FAMILY FUNCTIONING AND DIABETIC KETOACIDOSIS IN PEDIATRIC PATIENTS WITH TYPE I DIABETES

By

KELLY N. WALKER

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This document is dedicated to my parents, Arnold and Cheryl Walker.

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Kelly N. Walker

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Type I diabetes is a chronic condition caused by an inability of the body's cells to use sugar from foods for energy. Treatment involves daily insulin injections, a complicated regimen of blood glucose monitoring, dietary guidelines, and specific exercise recommendations. In some individuals, diabetic ketoacidosis (DKA), a life threatening complication of diabetes, can occur. The condition is typically caused by a shortage of insulin and chronic noncompliance to treatment. DKA may occur in any patient with diabetes, but patients with poor control are at a greater risk due to their non-compliant behaviors. Given the relationship between family functioning and adherence previously found in the literature, the purpose of this study is to determine if specific family functioning variables are related to episodes of DKA in pediatric patients with Type I diabetes. Specifically, it was predicted that (1) higher parental warmth will be associated with lower occurrence of DKA, (2) higher parental negativity will be associated with higher occurrence of DKA, and (3) lack of responsibility for diabetes-

related tasks will be associated with higher occurrence of DKA. Participants included 100 children with Type I diabetes and their caregivers recruited from Shands Hospital and clinics at the University of Florida. Participants completed disease-specific measures of family functioning to assess variables including parental warmth, parent and child perceptions of negativity, and family responsibility for the diabetes regimen. Glycosylated hemoglobin indexes and incidence of DKA were obtained by chart review. Family variables were analyzed to create a model to predict the presence or absence of DKA in children with Type I diabetes. This model was significant ($\chi 2$ (3, N = 100) = 26.137, $p < .001$) and diabetes specific family variables accounted for almost 44% of the variance. The data suggest that increased child perception of warmth and caring was associated with decreased odds of experiencing a DKA episode. The data also suggest increased parental negativity was associated with increased odds of experiencing a DKA episode. The hypothesis regarding family responsibility was not supported. The findings suggest that family factors play a significant role in the occurrence or absence of DKA in children's long-term management of their diabetes.

CHAPTER 1
INTRODUCTION

General Diabetes Overview

Diabetes is a chronic condition caused by an inability of the body's cells to metabolize carbohydrates from foods for energy. Type I, or insulin-dependent diabetes (IDD), results from a pancreatic failure to produce insulin, which is required for glucose to enter cells. Type II diabetes, or non-insulin-dependent diabetes (NIDD), occurs when the body still produces insulin, but the glucose cannot be effectively utilized. The focus of this study will involve Type I patients, who are most commonly diagnosed in childhood. In contrast, Type II patients are most commonly diagnosed in adulthood, although the number of Type II patients is rising in childhood and adolescence. Type I patients require exogenous insulin, typically delivered through daily injections. Genetic factors may play a role in the etiology of Type I, but the exact cause is unknown. Even with modern medical advances, life expectancy for the Type I patient is approximately 75% of normal, with disease related complications, such as retinopathy, nephropathy, and cardiovascular problems developing later in life (U.S. Health and Human Services, 1985). In 1985, it was estimated that approximately 1 in 600 children held a diagnosis of Type I diabetes (LaPorte et al., 1985), making it a serious and common chronic childhood illness. Currently, diabetes affects 6% of the U.S. population, or approximately 17 million individuals (Centers for Disease Control, 2002).

Diabetic Ketocidosis (DKA)

In children, the most severe problem of diabetes is diabetic ketoacidosis (DKA). DKA is a life threatening event for Type I diabetes. In 1985, the mortality for DKA was between one and eight percent (Mazze, Sinnock, Deeb, & Brimberry, 1985). Current mortality rates for DKA lie between 2.3-9.2% in the United Kingdom (Edge, Ford-Adams, & Dunger, 1999). The incidence rates of DKA in the United States is currently 3-8 per 1000 people with Type I diabetes per year (U.S. Health and Human Services, 1985). This condition is typically caused by a shortage of insulin or a dysfunction in insulin activity. The insufficient amount of insulin in the bloodstream forces the body to break down muscles and fats for energy, resulting in toxic levels of ketones in the bloodstream (Travis, 1985). DKA symptoms may include hyperglycemia, metabolic acidosis, vomiting, dehydration, and difficulty breathing. Treatment for DKA typically involves hospitalization to return the patient to normal functioning.

Despite the severity of DKA, research examining the event is limited in the empirical literature. In a study of the relationship between adherence and DKA conducted by Morris et al. (1997), participants included 89 patients with diabetes under the age of 30, with a mean age of 16 years, and mean HbA1c approximately of 8.4%. Physician prescriptions and pharmacy records were combined to create an index score to assess adherence. Analyses with adherence index scores, average HbA1c scores, and DKA episodes were significantly related. DKA episodes were significantly related to lower adherence indexes. However, adherence is not the only factor found to be associated with DKA (Liss et al., 1998; Travis, 1985).

Although patients with poor control are at a greater risk due to their noncompliant behaviors (Travis, 1985), stress and family support have also found to be correlated with

incidence of DKA in the empirical literature (Aikens, Wallander, Bell, & Cole, 1992). Stress may also play a role in a patient experiencing a DKA episode, as stress may disrupt behavioral functioning with the diabetes regimen and several stress hormones have counter regulatory effects on insulin. Other factors correlated with DKA are psychiatric illness and family support, as indicated by Liss et al. (1998) with a sample of 25 children with DKA hospitalizations and 25 matched outpatient controls with no history of DKA hospitalizations. Participants who had experienced DKA episodes had significantly higher psychiatric illness diagnoses, less diabetes-specific family support, lower self-esteem, and social competence.

Common Treatments for Type I Diabetes

Optimal treatment for Type I diabetes involves a complicated regimen of self-care tasks, a complex set of contingency based behaviors, and recommendations encompassing all aspects of the patient's life. Further complicating treatment, these recommendations vary widely across individuals (McNabb, 1997). Additionally, as much as 98% of diabetes care is self-care by the patient (Anderson, 1995). Treatment of diabetes aims to lower blood glucose levels to values as close to normal metabolic functioning as possible. High blood glucose levels are associated with an increased risk of diabetic ketoacidosis, vision problems, polyuria, polydipsia, fatigue, decreased weight loss, vaginitis, balanitis, retinopathy, nephropathy, neuropathy, and poorer atherogenic lipid profile. Better metabolic control is accomplished by an intensive treatment regimen involving frequent self-monitoring of blood glucose, appropriate nutritional intake, regular exercise, individualized insulin injections, prevention and treatment of hypoglycemia and other acute chronic complications, and a periodic assessment of treatment goals. With regard to children, additional considerations must be taken

including setting developmentally appropriate goals for self-management, proper diabetes education, “sick-day” management rules for diabetes-related and other illnesses, caution in overaggressive dietary manipulation, and assessment of lifestyle needs (American Diabetes Association, 2001).

The Diabetes Control and Complications Trial (1986; 1993; 1994) demonstrated the benefits of an intensive regimen involving three or more insulin injections or insulin pump treatments as compared to the previous conventional therapy involving only 1-2 injections per day. This multi-site study involving 1441 patients aged 13-39 years with Type I diabetes compared intensive therapy to conventional therapy. The results of the study found adherence to self-care was essential to prevent diabetes-related complications. Specifically, intensive therapy reduced the adjusted mean risk of retinopathy by 76% and slowed its progression in pre-existing cases by 54%. Intensive therapy also reduced the mean occurrence of microalbuminuria by 39%, reduced the risk of albuminuria by 54%, and the risk of clinical neuropathy by 60%. The only adverse event associated with intensive therapy was a two-to-threefold increase in severe hypoglycemia. Additionally, those in intensive therapy group reduced their glycosylated hemoglobin, a common measure of metabolic control in individuals with diabetes (Diabetes Control and Complications Trial, 1993). However, although the results of this study are generalizable to adolescents and children, more research is needed with these populations.

Adherence in Type I Diabetes

Adherence has been previously defined as the “extent to which a person’s behavior (in terms of medications, following diets, or executing lifestyle changes) coincides with medical or health advice” (Haynes, 1979, p. 2-3). These behavioral changes and

modifications are necessary to follow medical and health advice but often present as a difficult task for many patients with chronic illnesses. In children with chronic illnesses, three main categories have been linked to nonadherence including: regimen characteristics, disease characteristics, and patient/family variables (LaGreca & Schuman, 1995; Rapoff & Bernard, 1991). These factors are of importance because each year nonadherence leads to higher health care costs and medical complications (Rapoff & Bernard, 1991). Specific to diabetes, these complications could include recurrent ketoacidosis and increased symptoms such as hyperglycemia and poorer metabolic control (Quittner, Espelage, Ievers-Landis, & Drotar, 2000). Adolescents with poor metabolic control are at greater risk for more frequent hospitalizations (due to ketosis and hypoglycemia) and long-term complications such as retinopathy and renal failure (Cahill, Etzwiler, & Freinkel, 1976). However, even given these consequences, nonadherence remains a significant problem for pediatric patients with diabetes (Kovacs, Goldston, Obrosky, & Iyengar, 1992). Adherence rates in one study by Cerkoney and Hart (1980) found that only 2 individuals out of a sample of 30 individuals with diabetes were fully adherent with all aspects of the treatment regimen. Specifically in this study, the frequency of adherence to monitoring recommendations was at 57% and adherence to frequency and accuracy of insulin injections reached a high of only 80% adherent (Cerkoney & Hart, 1980). Other studies have found diverse rates of adherence as well. Other studies cite dietary recommendation adherence at an average of 65% (Glasgow, McCaul, & Shafer, 1987), and variation in adherence to an exercise program from 19% (Kratvitz et al., 1993) to 30% (Kamiya et al., 1995).

A study by Morris and his colleagues (1997) noted the associations between treatment adherence and health outcome in 89 patients under 30-years-old. This study monitored the amount of insulin dispensed by the participating patient's pharmacy, the patient's gylcemic control through the HbA1c index, and patient hospitalizations. The researchers found a failure to take insulin in at least 28% of the patients. Additionally, failure to take insulin was associated with poorer glycemic control, acute hospital admission for DKA, and other acute problems related to diabetes. Interestingly, the lowest adherence rating was found in children 10-20 years old (Morris et al., 1997). This age-related finding is consistent with other studies, which have concluded children's adherence deteriorates as disease duration increases into adolescence (Kovacs et al., 1992; LaGreca, Auslander, Greco, & Spetter, 1995). Specifically, older children have been found in the empirical literature to be less adherent and to demonstrate worse metabolic control than younger children (Johnson et al., 1992). This finding was replicated by Johnson (1995), and by Kovacs et al. (1992) who found that adolescents have poorer metabolic control and levels of self-care than children and adults. The researchers suggested this was due to the adolescents' less-structured lifestyle and developmental phase characterized by a pattern of resistance to rules and authority, and peer pressure for conformity (Johnson, 1995; Kovacs et al., 1992).

Further examination of the impact of nonadherence on a range of diabetes related problems in children and adolescents with diabetes was demonstrated in one study of residential treatment for diabetes where patients' treatment regimens were monitored to ensure full adherence to their treatment regimen (Geffken et al., 1997). In this study, the individuals participating in residential treatment had a significant reduction in diabetes-

related hospitalizations, improved school attendance, decreased glycosylated hemoglobin levels, increased weight gain, individualized insulin changes, improved knowledge about diabetes, and a normalization of familial attitudes toward the disease. However, when participants entered a follow-up phase of treatment where patients returned home, increases in glycosylated hemoglobin levels occurred. Researchers suggested that this increase may have been due to a decrease in treatment adherence, given the positive disease management found when the residential treatment center staff controlled patients' treatment regimens. Researchers also suggested that the decreases in adherence might have been related to aspects of the family unit. Given the multitude of adherence complications consistently found in children, examination of the family context in which children with diabetes reside is imperative.

Family Functioning and the Pediatric Patient with Type I Diabetes

With regard to diabetes and treatment adherence, family members and parents have been found to be the primary sources of support for adolescents with diabetes (LaGreca et al., 1995; Lewin et al., 2004). Greater family support has been found in the literature to be correlated with decreased age and shorter disease duration of children's diabetes and linked with better treatment adherence (LaGreca et al., 1995). Additional studies have strengthened the relationship found between family functioning and treatment adherence. Parents who provide more diabetes-specific support have adolescents with better treatment-regimen adherence than parents who were less supportive of diabetes care activities (Hanson, Henggeler, & Burghen, 1987). A study of parents of 34 adolescents with diabetes using the Camberwell Family Interview found that poor glycemic control was not associated with parental apathy, criticism of the child, or marital discord, but that greater supportive emotional involvement by parents was associated with better glycemic

control (Stevenson, Senskey, & Petty, 1991). Another study explored family correlated variables using the Diabetes Family Behavior Scale (DFBS), a diabetes-specific instrument, sampling 321 children and adolescents aged 7-18 years. The researchers found an association between the DFBS total score (indicating overall family support), guidance-control, and HbA1c (McKelvey et al., 1993). With regard to health outcome, well-controlled patients have described their mothers as highly supportive at disease onset and less supportive over time, but a different pattern emerged for patients in poor control (Steinhausen, 1982).

Parents who are less involved and supportive have children who are less adherent with their treatment regimen, make more mistakes in self-care, and have poorer metabolic control than children whose parents are involved in a developmentally appropriate style (Weissberg-Benchell et al., 1995; Wysocki et al., 1996). A study assessing parental involvement using diabetes-specific measures included 104 youth (8-17 years, 69 aged 8-12 years, 35 aged 13-17 years) who completed the Diabetes Conflict Scale and Diabetes Family Responsibility Questionnaire (DFRQ). Fifty-three percent of patients showed moderate parental involvement in blood glucose monitoring tasks, and 40% showed moderate parental involvement for insulin treatment. The study found that parental involvement was a significant predictor of adherence to blood glucose monitoring, and child conflict scores, parent conflict scores, and self-report of blood glucose monitoring frequency predicted glycemic control. Additionally, parents of older patients were significantly less involved than parents of younger patients. (Anderson et al., 2002).

However, support and involvement are not the only family variables related to health outcome in pediatric patients with Type I diabetes. Negative patterns of interaction

such as, parental hostility, negative parental interactions, and lack of responsibility for the treatment regimen are also associated with adherence and health outcome (Schafer, Glasgow, McCaul, & Dreher, 1983; Worrall-Davies, Owens, Holland, & Haigh, 2002). In a study by Worrall-Davies et al. (2002), parental hostility was correlated with glycemic control, not over-involvement or criticism in a study of 45 children and their caregivers. Specifically, parental hostility, as assessed through an interview measure using an adapted form of the Camberwell Family Interview, was associated with elevated levels of glycosylated hemoglobin. Parental hostility accounted for 22% to 29% of the variation in glycosylated hemoglobin 12 months before and 12 months after hostility was assessed.

A study examining negative family interactions with diabetes specific instruments involved 34 adolescents 12-14 years old and assessed four aspects of regimen adherence (insulin injections, dietary patterns, glucose testing, and exercise), psychosocial variables measured by the Barriers to Adherence and Problem Solving Scale and the Diabetes Family Behavior Checklist (DFBC), and metabolic control. Although psychosocial measures were not directly related to metabolic control, they were associated with adherence. Negative family interactions, as measured on the DFBC, predicted the number of blood glucose tests conducted. The Barriers to Adherence scale predicted diet and measurement of insulin doses with higher barrier ratings indicating that the children were less likely to follow their diabetic diet and to take care in measuring insulin doses. However, no significant relationship was found between metabolic control and general family functioning (Schafer et al., 1983). Studies using diabetes-specific instruments have also contributed to the association between family functioning and adherence to treatment. A study of 54 adults and 18 unrelated adolescents with Type I diabetes given

Diabetes Family Behavior Checklist (DFBC) and adherence measures found differences in reporting between adolescents and adults. Adolescents reported more negative interactions with their families. In turn, adolescents reporting negative interactions were in poorer control. In adults, negative DFBC scores predicted poorer adherence at a 6-month follow-up interval and was marginally associated with HbA1c levels (Schafer, McCaul, & Glasgow, 1986).

A study by Anderson, Auslander, Jung, Miller, and Santiago (1990) examined lack of responsibility for the child's treatment regimen. The study included 121 children 6-21 years old and their mothers using the Diabetes Family Responsibility Questionnaire (DFRQ). The findings with the DFRQ found that child age, disease duration, and the gender of the patient predicted mother and child patterns of sharing diabetes responsibilities. Additionally, disagreements between the mother and child in perception of who is assuming responsibility and adherence level predicted HbA1c levels. Higher levels of mother-child scores indicating, "no one takes responsibility" and lower adherence contributed to poorer metabolic control. Age was also related to "no one takes responsibility" with higher disagreement between mothers and younger children. These findings with age were also significantly associated with level of overall adherence, where lower adherence was found in older children, and age correlated with metabolic control with older children in poorer control than younger children (Anderson et al., 1990). Children assume increasing responsibility with increasing age and it has been suggested that the parental shift of responsibility for diabetes care to the child usually occurs around 12 years of age (La Greca et al., 1995).

Family Functioning and DKA

Few studies have explored the relations between family functioning, adherence, and health outcome assessed by incidence of DKA in children and adolescents with type I diabetes. Davis et al. (2001) examined the associations between psychosocial characteristics, adherence, and health outcome in 55 parents of children aged 4-10 years with type I diabetes and no other major diagnoses. Four of the children had experienced a DKA episode within past year, excluding a diagnosis-related DKA. The study used the Parenting Dimensions Inventory to assess 8 parenting dimensions and the Self-Care Inventory (Hanson et al., 1996) to assess adherence. Parental warmth was associated with better adherence ratings and explained 27% of the variance in adherence ratings. Demographic variables, SES, parental control and restrictiveness, and physical punishment did not predict adherence. Parental restrictiveness was, however, associated with worse glycemic control. Only African American ethnicity and low SES were associated with more parental restrictiveness and worse glycemic control (Davis et al., 2001).

Other previously established factors correlated with DKA are psychiatric illness and family support. Liss and her colleagues (1998) studied 25 children with DKA hospitalizations and 25 matched outpatient controls without a history of DKA hospitalizations. Psychiatric illness in participants was assessed using the Diagnostic Interview Schedule for Children (DISC) and diabetes-related family functioning was assessed using the Diabetes Family Behavior Scale (DFBS). Participants who had experienced DKA episodes had significantly more psychiatric illness diagnoses, less diabetes-specific family support, lower self-esteem, and lower social competence. These participants' families were lower on problem solving and diabetes-specific parental

"warmth caring" (Liss et al., 1998). Currently, this is the only study to examine such family functioning variables with diabetes specific measures and DKA occurrence.

Purpose and Hypotheses of this Study

Empirical literature has established the importance of family functioning and its effect on adherence and health outcome in pediatric patients with Type I diabetes. However, the literature supporting family functioning variables and occurrence of DKA in this population is less examined and recognized. This study will strengthen those relationships by examining specific family functioning variables previously established as relevant in the literature to the health outcome event of diabetic ketoacidosis (DKA) in pediatric patients. Based on the previously presented literature, it is expected:

1. Higher parental warmth will be associated with a lower occurrence of DKA episodes,
2. Higher parental negativity will be associated with an higher occurrence of DKA episodes, and
3. Lack of responsibility for diabetes-related tasks will be associated with an higher occurrence of DKA episodes.

CHAPTER 2
METHOD

Participants

Participants were 100 children with Type I diabetes (45 male, 55 female) recruited from the inpatient program and outpatient diabetes clinic in Shands Hospital at the University of Florida. Eighty-nine participants were from the outpatient clinic seen during routine clinical physician appointments. Eleven participants were from the diabetes inpatient unit. These subjects were placed in the inpatient unit following physician recommendation due to poor metabolic control. Subjects were not recruited if they (a) were diagnosed with Type I diabetes for less than one year, (b) were currently using an insulin pump, or (c) were diagnosed with a pervasive developmental disorder. Participants ranged in age from 7 to 18 years with a mean age of 13.2 years ($SD = 2.47$). Thirty-four subjects (11 male, 23 female) had a history of presence of DKA according to a review of medical records. Of these subjects, 65% were Caucasian, 23% were African American, 8% were Hispanic, and 3% were members of another ethnic group. Sixty-six subjects (34 male, 32 female) did not have a history of DKA according to a review of medical records. Of patients not having a history of DKA, 81% were Caucasian, 7% were African American, 5% were Hispanic, and 6% were members of another ethnic group. Between group analyses indicate the two groups differed significantly on HbA1C indexes ($t = -4.93$, $p < .001$). No other between group differences was found on demographic variables. Means and standard deviations for demographic variables are presented in Table 1.

Table 1 Means and Standard Deviations for Demographic Information for Participants Experiencing and Not Experiencing DKA

Variable	DKA Sample *n* = 34 mean (*SD*)	Non-DKA Sample *n* = 66 mean (*SD*)
Age	13.79 (2.01)	12.95 (2.65)
HbA1c	10.25 (2.02)	8.35 (1.37)
Duration of Diabetes	6.52 (3.81)	5.05 (3.25)

Procedure

Outpatient participants were recruited while waiting for their routine clinical appointment. After consent was obtained, pediatric patients and their caregiver completed demographic and diabetes-specific questionnaires. Inpatient participants and their caregivers were administered the questionnaires at the time of their admission to the inpatient program. Presence or absence of DKA was then obtained from a review of the participants' medical records for both groups. It was necessary to code DKA as a dichotomous variable as medical records were non-specific and frequently described "multiple" episodes of DKA rather than a specific number. DKA episodes experienced at the time of diagnosis of Type I diabetes were not considered as these episodes occurred before the patient and family were educated about the treatment regimen and disease.

Measures

Diabetes Family Behavior Scale (DFBS)

The DFBS is a child-completed measure designed to assess diabetes-specific family support. Originally a 60-item scale, the measure has been revised by to include 47 items. The measure includes a guidance-control subscale (24 items) and warmth-caring subscale (23 items). Children rate how often certain supportive or non-supportive

behaviors occur on a 5-point scale of (1) all the time, (2) most of the time, (3) sometimes, (4) hardly ever, to (5) never. Scores range from 47 to 235, with lower scores indicating more diabetes-specific family support behaviors. For the purposes of the current study, only the warmth-caring subscale was used. The warmth-caring subscale has an internal consistency of .79.

Diabetes Family Behavior Checklist (DFBC)

The DFBC was designed to assess supportive and non-supportive family behaviors that have been shown to relate to diabetes self-care completed by children with diabetes and their caregivers. The scale consists of 16 questions divided into 9 supportive behavior questions and 7 non-supportive behavior questions. Items are rated on a 5-point scale of (1) never, (2) twice a month, (3) once a week, (4) several times a week, to (5) at least once a day. Scores are calculated to create a positive summary score range from 9 to 45, and a negative summary scores range from 7 to 35. For the purposes of this study, only the parental negativity scale was used. This scale has an internal consistency of .60 (Schafer et al., 1986) and test-retest value of .77 for negative scores (LaGreca et al., 1995). Schafer and her colleagues (1986) found a correlation between negative DFBC scores and adherence to glucose testing, diet, and insulin injections.

Diabetes Family Responsibility Questionnaire (DFRC)

The Diabetes Family Responsibility Questionnaire (DFRC) is a scale designed to assess the perception of family members' responsibility for diabetes-related behaviors. The scale includes 17 diabetes and general health related circumstances divided into three subscales, General Health and Regimen tasks, General Health and Social Presentations, and Regimen Tasks and Social Presentations. For each item, the rater indicates if the task is the responsibility of the parent, child, or shared by both. The same version of the form

is given to parents and children with diabetes, and scores are then combined to get a mother-child didactic score. This score ranges from 0 to 17, where 17 indicates that no one takes responsibility for any of the DFRC situations. For the purposes of this study, the 'no responsibility' score was used (Anderson et al., 1990). Anderson et al. (1990) found the scale to have an internal consistency between .69 to .85 for the various subscales and concurrent validity with the Family Environment Scale.

CHAPTER 3
RESULTS

Preliminary Analyses

To explore relations between demographic, family functioning variables, and incidence of DKA, Pearson product-moment correlation coefficients were obtained between the variables. Results are provided in Table 2. Age was significantly correlated with HbA1c ($r = .21$, $p < .05$) and duration of diabetes ($r = .25$, $p < .05$). Warmth-Caring scores were negatively correlated with HbA1c indexes ($r = -.35$, $p < .001$), suggesting that children in poorer metabolic control rate their caregivers as less warm and caring than children in better metabolic control. Parental negativity was significantly correlated with HbA1c ($r = .37$, $p < .001$), suggesting that children in poorer metabolic control have caregivers who rate themselves as more negative regarding the child's diabetes regimen. Finally, incidence of DKA was significantly positively correlated with HbA1c ($r = .50$, $p < .001$) and parental negativity ($r = .24$, $p < .001$), and negatively correlated with warmth-caring scores ($r = -.38$, $p < .001$). This suggests children who had experienced a DKA episode presented with elevated HbA1cs, were more likely to rate parents as less warm and caring, and to have caregivers who rated themselves as more negative regarding the child's diabetes regimen. T-tests were run to explore group differences. Results indicated that the DKA and non-DKA groups differed significantly on Warmth-Caring ($t = 4.09$, $p < .001$) and Parental Negativity scores ($t = -2.49$, $p < .05$). Specifically, a rate of child-reported warmth caring was higher and parent-reported

negativity was lower in families with children who did not experience DKA episodes.

Means and standard deviations for measures are presented in Table 3.

Table 2 Pearson *r* Correlations Between Demographic, Family Functioning Variables, and Incidence of DKA

	Age	HbA1c	Duration of Diabetes	Warmth-Caring	No Respon-sibility	Parental Negativity
Age						
HbA1c	.21*					
Duration of Diabetes	.25*	.12				
Warmth-Caring	-.04	-.35**	-.01			
No Responsibility	.09	.10	.19	-.02		
Parental Negativity	.13	.37**	-.06	-.11	-.17	
Incidence of DKA	.16	.50**	.20	-.38**	.12	.24**

*$p < .05$, **$p < .01$

Table 3 Means and Standard Deviations for Family Functioning Variables for Participants Experiencing and Not Experiencing DKA

Variable	DKA Sample *n* = 34 mean (*SD*)	Non-DKA Sample *n* = 66 mean (*SD*)
Warmth-Caring	48.50 (9.53)	55.77 (7.82)**
No Responsibility	2.85 (2.71)	2.23 (2.40)
Parental Negativity	20.00 (4.62)	17.09 (5.95)*

** indicates significant differences at $p < .001$ level
* indicates significant differences at $p < .05$ level

Logistic Regression

A logistic regression was performed to explore the effect of family functioning variables on DKA due to the dichotomous nature of the dependent variable. Logistic regression has been suggested as an appropriate choice for dichotomous dependent variables (Davis & Offord, 1997; Peng, Lee, & Ingersoll, 2002). The presence or absence of DKA was entered as the dependent variable. Demographic predictors (age, gender, and ethnicity) were entered in the first step to control for possible influences. Family functioning variables (warmth/caring, no responsibility for diabetes treatment regimen, and parental negativity) were entered in the second step as the predictors. Analysis was performed using SPSS 11.0.

A test of the full model with all predictors against a constant-only model was statistically reliable, $\chi 2$ (3, $N = 100$) = 26.137, $p < .001$, indicating that the predictors, as a set, reliably distinguished between children who had and had not experienced a DKA episode. The logistic regression resulted in a model that explained as much as 44% of the variance based on these variables (Nagelkerke R Squared = .440). Using the Cox & Snell R Squared measure, the model accounted for 31.8% of the variance (R Squared = .318). Warmth-caring and parental negativity differentiated between the groups at $p < .001$ level. According to the model, the log of the odds of a child experiencing a DKA episode was negatively related to warmth-caring scores ($p < .05$) and positively related to parental negativity ($p < .05$). In other words, children in families with higher degrees of warmth-caring and less parental negativity were less likely to experience a DKA episode. Lack of responsibility for the treatment regimen was not a significant predictor in this model. This confirms the finding that family functioning variables of warmth/caring and parental

negativity are related to a child's health outcome. As there was no relationship between parent versus child responsibility for regimen and DKA, there was no support for the hypothesis that responsibility for the treatment regimen affects a child's health outcome.

To examine possible effects of multicollinearity, structure coefficients were calculated in accordance with Thompson and Borrello (1985). Analyses of structure coefficients indicate multicollinearity was not a problem with family variables. Odds ratios were calculated for significant predictor variables. For each one unit increase in a participant's warmth-caring subscale score, the odds of experiencing a DKA episode increases by 0.875. For every one unit increase in parent-report of negative behavior, the odds of experiencing a DKA increase by 1.150. Further results are presented in Table 4. The full model classified correctly 90.9% of the children who did not experience a DKA episode, and 52.9% of the children who did experience a DKA episode, resulting in an overall prediction rate of 78.0%. Overall classification prediction rates are presented in Table 5.

Table 4 Logistic Regression Analysis of DKA episodes by SPSS 11.0

Predictor	ß	*SE ß*	Wald's χ2	*df*	*P*	e ß (odds ratio)	r_s
Constant	-3.852	36.710	.011	1	.916	.021	
Demographics							
Age	.134	.113	1.391	1	.238	1.143	
Gender	-.716	.585	1.497	1	.221	.489	
Ethnicity			6.557	5	.256		
Family Functioning							
Warmth-caring	-.134	.037	13.219	1	.001	.875	-.573
No responsibility	.174	.115	2.281	1	.131	1.190	.181
Parental negativity	.139	.055	6.375	1	.012	1.150	.361
Test			χ2	*df*	*P*		
Overall model evaluation							
Model Chi-square			26.137	3	.001		
Goodness-of-fit test							
Hosmer & Lemeshow			3.263	8	.917		

Table 5 The Observed and Predicted Frequencies for DKA episodes by Logistic Regression With the Cutoff of 0.50

	Predicted		
Observed	No	Yes	% Correct
No	60	6	90.9
Yes	16	18	52.9
Overall % correct			78.0

Moderating Logistic Regression

Possible moderating effects of age on relationships between family functioning variables and DKA were explored using guidelines as specified by Baron and Kenny (1986). More specifically, moderation is determined if the following guidelines are met. Moderating effects are indicated if the interaction between family functioning variables (i.e. Warmth-Caring, Parental Negativity, and No Responsibility) demonstrate significant effects after controlling for family functioning variables and age. Possible moderation was explored separately for each of the three family functioning variables. All three regression models indicated non-significant moderating effects between age and family functioning variables.

CHAPTER 4
DISCUSSION

The purpose of this study was to demonstrate the association of family functioning variables and hospitalizations for DKA in pediatric patients with Type I diabetes. Our results suggest a good fit for a model linking occurrence of DKA and family functioning characteristics. Specifically, our hypothesis that families with increased amounts of warmth and caring would be associated with a lower occurrence of DKA was supported. The model also supports the hypothesis that increased amounts of parental-reported negativity would be associated with higher occurrence of DKA.

While warmth and caring, responsibility, and parent support as a group, have not been specifically examined in the literature with incidence of DKA, these findings are supported by the only study in the literature to examine one of these family characteristics, warmth-caring, and incidence of DKA (Liss et al., 1998). These findings are also supported by earlier studies reporting significant associations between family support and metabolic control (Steinhausen, 1982; Stevenson et al., 1991; Weissberg-Benchell et al., 1995; Wysocki et al., 1996).

However, the hypothesis regarding the association between lack of responsibility for the diabetes treatment regimen and increased incidence of DKA episodes was not supported. This was surprising given the previously established association between lack of responsibility and poor metabolic control (Anderson et al., 1990). One possibility for this finding may be due to bias in self-report and social desirability. Children and their caregivers may not have been willing to admit that no one takes responsibility for certain

aspects of treatment in a clinical setting. Another possibility is that this scale only indicates that someone in the family takes responsibility, but not whether that individual is the child or caregiver. Therefore, children may assume responsibility for aspects of the treatment regimen prematurely. This rationale is supported in a study by LaGreca, Follansbee, and Skyler (1990) who found that preadolescents who assume greater responsibility for diabetes care are usually in poorer glycemic control than their peers who have more parental support for diabetes responsibilities.

Previous research in the empirical literature has found associations between age and family variables (Anderson et al., 1990; Anderson et al., 2002; LaGreca et al., 1995), and age and metabolic control (Johnson, 1995; Johnson et al., 1992; Kovacs et al., 1992). Given these previous findings, it was surprising that no association was found regarding the effects of age between family functioning variables and DKA. However, a major difference between this study and previous research examining the effects of age on health outcome has examined metabolic control as the dependent variable, while the health outcome measure in this study was the presence or absence of DKA. This may be one possibility why a relationship between age, family functioning variables, and health outcome was not found.

This study is the first to investigate the association between family characteristics and DKA as a measure of health outcome in children with Type I diabetes. Previous literature examining family functioning has focused on health outcome as measured by metabolic control (McKelvey et al., 1993; Steinhausen, 1982). The association between family functioning and adherence has been well supported in the literature (LaGreca et al., 1995; Hanson et al., 1987), as has the association between family functioning and

health outcome as measured by metabolic control, or glycosylated hemoglobin (Stevenson et al., 1991). However, the associations between adherence and health outcome are mixed, with some studies supporting the association and some studies not supporting the association. DKA commonly results from chronic poor metabolic control (Travis, 1985) and individuals experiencing DKA often report more noncompliance with diabetes treatment than controls without DKA episodes (Morris et al., 1997; Liss et al., 1998). The current study demonstrates the more direct effect that family functioning has on the health outcome measure (i.e. DKA) that is related to adherence to the treatment regimen.

Another strength of the study is the use of diabetes-specific measures and questionnaires. Researchers have suggested that disease-specific measures of psychosocial variables are better predictors of adherence than global measures (Shafer et al., 1983). Similarly, disease-specific measures should serve as better indicators of characteristics in families including children with chronic illnesses than global measures. Global measures may not pick up on behaviors in the family unit related to aspects of the treatment regimen, health outcome, adherence, and the subtle differences in families including children with chronic illness as compared to families including only healthy children.

Limitations

This study has several limitations. First, the study design was cross-sectional, which prevents the researchers from making causal statements regarding the direction of influence between family variables and health outcome. In fact, family measures were used to predict past episodes of DKA. However, since family variables have been previously associated with HbA1c levels, and HbA1c levels have been associated with

DKA, it is probable that family functioning variables would predict DKA. Although the hypothesis that family functioning characteristics influence a child's adherence and therefore health outcome has clinical appeal, it is possible that poor health outcome in children contributes to changes in the family environment. Future investigations with longitudinal designs assessing family variables and subsequent incidence of DKA would be beneficial to explain the relationship between family characteristics and health outcome. Second, the population used in this study is a sample of convenience taken from a tertiary care center serving a large geographic region. The percentage of individuals who have experienced a DKA episode in this sample is higher than the national average due to the tertiary care nature of the setting. Finally, the measures used in this study were self-report questionnaires. Social desirability may have played a role in participants' responses and subsequently skewed the results of the study if family members were overly positive in their report of family characteristics.

Conclusions and Clinical Implications

In conclusion, this study is the first of few studies to explicitly examine family functioning variables and DKA in children with Type I diabetes. Families with lower rates of parental warmth and higher rates of parental negativity are associated with higher occurrence of DKA episodes. Examination of these two variables alone correctly classifies a child's likelihood of having experienced a DKA episode or not 78% of the time. Specifically, changes of only one unit in these variables (as measured by diabetes-specific measures) leads to a significant change in the odds that a child will fall into the group that has experienced a DKA episode. This is of clinical importance because families who present to a physician or psychologist with these characteristics could be targeted for early intervention or additional involvement directed at these specific aspects

of warmth, caring, and negativity. This study also suggests the need to develop new interventions to more intensely address these aspects of the families. Targeting these family characteristics may improve compliance and metabolic control, and decrease the probability that the child will experience future diabetes-related complications, such as DKA.

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BIOGRAPHICAL SKETCH

Kelly Walker is a native West Virginian who completed a bachelor's degree in psychology at West Virginia University in May 2002. Following her graduation, she began her post-graduate work at the University of Florida in August 2002, and plans to pursue a doctorate in clinical and health psychology following the attainment of her master's degree.