 7.4%, blood glucose monitoring (BGM) frequency at baseline = 4.8 checks/day) and two levels "not meeting targets": "normatively similar" youth (40%; A1c = 9.2%, BGM frequency = 2.8 checks/day), and "high risk" youth (20%; A1c = 11.2%, BGM frequency = 2.9 checks/day). Subgroup membership was maintained over 18–24 months. There was minimal change across time, although only one-third met treatment targets. Older age, longer diabetes duration, ethnic minority status, unmarried caregiver status, insulin delivery via injections vs. CSII, greater depressive symptoms, negative affect about BGM,

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and diabetes-specific family conflict each predicted membership in a subgroup with poorer diabetes management and control.

Conclusions—Among the nearly two-thirds of adolescents with management and control that do not meet treatment targets, modifiable and non-modifiable factors may signal the need for prevention or intervention. Demographic and medical factors may call for proactive efforts to prevent deterioration, while psychological symptoms and family conflict signal opportunities for clinical intervention to promote improved diabetes management and control in adolescence.

Keywords

type 1 diabetes; depression; distress; family conflict; blood glucose monitoring; glycemic control

The treatment regimen for type 1 diabetes is complex and demanding(1). Data from large-scale clinical and epidemiological studies show that deteriorations in diabetes management and control are common during adolescence(2–8). These deteriorations raise the risk for complications and contribute to rising health care costs(9). Yet, clinical observations and study data reveal substantial individual differences in diabetes management and control(7, 10–11).

Researchers have begun to delineate subgroups of pediatric patients with distinct patterns of diabetes management and control. Rohan and colleagues(10) detected three distinct patterns of diabetes management behaviors in early adolescence. Helgeson and colleagues(11) and Luyckx and Sieffge-Krenke(7) identified similar subgroups of adolescents and young adults characterized by optimal, moderate, or poor/deteriorating glycemic control over five and ten years, respectively. Classifying the patient population into subgroups is valuable for estimating individuals' relative risk for particular outcomes over time and determining the appropriate type, level, and timing of treatment strategies. With these data, clinicians can tailor treatment plans and appropriately allocate clinical resources for prevention and intervention (i.e., personalized care planning; 12).

To our knowledge, patient subgroups based on longitudinal trajectories of both diabetes management behaviors and glycemic control have not been identified. However, clinicians routinely make treatment decisions based on both pieces of data. Despite this and the established associations between management and glycemic outcomes(13), the way management behaviors and glycemic control change together over time remains unclear. Thus, the aims of the current study were two-fold. First, we aimed to characterize subgroups of adolescents with type 1 diabetes based on 18–24 month trajectories of both diabetes management and control. Based on previous work(7, 10), we hypothesized that individuals would cluster into three subgroups. Given growth, hormonal changes, and developmental demands across social, academic, family, and interpersonal domains that are linked with declining glycemic control(2, 11, 14), we expected deterioration over time in all subgroups. The second aim was to identify predictors of membership in each trajectory subgroup. Based on previous findings indicating associations of demographic, medical, and potentially modifiable behavioral, emotional, and family characteristics with diabetes outcomes(3–5, 7–8, 10–11, 15–18), we anticipated that variables in each of these classes would predict subgroup membership.

Methods

Participants

Participants were adolescents between 13 and 18 years of age diagnosed with type 1 diabetes (mean age=15.5±1.4 years) receiving multidisciplinary care for type 1 diabetes at a tertiary pediatric medical center. We approached 166 families to participate in the study to enroll and collect baseline data from 150 (90% recruitment rate). Retention rates were 98% at the second visit, 97% at the third visit, and 89% at the fourth visit. Attrition was generally due to an inability to make contact at follow-up. The sample was 51% female, primarily Caucasian (86%), from two-parent families (75%), and covered by private insurance (85%). Participating parents were largely mothers (85%), 47% of whom had earned a college degree or beyond. The mean duration of diabetes at baseline was 6.0±3.9 years, mean A1c was 8.8±1.9%, and 63% of participants used continuous subcutaneous insulin infusion (CSII), with the remainder on basal-bolus injections.

Procedure

Potentially eligible diabetes center patients were identified and screened to ensure English fluency and the absence of a severe psychiatric, neurocognitive, or other serious chronic medical condition that would interfere with the ability to participate. Research staff obtained written informed consent and assent and administered questionnaires before or after every other quarterly diabetes clinic visit. Due to slightly longer intervals between appointments, the mean time from first to second visit=7.0±1.7 months, from first to third visit=13.4±2.3 months, and from first to fourth visit=19.7±3.0 months. Participants received $10/visit in appreciation of their time and effort. The hospital's institutional review board approved this study.

Measures

Outcomes—Hemoglobin A1c, the gold-standard measure of diabetes control, was collected at diabetes clinic visits. A1c values obtained at the clinic visit closest to each study visit were abstracted from the medical chart. Participants provided a sample of blood for A1c, measured by DCA+ 2000 (reference range=4.3–5.7%, Bayer Inc.; Tarrytown, NY, USA).

Diabetes management was quantified using frequency of blood glucose monitoring (BGM), given data demonstrating the key role of BGM in diabetes management and control (5). BGM frequency was downloaded from blood glucose meters at diabetes clinic visits and averaged over the previous 14 days. Downloads were available for 77% of the sample at the first visit. For the remainder, self-report or clinician-report based on review of meter data or clinical interactions were used. Neither A1c (p=0.77) nor BGM frequency (p=0.19) at baseline differed by the source of BGM frequency data.

Predictors—Measures assessing each predictor were completed by caregivers or adolescents at the baseline study visit. Caregivers provided demographic data, including adolescent age, gender, and ethnicity; caregiver marital status and education; and family

insurance coverage. Medical data including diabetes duration and insulin delivery method (injections versus CSII) were verified through medical chart review.

As a measure of general emotional distress, adolescents completed the Children's Depression Inventory (CDI; 19), a self-report measure of depressive symptoms. Depressive symptoms including irritability and decreased energy and motivation are known risk factors for poorer diabetes management and control(16, 20–21). Adolescents rated their level of depression on 27 items, with higher scores reflecting more depressive symptoms (possible range: 0–54). Internal consistency in this sample was good (α=0.84).

To assess diabetes-specific emotional distress, adolescents completed the Blood Glucose Monitoring Communication questionnaire(BGMC; 22). Diabetes-specific emotional distress uniquely contributes to youths' glycemic control(22). Adolescents reported how frequently they typically experience 8 negative emotions (e.g., scared, frustrated) surrounding blood glucose values on a 3-point likert scale (almost never to almost always). Higher scores indicate more negative affect related to BGM (range=0–16). The BGMC has demonstrated strong psychometric properties(22) and this sample's internal consistency was adequate (α=0.76).

To measure family-level distress related to diabetes, caregivers completed the revised Diabetes Family Conflict Scale (DFCS; 23). Family conflict surrounding youths' diabetes management has demonstrated robust associations with diabetes management and control(15, 23–25). The DFCS assesses the frequency of family arguments about 19 tasks of diabetes management (e.g., remembering to check blood sugar, adjusting insulin depending on results) on a 3-point likert scale (almost never to almost always). Higher scores indicate more frequent conflict (range=19–57). The DFCS has strong psychometric properties(23), and internal consistency was good in this sample (α=0.86).

Data Analytic Plan

To identify subgroups of the sample characterized by distinct trajectories of diabetes management and control, we conducted latent group-based trajectory modeling (25) using Mplus software (Version 6.1; Muthén & Muthén, 2008–2010). Because subgroup trajectories are allowed to vary substantially, latent group-based trajectory modeling primarily characterizes individual differences in trajectories over time. In our modeling, individuals are assumed to belong to a single subgroup throughout the observation period. For smaller sample sizes like ours (e.g., n< 200), trajectory modeling is more appropriate than growth mixture modeling.

Given no indication of nonlinear trajectories, we examined linear trajectories and assumed normality and constant variance for the errors. To determine the number of subgroups, we examined various solutions with an increasing number of subgroups. We selected the optimal solution based on the model that 1) yielded the best fit via the smallest value for the Bayesian Information Criterion (BIC) and 2) provided sufficiently large proportions (i.e., ≥10%) of the sample per subgroup to be used in predicting subgroup membership. We employed Nagin's diagnostics, including the model estimate of group probability, average

posterior probability, and odds correct classification(26), to evaluate the adequacy of the selected model.

We then identified predictors of membership in each subgroup using logistic regressions in Mplus software. First, we examined all eight measured demographic and medical characteristics at baseline as predictors of subgroup membership. Next, we examined general and diabetes-specific emotional distress as psychological predictors of subgroup membership. Finally, we examined diabetes-specific family conflict as a family-level predictor. The order of predictors was determined to first identify non-modifiable factors that increase the risk of being in a trajectory of poor management and control, then to identify psychological and family characteristics that are potentially modifiable through individual and/or family-level clinical intervention. We calculated odds ratios with 95% confidence intervals to determine the significance of each predictor.

Results

Subgroup Identification

Using trajectory modeling, we examined 3 unique solutions consisting of 2, 3, and 4 subgroups, respectively (Table 1). The 3-group solution provided the best statistical fit to the data, based on 1) a BIC of 4245.2 and 2) sufficiently large subgroups (≥10% of sample/subgroup). Nagin's diagnostics (26) confirmed the adequacy of the three-group solution (Table 2).

The characteristics of each subgroup are summarized in Table 3, and the diabetes management and control trajectories are represented graphically in Figure 1. We labeled the first of the three subgroups "meeting treatment targets" as this group demonstrated diabetes management and control that met American Diabetes Association (ADA) recommended guidelines(1). This subgroup represented 39.8% of the sample. At baseline, the A1c intercept for the "meeting treatment targets" subgroup was 7.4% and the BGM frequency intercept was 4.8 blood glucose checks per day. The A1c trajectory remained stable over time, while BGM frequency decreased by approximately one check per day by the end of the observation period. The second and third subgroups were outside the ADA targets and differ by the degree to which they diverge from guidelines. The second subgroup (39.7% of the sample) was labeled "normatively similar" to reflect the common occurrence of moderately out-of-range glycemic control in adolescence. The A1c intercept at baseline was 9.2% and the BGM frequency intercept was 2.8 checks per day; neither outcome significantly changed over time. The third subgroup (20.5% of the sample) was labeled "high risk" to reflect the more extreme divergence from ADA guidelines. In this subgroup, the A1c intercept was 11.2% and the BGM frequency intercept was 2.9 blood glucose checks per day; both were stable over time.

Predicting Subgroup Membership

The characteristics of each subgroup, based on the 11 predictors examined, are summarized in Table 4. Predictors were examined in three separate blocks: first, demographic and medical factors; second, psychological distress; third, family distress.

The first block of predictors included eight demographic and medical variables. Longer diabetes duration (OR=1.16, $p<0.05$) and unmarried caregiver status (OR=4.29, $p<0.05$) predicted membership in the “normatively similar” subgroup as compared to the “meeting treatment targets” subgroup. Older age (OR=1.83, $p<0.05$), insulin delivery via MDI rather than CSII (OR=8.41, $p<0.05$), and ethnic minority status (OR=5.92, $p<0.05$) significantly predicted membership in the “high risk” subgroup as compared to the “meeting treatment targets” subgroup.

The second block of predictors included general (depressive symptoms) and diabetes-specific (BGM negative affect) emotional distress. Compared to the “meeting treatment targets” subgroup, “normatively similar” subgroup membership was predicted by higher depressive symptom scores (OR=1.07, $p<0.05$), while “high risk” subgroup membership was predicted by higher levels of negative affect related to BGM (OR=1.16, $p<0.05$).

Finally, family diabetes-related distress was examined as a predictor of subgroup membership. Higher diabetes-specific family conflict predicted membership in both of the out-of-range subgroups (“normatively similar”: OR=1.16, $p<0.01$; “high risk”: OR=1.28, $p<0.01$) as compared to the “meeting treatment targets” subgroup.

Discussion

Observations from large-scale clinical and epidemiological studies(8) were replicated across a 2-year period in late adolescence, with 60% of the sample demonstrating diabetes management and control outside of ADA recommended ranges. A portion of the sample was substantially above the recommended range and may be at greatly elevated risk for acute and long-term health complications(2, 10). At the same time, over one-third demonstrated BGM frequency rates and A1c values that remained within the recommended range.

As expected, trajectory modeling resulted in three subgroups characterized by distinct patterns of diabetes management and control. Similar to previous findings(7, 10–11), the subgroups represented youth that met treatment targets and two out-of-range levels. Consistent with evidence of associations between BGM frequency and glycemic control(5, 10–11, 13), the pattern of BGM frequency and A1c in the “meeting treatment targets” subgroup was distinct from the other subgroups. Even after 18–24 months, “meeting treatment targets” subgroup members completed 1–2 more checks per day than teens in either of the out-of-range subgroups, providing support for the ADA recommendations of at least 4 daily blood glucose checks.

Unlike previous findings(7, 11) no subgroup in this sample demonstrated significant deterioration in glycemic control over time. The current sample’s shorter follow-up period and broader range of baseline A1c values may in part account for this difference. Further, this sample included a narrower age range consisting of older adolescents, who may have experienced the most marked deterioration in their glycemic control earlier in adolescence(3, 6). Over one-third of participants achieved and maintained adherence rates and glycemic control within the recommended range. Thus, despite the risks inherent to having and managing a chronic disease in adolescence, these data indicate that a sizable

portion of teens with type 1 diabetes do well with their diabetes care. Research on the characteristics that promote diabetes management and control and strategies to maintain optimal trajectories is needed to support this subset of adolescents. Future research in this area may also have implications for intervening with the larger subset of teens with suboptimal trajectories.

Clinically relevant demographic, medical, psychological, and family characteristics predicted membership in each trajectory subgroup. Older youth age, longer diabetes duration, ethnic minority status, unmarried caregiver status, and insulin delivery via injections vs. CSII, increased the likelihood of belonging to an out-of-range diabetes management and control subgroup, consistent with previous research(5, 8, 27). Although demographic and medical factors may not be directly amenable to change through clinical intervention, they may signal that particular patients are at increased risk and factors that clinicians may wish to consider in treatment planning. For example, preventive efforts related to diabetes management may be beneficial soon after diagnosis or in early adolescence to reduce the risk of embarking on a risky outcome trajectory during the teen years. Consistent with evidence of clinical benefits associated with CSII(27), adolescents receiving insulin via insulin injections were 8.41 times more likely to belong to the “high risk” subgroup. Additionally, ethnic minority youth and those with unmarried caregivers were 4–6 times more likely to belong to either of the out-of-range subgroups, similar to other studies(8, 28–29). These demographic characteristics often co-occur, and associations with diabetes management and control may be due to various factors including limited access to resources(28–29). Further, individuals who identify as a minority often underestimate their risk for complications(28). Thus, health beliefs and expectations about diabetes management may be an important avenue for discussion in clinic, and extra steps to ensure equal access to resources and diabetes care are vital.

Potentially modifiable psychological and family predictors were also identified. General and diabetes-specific psychological distress was linked with membership in an out-of-range subgroup. The odds ratio of 1.07 for the CDI, a measure of depressive symptoms, means that a rise of one standard deviation (7 points) on the CDI would make an individual 1.61 times more likely to belong to the “normatively similar” subgroup (1.07^7). Similarly, an increase of one standard deviation (3 points) on the BGMC, a measure of BGM-related negative affect, increased the odds of “high risk” subgroup membership by 1.56 (1.16^3). These indices of distress have demonstrated links with poor glycemic control previously(16, 18, 30), and this study demonstrates that elevations in general or diabetes-specific distress may position patients to be approximately one and one-half times as likely to continue along a path of poor diabetes management and control. That diabetes-related distress predicted “high risk” subgroup membership may suggest that diabetes-specific distress is more salient than or amplifies the impairments associated with general distress(16). Similarly, diabetes-related distress may cause adolescents to avoid tasks that remind them of diabetes, which could translate into poorer management and contribute to the A1c discrepancy between the two out-of-range groups.

Mental health providers familiar with diabetes may be best equipped to conduct psychological screening and interventions in pediatric diabetes clinics. Therapeutic

approaches to address individuals' general and diabetes-related distress may include cognitive-behavioral or interpersonal therapy techniques to target symptoms of depression(31, 32), education related to blood glucose monitoring(33), or a combination thereof. Systematic research on interventions to reduce emotional distress related and unrelated to diabetes management is needed.

Family interventions are also indicated by this research. Consistent with previous research(15, 23), discord within the family predicted belonging to a subgroup with poorer diabetes management and control. An increase of one standard deviation (5 points) on the DFCS increased the odds of "normatively similar" subgroup membership by 2.10 (1.16^5) and "high risk" subgroup membership by 3.44 (1.28^5). As with individual distress, diabetes-specific distress on the family level appears to be highly related to suboptimal diabetes management and control. Arguments about diabetes management between family members may interfere with supportive parent involvement, encourage avoidance of conflict-provoking diabetes-related tasks, or contribute to individual diabetes-related distress(24–25).

These data suggest that family therapy that directly targets diabetes management may be most effective. Indeed, interventions to reduce diabetes-specific family conflict have demonstrated beneficial effects on reducing conflict and enhancing diabetes outcomes(34–35). Given evidence of associations among family discord, depression, and negative affect around BGM(23), targeting family conflict may also potentially reduce psychological symptoms. Family interventions that address both general and diabetes-specific distress may thus be an optimal approach to improving adolescents' diabetes management and control.

Stratifying patients based on risk factor profiles can guide allocation of appropriate levels of treatment based on need(36). Clinical research is needed to determine if variations in intervention timing, dose (e.g., duration, frequency), modality (e.g., individual, family), or content are indicated for each subgroup. For example, maintenance and prevention efforts at the time of quarterly diabetes clinic visits may be sufficient to support patients in the "meeting treatment targets" subgroup and prevent deterioration in BGM frequency. On the other hand, "normatively similar" subgroup members may benefit from monthly interventions and "high risk" subgroup members may need more frequent contact or intervention that includes multiple modalities or targets of treatment.

This study builds on previous longitudinal analyses in several ways. The exploration of latent subgroups empirically supports clinical observations of individual variability in diabetes management and control. As an expansion of previous studies evidencing subgroups with distinct patterns of either management behaviors or glycemic control(7, 10–11), this study identified subsets of the sample by referencing trajectories of both BGM frequency and A1c. This modeling approach allows us to consider how diabetes management and control occur together over time and recognizes the importance of changes in both behavioral and glycemic outcomes. In addition, our large sample had a broad range of A1c values, including a sizable proportion above the recommended range. This reflects the gamut of patients that compose clinic populations, particularly within the targeted late adolescent age range. Finally, we included general and diabetes-specific psychological and

family predictors of subgroup membership, which are potentially modifiable characteristics with direct implications for interventions within a diabetes clinic.

A methodological consideration is the assumption that individuals remain within a single subgroup across the observation period, consistent with trajectory modeling(25). However, "normatively similar" subgroup members may be vulnerable to slipping into a "high risk" trajectory, or interventions may help them transition to the "meeting treatment targets" trajectory. An alternative analytic approach is to allow movement between subgroups over time and to examine predictors of improvement, deterioration, or no movement between subgroups.

Characteristics of the study sample should also be considered. Because the participants were between the ages of 13 and 18 at baseline, their trajectories extend through late adolescence. Thus, these findings may not generalize to early adolescence, given that a marked deterioration in outcomes is often seen earlier, around the entry to adolescence(3, 6). Because A1c represents a 10–12 week average, it does not fully capture the contribution of extreme blood glucose levels (i.e., hyperglycemia, hypoglycemia) to overall control or the potential impact of fear of hypoglycemia on emotional variables and diabetes management(37). Finally, although ethnic minority status was a significant predictor of subgroup membership, because the sample largely represented Caucasian adolescents on private insurance from two-parent, educated families, generalizability to adolescents from more ethnically, geographically, and socio-economically diverse backgrounds may be limited. While these demographics mirror the landscape of youth with type 1 diabetes, our sample's range of educational backgrounds and family structures likely represent families with more access to support and care. It will be important to replicate these findings among teens in poorer control and those with fewer resources or less access to care.

For many, adolescence is a period of suboptimal diabetes management and control, putting teens at risk for short- and long-term complications as they prepare to transition to young adulthood. Yet others achieve and maintain diabetes outcomes that are in line with ADA recommendations despite the risks inherent to managing a chronic condition in adolescence. The results of the current study identified a number of demographic, medical, psychological and family factors that predict which trajectory of diabetes management and control individuals are likely to experience during this period. These findings lay the foundation for testing a tiered approach to prevention and intervention with teens at elevated risk for poor outcomes, with the ultimate goal of promoting optimal diabetes management and control for all adolescents with type 1 diabetes.

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Abbreviations

A1c	glycosylated hemoglobin A1c, glycemic control

ADA	American Diabetes Association
BGM	blood glucose monitoring
BGMC	Blood Glucose Monitoring Questionnaire
BIC	Bayesian Information Criterion
CDI	Children's Depression Inventory
CSII	continuous subcutaneous insulin infusion, the insulin pump
DFCS	Diabetes Family Conflict Scale
OR	Odds Ratio

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Implications and Contribution

Many adolescents with type 1 diabetes meet treatment goals, yet nearly two-thirds engage in suboptimal diabetes management and have out-of-range glycemic control. Depressive symptoms, diabetes-related distress, and family conflict raise some teens' risk for poorer diabetes management and control, and these issues may be important targets of intervention.

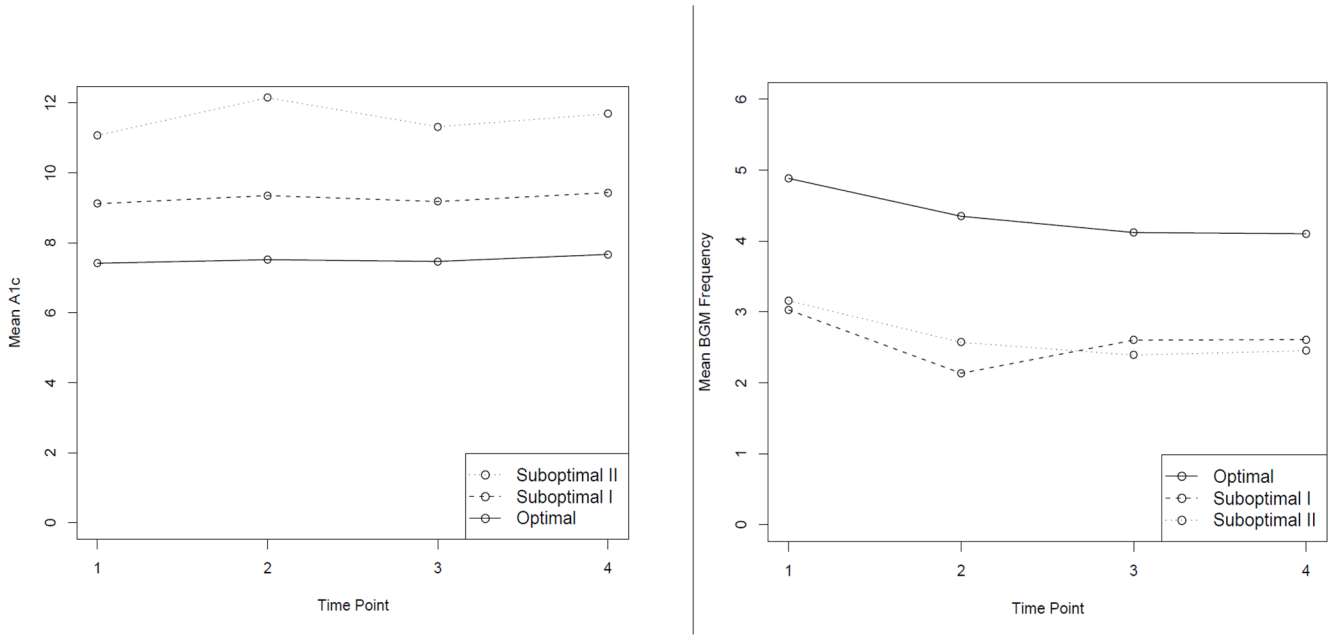

Figure 1.
Longitudinal plots of A1c and BGM frequency for three subgroups.

Table 1

Bayesian Information Criterion (BIC) values and predicted group proportions for group-based trajectory models solutions.

Number of Groups	BIC	Proportion of sample per group			
		Group 1	Group 2	Group 3	Group 4
2	4322.5	.44	.56		
3	4245.2	.40	.40	.20	
4	4210.3	.35	.06	.20	.39

Table 2

Diagnostics for group-based trajectory model

Group	Model estimate of group probability (95% CI)[a]	Proportion classified in group[b]	Average posterior probability[c]	Odds correct classification[d]
Meeting Treatment Targets	.40 (.30–.50)	.41	.95	28.5
Normatively Similar	.40 (.29–.51)	.40	.91	15.2
High Risk	.20 (.12–.33)	.19	.93	53.1

Note.

[a] Confidence intervals based on parametric bootstrap as stated in Nagin (2005, pp. 111–113).

[b] Proportion classified in group is based on the maximum posterior probability rule. The proportion classified in group values should be similar to the model estimates of group probabilities in the 2nd column of the table.

[c] Average Posterior Probability is obtained by averaging the posterior probabilities for a given group for all individuals placed in this group by the maximum posterior probability rule. Acceptable values for this criterion are .7 or greater for all groups (Nagin, 2005, p. 88).

[d] Acceptable values of the odds correct classification are 5.0 or greater for all groups (Nagin, 2005, p.89).

Table 3

Intercepts and slopes of A1c and BGM frequency by subgroup

	Meeting Treatment Targets	Normatively Similar	High Risk
A1c			
Intercept (SE)	7.41 (0.12)	9.15 (0.18)	11.24 (0.72)
Slope (SE)	0.07 (0.04)	0.07 (0.12)	0.12 (0.26)
Slope *p*	0.07	0.58	0.64
BGM Frequency			
Intercept (SE)	4.78 (0.26)	2.77 (0.21)	2.91 (0.32)
Slope (SE)	−0.27 (0.07)	−0.09 (0.09)	−0.20 (0.16)
Slope *p*	0.00*	0.32	.22

* $p < .05$

Table 4

Predictors of subgroup membership.

	Subgroup Membership			Odds Ratio	95% Confidence Interval
	MTT	NS	HR		
Demographic & Medical Predictors					
Age (years, M±SD)[b]	15.1±1.5	15.6±1.4	15.9±1.1	1.83	1.09–3.09
Diabetes duration (years, M±SD)[a]	5.1±3.6	7.0±3.7	6.1±4.5	1.16	1.02–1.32
Gender (% male)	44%	52%	52%	n.s.	
Insulin (% injections)[b]	23%	37%	66%	8.41	1.52–46.67
Minority status (% minority)[b]	8%	10%	34%	5.92	1.17–30.30
Insurance coverage (% public)	10%	13%	31%	n.s.	
Caregiver marital status (% unmarried)[a]	11%	32%	41%	4.29	1.23–15.01
Caregiver education (% ≤high school diploma)	48%	53%	66%	n.s.	
Psychological Predictors					
General emotional distress (CDI score, M±SD)[a]	6.2±6.0	9.3±7.8	8.9±7.2	1.07	1.01–1.15
Diabetes-related distress (BGM affect, M±SD)[b]	13.0±3.0	13.5±3.4	14.7±3.5	1.16	1.00–1.35
Family Predictor					
Diabetes-specific conflict (DFCS score, M±SD)[a,b]	23.7±3.7	26.5±4.8	29.3±7.4	1.16[a] 1.28[b]	1.06–1.27 1.14–1.43

Note. MTT = Meeting treatment targets. NS = Normatively Similar. HR = High Risk.

[a] significant (p<.05) difference between MTT and NS/HR subgroups,

[b] significant (p<.05) difference between MTT and NS/HR subgroups, n.s. = not significant.