Identification of Distinct Self-Management Styles of Adolescents With Type 1 Diabetes

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OBJECTIVE — Using a profile-based approach to the assessment of diabetes management, the purpose of this study was to identify and evaluate an empirically derived classification system of distinct self-management styles.

RESEARCH DESIGN AND METHODS — Youth with type 1 diabetes ($n = 156$) aged 10–16 years and their parents were administered a modified version of the Diabetes Self-Management Profile (DSMP). Cluster analyses were performed independently on parent and youth report forms to categorize patients based on their patterns of scores in five diabetes self-management areas.

RESULTS — Cluster analyses revealed three self-management styles that emerged from both youth and parent report: a "methodical style" (33%) with an emphasis on careful meal planning and correct insulin administration; an "adaptive style" (46%), characterized by high rates of blood glucose testing, exercise, and self-care adjustments; and an "inadequate style" (21%) with moderate rates of self-care adjustments and otherwise low DSMP scores. Convergence between parent and youth report classifications was moderate (Cohen's $\kappa = 0.47$, $P < 0.0001$). A1C was 1.6% higher in the inadequate style group than in both other groups ($P < 0.0001$), and the classification significantly accounted for differences in A1C above what was explained by an overall DSMP score.

CONCLUSIONS — The findings provide support for recognizing subgroups of patients with unique multidimensional patterns of self-care behaviors. The assessment of self-management styles may prove useful for customized treatments that are targeted directly to the patients' needs.

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Successful treatment of type 1 diabetes in adolescence rests heavily on the involvement of the young patients and their families. Evidence indicates that interventions that enhance adherence to the diabetes regimen improve adolescents' metabolic control (1,2). This in turn produces significant and long-lasting health benefits by reducing the risk of severe long-term complications and increasing life expectancy (3,4). Despite numerous technological advances, problems with adherence and metabolic control continue to be common and are exacerbated during the adolescent years (5–10). Thus, evaluating and improving diabetes self-management remains a critical issue in research and clinical practice.

Many authors have noted that self-management cannot be adequately defined as a static and unitary response to instructions given by health professionals. Instead it is multifaceted and involves sophisticated processes of day-to-day self-regulation (11–14). Optimal diabetes management requires a patient to maintain a delicate balancing act between insulin dose, food intake, and physical activity, guided by frequent blood glucose monitoring (14,15). Consistent with the notion of multidimensionality, adherence in different treatment areas has been found to be only weakly intercorrelated (11,12,16,17). Although parents and children might initially intend to follow the entire treatment protocol as recommended, eventually they may make certain concessions and adaptations to accommodate their lifestyle and priorities. That is, they may selectively direct more energy toward certain self-care behaviors and compensate for nonperformance of others (16,18). Different strategies may reflect effective problem solving or cause recurrent problems with maintaining diabetes care objectives (19–21).

Although most assessment methods to date address multiple self-care components (13,22), little is known about how these components integrate to form different strategies or styles patients adopt to manage their health condition. Contemporary research predominantly focuses on the management of distinct behaviors, thus taking a "variable-centered" approach. The consideration of discrete behaviors separately or in linear combination indicates their differential therapeutic impact; however, the integrated nature of patients' self-management endeavors may be missed (19,23). It is also common to incorporate self-management behaviors into global measures by summing up item or subscale scores to derive an overall index (13,24). This lumping together of heterogeneous criteria is likely suboptimal when each patient in fact displays a multidimensional pattern of behavior.

We might better understand the different strategies families develop to manage the diabetes regimen by taking a "patient-centered" approach that looks for common structural patterns within their reports of self-care behaviors. If our

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Abbreviations: ADAP, adaptive self-management style; BIC, Bayesian Information Criterion; DSMP, Diabetes Self-Management Profile; INAD, inadequate self-management style; METH, methodical self-management style.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

goal becomes to classify families based on characteristic profiles of behaviors, it may be possible to identify distinct types of management styles rather than reducing all behaviors to a single continuous variable. Early categorical classifications have made dichotomous distinctions between compliant and noncompliant types of patients, often based on arbitrary cutoffs. These dichotomies failed to appreciate the complexity of diabetes management, but instead served to confirm preestablished stereotypes about the pathology of noncompliance (12,15,23). Alternative individualized and integrative taxonomies of self-management are needed. Cluster analysis provides a useful approach to discriminating groups of patients based on their characteristic patterns of behaviors. Cluster analysis partitions participants with similar scores on a designated set of variables into mutually exclusive groups. No restrictions are imposed initially on the number of groups that are revealed, and the profiles may differ both in scale (i.e., generally high or low scores) and in shape (i.e., differential patterns of scores) (25).

The purpose of this study was to identify and evaluate an empirically derived classification of distinctive diabetes self-management configurations or styles, using cluster analysis on individual profiles of parent and youth scores in five areas of self-care. The resulting classifications were then examined for differences in youth characteristics and in glycemic control.

RESEARCH DESIGN AND METHODS

Study participants were youth with type 1 diabetes and their parents or caregivers who entered two studies: an observational study and a randomized clinical trial. The data reported here are from the baseline assessments. Youth-parent dyads were recruited from three urban pediatric clinics. Eligibility criteria included *1*) youth diagnosed for a minimum of 1 year with type 1 diabetes requiring insulin treatment and *2*) youth aged 10–16 years. Exclusion criteria were *1*) major chronic illness (except for well-controlled asthma or thyroid problems) and *2*) a youth or parent who could not speak or write English. Of 222 families who met the inclusion/exclusion criteria, 168 (76%) consented to participate and provided baseline assessments. For the purposes of the present study, only those families for whom full baseline data were available were included in the analyses. Twelve families were excluded because of incomplete data, resulting in a study sample of 156 youth and 156 parents.

The youth had an age of 13.6 ± 1.9 (mean ± SD) and 45% were boys (n = 70). The sample was 81% white (n = 126), which is representative of the clinic populations from which it was drawn. The average duration of diabetes was 7.0 ± 3.8 years. Approximately 61% were on flexible insulin regimens (46%, n = 71, used an insulin pump; and 15%, n = 24, were on basal-bolus injection regimens with Lantus); 39% of the sample (n = 61) used conventional multiple daily injections with a combination of short- and longer-acting insulin.

Procedures and measures

Institutional review board approval was obtained from each institution involved. Parents provided written informed consent, and youth provided written informed assent. The measures were completed in the home or other convenient location selected by the parent. Two trained interviewers independently administered the self-management interview to parent and child. Each participant (parent and youth) was compensated with $25 after completion of the assessment.

Self-management. Both parent and youth completed a modified version of the Diabetes Self-Management Profile (DSMP) (24,26), a structured interview. The DSMP has demonstrated sound psychometric characteristics and moderate correlations with glycemic control (26). In the modified version (24), interview administration and scoring are standardized to facilitate administration by nonmedical interviewers and to make the instrument more suitable for interviewing younger children separately from parents. The interview includes 29 items assessing the following five self-management areas:

- Insulin administration: Accuracy in timing and dosage of insulin administrations in the past 4 weeks (α = 0.70 for youth, 0.61 for parents).
- Meal planning: Precision and regularity of meal planning and food intake during the past weeks (α for flexible insulin regimens = 0.73 for youth, 0.79 for parents; α for conventional insulin regimens = 0.57 for youth, 0.60 for parents).
- Self-care adjustments: Adjustments to insulin or food intake made to correct for irregularities in self-care behavior and deviations from targeted blood glucose levels (α = 0.73 for youth, 0.75 for parents).
- Blood glucose testing: Number of daily blood glucose tests obtained during the past week (single item).
- Exercise: Frequency of physical activities during the past week (composite score).

An overall self-management score is obtained by averaging the five subscale scores (possible scores of 0.00–1.00).

Glycemic control. Results of the most recent test of glycosylated hemoglobin (A1C) obtained at the clinics within a range of 3 months before or after administration of the DSMP were retrieved from each youth's medical chart as an index of glycemic control. Because the three clinics involved used different methods and laboratories for these essays, the values of youth from each clinic were transformed into z scores relative to that clinic's distribution of A1C test results. The z scores were used for all statistical analyses concerning glycemic control. Demographic data were gathered during parent interviews.

Analysis plan

Profiles of diabetes self-management were identified via cluster analysis of the five self-management areas assessed with the modified DSMP. Independent cluster analyses were performed for youth and parent report data. The SPSS two-step cluster method was used, which first structures the cases by forming cluster centers and then applies the agglomerative hierarchical clustering method to the resulting configuration. Cluster distances were estimated using the log-likelihood function, such that cluster membership was assigned based on the maximum decrease in log likelihood. This approach allowed model comparison to determine the optimal number of clusters by means of the Bayesian Information Criterion (BIC), which estimates goodness of model fit based on a log-likelihood function (27). The model with the lowest value of BIC is the one to be preferred. Analyses of variance and χ^2 tests were used to evaluate differences between the clusters on youth characteristics and A1C.

RESULTS

Table 1 presents the means and SDs for the self-management subscales and their intercorrelations. Consistent with the multidimensionality of adherence, the subscale correlations were weak to moderate in magnitude.

Table 1—*Descriptive statistics and correlations of youth and parent report self-management scores*

Subscales	Youth report	Parent report	Zero-order correlations* 1	2	3	4	5
1) Insulin administration†	0.69 ± 0.22	0.75 ± 0.21	<u>0.48‡</u>	0.40‡	−0.04	−0.09	−0.33‡
2) Meal planning§	0.73 ± 0.12	0.70 ± 0.13	0.42‡	<u>0.54‡</u>	−0.01	0.21‖	0.01
3) Exercise	0.46 ± 0.24	0.47 ± 0.28	−0.06	0.07	<u>0.48‡</u>	0.17¶	0.05
4) Blood glucose testing	0.72 ± 0.21	0.74 ± 0.21	0.05	0.30‡	0.22‖	<u>0.69‡</u>	0.20¶
5) Self-care adjustments#	0.56 ± 0.24	0.61 ± 0.24	−0.12	0.15	0.22‖	0.27‡	<u>0.37‡</u>

Data are means ± SD or correlations. *Correlations between youth report scores are above the diagonal, and correlations between parent report scores are below the diagonal. Underlined correlations in the main diagonal express parent-child agreement on the subscales. ¶$P < 0.05$, ‖$P < 0.01$, ‡$P < 0.001$. †Compared with youth-report means, parent-report means are higher at $P < 0.001$. §Compared with youth-report means, parent-report means are lower at $P < 0.01$. #Compared with youth-report means, parent-report means are higher at $P < 0.05$.

Parent and youth scores were moderately correlated, ranging from $r = 0.37$ to $r = 0.69$ for the subscales and $r = 0.52$ for overall DSMP scores (all P values <0.0001). Paired-sample t tests indicated that parents reported higher scores on the subscales insulin administration ($P < 0.001$) and self-care adjustments ($P < 0.05$) but lower scores on the meal planning subscale ($P < 0.01$) than youth.

Child-report cluster solution

As suggested by the lowest BIC (552.41), the model fit was optimal when three clusters were retained. Figure 1*A* shows the profiles of subscale scores for the three-cluster solution. Cluster 1 ($n = 51$; 33%) was labeled "methodical self-management style" (METH). These youth reported high scores on the insulin administration and meal planning subscales, average rates of exercise and blood glucose testing, and few self-care adjustments. Cluster 2 ($n = 72$; 46%) was termed "adaptive self-management style" (ADAP), demonstrating the highest rates of exercise, blood glucose testing, and self-care adjustments but average to low scores on the insulin administration and meal planning subscales. Cluster 3 ($n = 33$; 21%) displayed an "inadequate self-management style" (INAD): these youth showed moderate rates of self-care adjustments and otherwise low scores. A multivariate ANOVA indicated that the three clusters accounted for 60% of the variance in the combination of subscale scores.

Parent-report cluster solution

For the separate cluster analysis on parent-reported diabetes management, a three-cluster solution also provided the best fit, as indicated by the lowest BIC (537.25). As illustrated in Fig. 1*B*, the profiles closely paralleled the youth reports. Sample sizes in each cluster were comparable to those obtained from the youth report: 57 (37%) youth were in the METH cluster, 64 (41%) in the ADAP cluster, and 35 (22%) in the INAD cluster. Agreement between parent and youth report classifications was moderate, with a κ reliability coefficient of 0.47 ($P < 0.0001$). This agreement was evident both in younger youth (age 10–12 years, $n = 63$) and in older youth (age 13–16 years, $n = 93$), with κ values of 0.44 and 0.46, respectively.

Cluster differences on background variables

Table 2 summarizes youth characteristics in each cluster and in the total sample. Youth-report clusters differed significantly on age [$F(2,153) = 8.13$, $P < 0.001$]: the INAD group was older than the groups with METH ($P < 0.001$) and ADAP ($P < 0.01$) profiles. The clusters also differed significantly in duration of diabetes [$F(2,153) = 4.06$, $P < 0.05$]: disease duration was significantly shorter in the METH group than in the INAD ($P < 0.01$) and ADAP ($P = 0.05$) groups. Boys and girls were equally distributed across the groups [$\chi^2(2) = 1.99$, $P > 0.30$]. However, cluster assignments differed significantly across insulin regimens [$\chi^2(2) = 20.72$, $P < 0.001$]. Compared with the distribution of conventional injection versus flexible regimens in the total sample, the proportion of conventional injection users was 22% higher in the METH group, 18% lower in the ADAP group, and 7% higher in the INAD group, respectively. Corresponding group differences were found between the parent-report clusters (Table 2).

Cluster differences on A1C

Criterion validity was evaluated by comparing the clusters on glycemic control (Table 2). A1C in the METH and ADAP groups was virtually identical at 8.0%, but it was substantially higher at 9.6% in the INAD group. The cluster assignments accounted for 13% of the variance in A1C [$F(2,153) = 11.37$, $P < 0.0001$]. To evaluate whether the classification had unique ability to explain A1C above the usual summary score of overall self-management, an ANCOVA was performed with the overall DSMP score as

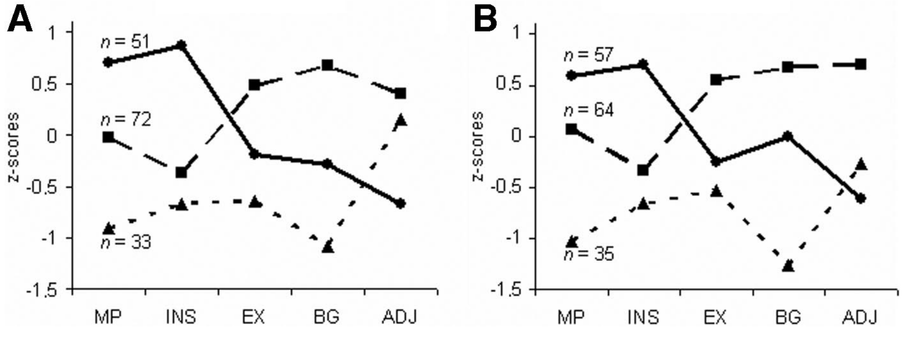

Figure 1—*Profiles of self-management scores by cluster based on youth report* (A) *and parent report* (B). ●, *METH;* ■, *ADAP;* ▲, *INAD. ADJ, self-care adjustments; BG, blood glucose testing; EX, exercise; INS, insulin administration; MP, meal planning.*

Table 2—*Youth characteristics across self-management styles and in the total sample*

	Interview	Diabetes self-management styles: Methodical	Adaptive	Inadequate	Total sample
Age (years)					
	Child*	13.1 ± 1.9	13.4 ± 1.9	14.7 ± 1.5	13.6 ± 1.9
	Parent†	13.2 ± 1.9	13.5 ± 1.9	14.4 ± 1.7	
Duration of diabetes (years)					
	Child†	5.9 ± 4.1	7.2 ± 3.4	8.2 ± 3.8	7.0 ± 3.8
	Parent‡	5.7 ± 4.0	7.8 ± 3.4	7.5 ± 3.8	
Male sex					
	Child	26 (51)	28 (39)	16 (49)	70 (45)
	Parent	22 (39)	30 (47)	18 (51)	
Conventional injection regimen					
	Child*	31 (61)	15 (21)	15 (46)	61 (39)
	Parent*	35 (61)	9 (14)	17 (49)	
A1C					
	Child*	8.0 ± 1.5	8.0 ± 1.4	9.6 ± 2.4	8.4 ± 1.8
	Parent*	8.0 ± 1.6	7.9 ± 1.2	9.6 ± 2.4	

Data are means ± SD or *n* (%). *$P < 0.001$, †$P < 0.05$, ‡$P < 0.01$, for cluster differences based on ANOVA (age, duration of diabetes, A1C) and χ^2 test (sex, race/ethnicity, insulin regimen).

covariate. The cluster assignments and the overall DSMP score shared 44% of the variance. Nevertheless, the clusters significantly accounted for incremental variance in A1C [$F(2,152) = 3.15$, $P < 0.05$] beyond the contribution of the overall score [$F(1,152) = 3.93$, $P < 0.05$].

Additional analyses explored whether the cluster differences on A1C were moderated by demographic factors: disease duration significantly moderated the relationship between parent-report clusters and A1C [$F(2,150) = 3.60$, $P < 0.05$]. In the METH ($P < 0.01$) and INAD ($P < 0.05$) groups, longer disease duration was associated with poorer A1C; however, in the ADAP group, disease duration did not affect A1C ($P > 0.80$). When disease duration was above 7 years, A1C of the ADAP style was superior to both the METH ($P < 0.05$) and INAD ($P < 0.001$) style.

CONCLUSIONS— The present analyses demonstrated the utility of a multicomponent assessment of diabetes management for the development of an empirically derived and conceptually meaningful classification of self-management styles. The three profiles that emerged independently from youth and parent reports were largely equivalent despite some variation in cluster assignments, suggesting that the obtained taxonomy is robust and not an artifact of biased responding.

The evidence of an inadequate self-management profile in several respects converged with prior research using different methodological approaches. The INAD group comprised ~21 and 22% of the sample in the youth and parent report, a prevalence largely consistent with previous reports. Kovacs et al. (6), for example, reported a rate of 29.5% pervasive noncompliance in patients aged 8–21 years. The INAD profile was more prevalent in older youth, which corresponds with previous evidence indicating that difficulties with treatment adherence increase in adolescence (5–7,10). Supporting the criterion validity of the classification, mean A1C in the INAD group was 1.6% above the levels in both other groups—a statistically and clinically significant difference.

Strikingly, the classification was sensitive to differences in A1C that were not detected by the traditional measure of overall self-management—a one-dimensional score comprised of the sum of subscales. Dimensional measures assume continuous and usually linear associations between adherence or self-management and glycemic control, but these are not necessarily optimal representations of the underlying influences (17,26). Hence, the categorical styles may have accounted for additional nonlinear or discontinuous effects. Moreover, a global score dimension does not account for differential patterns of behaviors. Recall that the INAD style did not show consistently low scores, but rather moderate rates of adjustments were paired with irregular insulin and food intake and few blood glucose tests. This pattern of uncontrolled adjustments is clearly most problematic for effective problem solving and blood glucose regulation (7,21). Thus, it appears that this classification system provides additional relevant information beyond an overall self-management score by taking the interplay of behaviors into account.

The cluster solution did not reveal a group of patients with optimal adherence in a traditional sense, that is, with consistently high scores in all areas. Instead, two groups were evident with high scores on individual subscales but contrasting patterns of self-care behaviors. The METH cluster reported management of diabetes with a focus on precise and consistent routine in insulin administration and diet and with few regimen adjustments. This very structured strategy was more prevalent in youth with relatively short disease duration and conventional insulin regimens. Evidently, the restrictions imposed by conventional regimens are conducive for families to adopt a METH style; yet this association may also be an expression of families' and health care providers' inclination to choose insulin regimens that best fit the child's needs, preferences, or personal style. In contrast, the group with the ADAP profile reported a very active and vigilant approach to diabetes management. In this group, frequent regimen adjustments were coupled with frequent blood glucose testing, on average five or more times per day, allowing for meticulous correction of blood glucose (7,9). With the highest exercise frequency, the ADAP style may also be associated with a generally more active lifestyle. It is noteworthy that a recent factor analysis found two relatively distinct factors underlying a subset of DSMP items (28). The factors "Food and Insulin Schedule Adherence" and "Adherence to Blood Sugar Testing and Adjustments" emphasize self-management skills similar to those characterizing the METH and ADAP profiles, which further corroborate the distinction between these two styles.

Youth in the METH and ADAP clusters had generally equivalent A1C, suggesting two distinct pathways to good glycemic control. However, the ADAP style was most successful in youth with longer illness duration. This style entails autonomous decision-making accompanied by proficient daily regimen adjustments, which may require a considerable amount of familiarity with managing the disease in order to be most effective. With growing expertise, adopting an ADAP style may assist families to maintain optimal blood glucose control while dealing with the realities of living with a demanding illness for a lifetime. By contrast, the METH style would appear to mirror orthodox practices of self-management based on the attempt to follow consistent and reliable directions. Thus, the METH style may be most appropriate in response to recent diagnosis but may be difficult for many families to sustain and successfully implement indefinitely.

Several limitations of the present research should be noted. In view of the paucity of research available for direct comparison, the profiles identified are clearly tentative and need to be replicated. Cluster analysis is an empirically driven approach to category development, and the results are contingent upon measure and sample characteristics. Furthermore, the study provided limited insight into adaptive correlates of the profiles and the conditions under which a given style is most beneficial or most problematic. Future studies should use larger and more diverse samples to determine whether the profiles replicate across different ages, medical settings, and cultural backgrounds. Longitudinal (cohort) studies are necessary to determine the stability of these profiles over time. This is imperative, especially in view of the suboptimal internal consistencies of some of the subscales constituting the profiles in this study. To evaluate the utility of the classification, it will be important to determine its linkages with physiological, psychosocial, and developmental influences that play an integral role in diabetes management (1,12,29).

Pending further research, the present study has set the stage for an assessment strategy of self-management that recognizes subgroups of patients based on unique multidimensional patterns of behavior. It challenges the traditional assumption that the same kinds and levels of self-management behavior are uniformly most optimal and provides a framework for the development of customized treatments for specific kinds of patients. Systematic assessment of the identified profiles could assist clinicians to provide treatment regimens and opportunities for families to implement the specific approach to diabetes management that best fits with their lifestyle and expertise and to target significant intervention to patients with inadequate patterns of self-management. Ultimately, this may improve treatment efficacy by facilitating innovative interventions that are directly tailored to the needs of adolescents and their families (1,2,23).

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