ABSTRACT

Title: RELATIONSHIP BETWEEN DISINHIBITION
                                AND METABOLIC CONTROL IN
                                ADOLESCENTS WITH TYPE 1 DIABETES

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Given that adolescence poses a high-risk period for diabetes mismanagement, and

consequently, threats to long-term health status, it is important to examine factors that

contribute to individual differences in the propensity to exhibit poor management and

engage in health incompatible behaviors. Importantly, researchers have identified

personality constructs related to disinhibition, including impulsivity, sensation seeking,

and risk-taking propensity, to be prospectively linked to engagement in real-world risk

behaviors such as use of alcohol, nicotine, illegal drugs, and risky sexual behavior

(Lejuez et al., 2002, 2003). However, this relationship has yet to be explored in

adolescents with diabetes. Thus, the purpose of the current study was to examine whether

disinhibition was related to metabolic control, and the extent to which self-management

behavior and drug/alcohol use mediated this potential relationship. The sample consisted

of 43 subjects with Type 1 diabetes aged 13-18 years who were recruited from diabetes

clinics at Children's National Medical Center. Teens were assessed with self-report and

behavioral measures of risk-taking and participated in an interview regarding self-

management behaviors. Substance use and diabetes knowledge were measured by self

report, and the glycosylated hemoglobin (HbA1c) test was used as a proxy for metabolic

control. Results of partial correlational analyses indicated that disinhibition was not

directly related to behavioral adherence, engagement in health incompatible behaviors, or glycemic control after controlling for race, gender, and insulin regimen type. Rather, results of regressional analyses suggested that sample characteristics, particularly race and insulin regimen, are the key variables in assessing overall management in adolescence. Results may have important implications for the prevention and treatment of morbidity associated with diabetes.

RELATIONSHIP BETWEEN DISINHIBITION AND METABOLIC CONTROL IN ADOLESCENTS WITH TYPE 1 DIABETES

By

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Dedication

This work is dedicated to my family, who provided encouragement and financial support longer than any parent should have to; and to my friends, who kept me going through the worst times, when I wanted to drop out and work at Starbucks.

Acknowledgements

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Chapter 1: Introduction

Type 1 Diabetes

Type 1 diabetes (insulin dependent diabetes mellitus [IDDM]; juvenile diabetes) is a chronic autoimmune disease characterized by the destruction of insulin-producing beta cells in the pancreas. Without the hormone insulin, the body loses its ability to metabolize carbohydrates, thereby compromising many aspects of growth, wound healing, and brain function (Peterson, Reach, & Grabe, 2003; Wysocki, Greco, & Buckloh, 2003). Whereas Type 1 diabetes results from insulin deficiency, Type 2 diabetes results from insulin resistance (an impaired cellular uptake of insulin) and may be managed with diet and exercise alone, or with oral medications that enhance body's use of insulin (Wysocki et al., 2003). In contrast, all children with Type 1 diabetes rely on daily insulin replacement to survive.

Although the incidence of Type 2 diabetes has been increasing in recent years, Type 1 diabetes is the most prevalent type diagnosed in childhood. In the U.S., approximately 1 in 600 school-aged children are afflicted with Type 1 diabetes, making it one of the most common chronic illnesses diagnosed in children (Wysocki et al., 2003). Genetic predispositions have some relationship to the etiology of Type 1 diabetes; however, unknown environmental factors appear to play a role as well (Johnson, 1998). The onset of Type 1 diabetes typically occurs in middle childhood, and symptoms may include fatigue, thirst, frequent urination, and weight loss (Peterson et al., 2003). Treatment of this condition involves a daily regimen of monitoring food intake, blood glucose (BG) levels, and activity, in addition to insulin replacement via subcutaneous injections or use of an insulin pump, which delivers insulin through a catheter (Peterson

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et al., 2003). Because there is no cure for diabetes, the condition requires compliance with complex daily regimens over the course of the lifespan in order to regulate glucose metabolism.

Although insulin replacement therapy allows children with diabetes to live relatively normal lives, it only approximates normal pancreatic function. Therefore, blood glucose levels regularly fluctuate outside of a normal range even with proper management. There are two conditions that result when large deviations in blood glucose levels occur. The first, hypoglycemia, is characterized by a low BG level (typically defined as below 80 mg/dl; Chase, 2002). This condition can occur if the dose of insulin provided is too high, when meals or snacks are missed, or with extra exercise. Symptoms often include sweating, shaking or shakiness. Severe hypoglycemia can lead to unconsciousness and seizures, and can be associated with permanent brain damage (Rovet, 2000).

The second condition that results from deviations in blood glucose levels, hyperglycemia, occurs when BG levels are too high (typically defined as above 200 mg/dl; Chase, 2002). Hyperglycemia can occur when insulin doses are missed, or an insufficient dose is provided. Without adequate amounts of insulin, the body is unable to use carbohydrates for energy, and the body begins to starve (Peterson et al., 2003). The effects of chronic hyperglycemia are cumulative and thus, are rarely seen in young children. However, they appear to have their beginnings in puberty (Kostraba, 1989). Although both hypo and hyperglycemia occur even with well-controlled diabetes, chronic and large deviations from the normal range can be a function of poor management and can lead to serious conditions. For example, chronic hyperglycemia is associated with

vascular disturbances, including heart disease, retinopathy, nephropathy, and neuropathy. Further, prolonged severe hyperglycemia can lead to a serious condition called diabetic ketoacidosis (DKA), which can cause permanent neurological dysfunction and has a 1-2% mortality rate (Kitabchi & Wall, 1995).

Medical Management

Good diabetes management is essential to long-term health. The results of a landmark clinical trial has shown that good metabolic control and adherence to regimen components can delay, decrease, or prevent complications associated with diabetes (Diabetes Control and Complications Trial [DCCT], 1993; 1994). Insulin replacement therapy is the most important daily behavior involved in overall management of diabetes. Typically, insulin administration involves injections two or more times a day, with the goal of maintaining BG levels within a normal range. In children 12 years and older, it is generally recommended that blood sugar levels be kept within a range of 70-150 mg/dl (Chase, 2002). Therefore, an important aspect of management involves daily monitoring of BG levels (generally recommended at least 4 times a day) so that appropriate steps can be taken to manage hypo or hyperglycemia. The practice of monitoring glucose levels relies on a finger prick, used with a needle or specialized equipment. Blood is then placed into a computerized meter that reports current blood glucose levels (Peterson et al., 2003). See Appendix A for additional detail regarding medical management of Type 1 diabetes.

As previously noted, many factors other than insulin can impact metabolic function. For example, certain lifestyle practices such as diet and exercise can impact BG levels. Therefore, as part of overall management, physicians often will recommend that

individuals meet with a nutritionist to work out a plan that involves attention to timing of meals and number of carbohydrates per meal. In addition, it is important that individuals with diabetes engage in regular exercise as it helps lower BG and improve insulin action (Johnson, 1998). Although insulin replacement, diet, and exercise are aspects of managing diabetes that are within an individual's control, there are other factors that can impact metabolic function that occur largely outside one's control. For example, illness, stress, hormones, and genetic factors all contribute to BG variability (Johnson, 1998). See Appendix B for additional detail regarding self-management and behavioral issues related to metabolic control. In sum, achieving an overall pattern of good metabolic control involves daily behavioral adherence to multifaceted regimens and lifestyle decisions.

To take into account the multidimensional nature of diabetes management behaviors, the term *diabetes self-management* (DSM) has been used to encompass behaviors aimed at the "establishment, maintenance, and monitoring of diabetic control, as well as the prevention or correction of deviations from targeted blood glucose levels (Harris et al., 2001, pg 1301)." This term emphasizes the amount, accuracy, and regularity of behaviors rather than just the degree to which behavior coincides with ideal medical advice (typically referred to as *adherence* or *compliance*). Extant research suggests that adherence with various regimen components is uncorrelated and differentially stable over time (Johnson, 1992, 1994). Therefore, self-management better represents the set of behaviors related to ongoing management of diabetes.

Issues related to DSM represent the leading reason that individuals with diabetes are referred to health psychologists (Ruggiero & Javorsky, 1999). Although specific rates of engagement in DSM are unknown, longitudinal studies indicate that management is

best at the time of diagnosis and deteriorates after that time (Jacobson et al., 1990). Diabetes management problems and poor metabolic control have been reported to be greater in adolescence than during younger and older age periods and most research shows reduced treatment compliance as children develop and reach adolescence (e.g., Hamilton & Daneman, 2002; Jacobson et al., 1990; Kovacs, Goldston, Obrosky, & Iyengar, 1992). This lack of sufficient attention to diabetes management is particularly problematic because this developmental period is accompanied by physiological changes (i.e. growth hormones) that may adversely impact metabolism, above and beyond the effects of poor self-management. In addition, adolescents are more likely than younger children and adults to engage in other behaviors that are incompatible with good diabetes management, such as drug, alcohol, and tobacco use (Rowe & Linver, 1996; United States Department of Health and Human Services, [USDHHS], 1994). As will be discussed subsequently, adolescents with diabetes are much more vulnerable to the effects of substance use, and use of tobacco, alcohol and illicit substances can cause serious short and long-term complications. Therefore, although substance use is not directly related, nor included, in measures of self-management, it is clearly an important aspect of diabetes self-care.

Given that adolescence poses a high-risk period for diabetes mismanagement, and consequently, threats to long-term health status, it is important to examine factors that contribute to individual differences in the propensity to exhibit poor DSM as well as engagement in other behaviors incompatible with good metabolic control such as substance use. As previously noted, the tendency of individuals to demonstrate poor DSM patterns during adolescence has been well documented (e.g., Hamilton &

Daneman, 2002; Jacobson et al., 1990; Johnson, 1995; Kovacs et al., 1992) and linked to biological and social changes that occur during puberty (i.e. growing levels of independence, increased importance of peer relationships, decreases in parental responsibility for management; Chase, 2002; Walker, 2002). However, it is also important to assess why some teenagers are more vulnerable than others to demonstrate poor management. Research has identified several dimensions of family functioning, environmental support, and cognitive styles to be correlated with self-management and metabolic control. For example, low parental involvement (Grey et al., 2001), low perceived self-efficacy (Iannotti et al., 2006), health beliefs and attitudes (Patino, Sanchez, Eidson, & Delamater, 2005), high family conflict (Hauser et al., 1990), poor family communication (Miller-Johnson et al., 1994), and poor problem solving skills (Grey, Boland, Davidson, Li, & Tamborlane, 2000; Alioto & Janusz, 2004) have been shown to be related to decreased self-care and poorer metabolic control (See Appendix B for additional detail regarding psychosocial factors associated with metabolic control). However, one potentially important factor that has been absent from current conceptualizations is temperamental characteristics such as disinhibition. To explore the utility of this framework, the relationship between disinhibition and diabetes management was explored.

Impact of Disinhibition on Diabetes Management

Despite knowledge of adverse health consequences, youth with diabetes continue to engage in behaviors that negatively impact metabolic control and health status (albeit at a lower rate than non-diabetic children; Frey, Guthrie, Loveland-Cherry, Park, & Foster, 1997). As previously noted, adolescents are more likely to engage in poorer

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behavioral adherence to diabetes regimen components (i.e., diet, exercise, insulin replacement; Jacobson et al., 1990) as well behaviors that are incompatible with good diabetes management, such as substance use (Rowe & Linver, 1996). Although rates of substance use among adolescents with diabetes appear to be somewhat lower than in the general population, there still exists a substantial prevalence. Studies have reported rates of 50% for alcohol use; 25% for drug use; and 50% for cigarette use among adolescents with diabetes (Glasgow, Tynan, & Schwartz, 1991; Gold & Gladstein, 1993) compared to community rates of 76.6% for alcohol use; 51% for drug use; and 54% for cigarette use (lifetime prevalence for 12th graders; Monitoring the Future Study [MTF], 2003). The incidence of substance use in this population is problematic because adolescents with diabetes are more vulnerable than others in their age group to the short and long-term effects of substances on physiological functioning. For example, smoking greatly increases morbidity and mortality (Ford & Newman, 1991; Gay, Cai, & Gale, 1992), and alcohol use increases the risk of hypoglycemia (American Diabetes Association [ADA], 1998; Franz, 1990). In addition, use of tobacco, alcohol and other drugs has all been shown to be associated with poorer metabolic control (Glasgow et al., 1991; Lundman, Asplund, & Norberg, 1990). Clearly, a better understanding of an individual vulnerability to engage in behaviors that are incompatible with good diabetes management among adolescents is needed. This understanding might help to tailor and optimize the yield of approaches aimed at improving DSM and reducing the risk of health complications associated with diabetes (Biglan & Severson, 2003; Tucker, Ellickson, & Klein, 2003).

Some have suggested that individual differences in cognitive/information processing, specifically risk perception, is an important factor in understanding decisions

to engage in health compromising behaviors among diabetic adolescents. The health belief model (HBM, Janz & Becker, 1984) is a conceptual framework that posits that perception of vulnerability to disease complications is a key factor in determining an individual's health behaviors. In this framework, risk is defined as feelings of personal susceptibility or vulnerability to a condition where stronger feelings of vulnerability motivate behaviors aimed at reducing risk (Frey et al., 1997). A small number of studies (Frey et al., 1997; Joseph et al., 1992, 1994; Patino et al., 2006; Woolridge et al., 1992) have examined the role of risk perception in adolescents with diabetes on blood sugar levels and participation in risky behaviors. Generally, findings have not supported a significant association between perception of risk of complications and DSM or metabolic control. These findings are consistent with research in community samples of adolescents indicating that knowledge and perception of risks often does not correlate with behavior, and that accurately perceiving risk is not traditionally a sufficient or direct predictor of engagement in risky behavior (Sitkin & Weingart, 1995).

In contrast, evidence has increasingly indicated that dispositional variables (i.e., personality and temperamental characteristics); specifically, differences across the disinhibition spectrum, may play a crucial part in engagement in risk behaviors among adolescents (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Krueger et al., 2002; Lejuez, Aklin, Bornovalova, Moolchan, 2005; Sher, Bartholow, & Wood, 2000). Theoretical models suggest that disinhibition is a biologically based factor that may relate to risk taking specifically, as well as externalizing spectrum disorders more broadly (Markon, Krueger, & Watson, 2005). Determinants of trait-disinhibition have been found to be composed of several constructs, such as impulsivity and sensation seeking (Sher et

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al., 2000; Zuckerman & Kuhlman, 2000). For the purposes of this study, we draw on Eysenck's (1985) definition of impulsivity; namely, the tendency to enter into situations or rapidly respond to cues for potential reward without much planning or deliberation and without consideration of potential punishment. The most comprehensive definition of sensation seeking has been put forth by Zuckerman (1994), who defines it as "the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience (Zuckerman, 1994, p. 27)." Whereas impulsivity relates to the reduced ability to withhold approach behavior in the presence of reward-related stimuli (Brady, Myrick, & McElroy, 1998), sensation seeking relates to sensitivity to reward stimuli, and consequently, the approach behavior in itself (e.g., Zuckerman, 1991; Zuckerman & Kuhlman, 2000).

The construct of disinhibition as a broad characteristic has been proposed to underlie the propensity to engage in risky and norm-violating behaviors (i.e. substance use, risky sexual behavior, antisocial behavior) and is thought to have a biological, largely heritable basis. Gray (1982) first theorized that neurological processes; specifically, the behavioral inhibition system (BIS) and behavioral activation system (BAS), influenced the tendency of individuals to engage in either anxious or impulsive behavior. The tendency of some individuals to persistently search for highly stimulating experiences has been linked to a low activation of the behavioral inhibition system, experienced as a relatively low level of anticipatory anxiety (e.g., Zuckerman, 1991). Indeed, research has linked self-reported BAS/BIS scores with frontal cortical activity (e.g., Hewig et al., 2006). Similarly, others have noted that impulsivity and sensation seeking are indicators of a core neurobiological process; namely, the underlying

approach/avoidance system oriented toward engagement in hedonic behavior (Depue & Collins, 1999; Zuckerman, 1991; Zuckerman & Kuhlman, 2000). Others have rejected the theory that trait-personality variables form the primary basis for engagement in norm-violating behaviors; rather, they propose that it is the interaction between personality/genetic predisposition and social-contextual variables that is of primary importance (e.g., Jaffee et al., 2005). Regardless of the etiological basis, studies have clearly documented a relationship between components of disinhibition (i.e. impulsivity, sensation seeking) and risky behaviors (i.e. substance use, smoking initiation, gambling, risky sexual behavior), as well as subsequent diagnosis of externalizing disorders (Krueger et al., 2002; Lejuez et al., 2002; Sher, Bartholow, & Wood, 2000; Tarter et al., 2003; Zuckerman et al., 1988).

Despite robust results that indicate a significant association between disinhibition and risky behavior, several aspects of extant research are in need of further improvement. For example, one limitation of research related to disinhibition in adolescents is the absence of comprehensive measures. Traditionally, researchers have relied exclusively on self-report instruments to determine levels of disinhibition, but these approaches have several limitations, and their success in identifying at-risk adolescents has been limited. In contrast, translational research and theory (Zvolensky, Lejuez, Stuart, & Curtin, 2001) have provided a strong argument for the assessment of disinhibition using on-line behavioral tasks. Based on these recommendations, researchers have developed the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), which indexes manifest riskiness using a computer-generated behavioral task. This behavioral measure of risk taking propensity is easy-to-use and adolescent appropriate. In this task, larger prizes can

be earned for increased risk-taking up to a point at which overly risky behavior produces diminishing returns. Data suggest that level of risk taking propensity on the BART is related to current engagement in many real-world risk behaviors (e.g., smoking, delinquent behaviors), particularly those most relevant to risky behaviors in adolescents (e.g., unprotected sexual intercourse, polysubstance use). In addition, the BART has been shown to predict risk behaviors in adolescents over and above self-report assessments of impulsivity and sensation-seeking (Aklin et al., 2005; Lejuez, Aklin, Zvolensky, & Pedulla, 2003). Therefore, the use of behavioral tasks in addition to self-report instruments may provide a more comprehensive assessment of constructs related to disinhibition.

A further limitation of extant research is that despite the association between behavioral and self-report assessments of constructs related to disinhibition and risk behaviors, this relationship has not yet been documented in samples of individuals with diabetes. Similarly, there is a complete absence of research examining the relationship between disinhibition and the quality of diabetes self-management and metabolic control. Based on research on risk-taking behaviors in community samples of adolescents, it is clear that constructs related to disinhibition, measured by self-report instruments and behavioral tasks such as the BART, are correlated with a range of high-risk behaviors such as unsafe sexual practices, illicit drug use, alcohol use, and smoking, with all correlations ranging from .25 to .44 (e.g., Aklin et al., 2003; Lejuez et al., 2003). Therefore, adolescents with disinhibited personality styles are more likely to use alcohol and drugs. This phenomenon has particular relevance to adolescents with diabetes, given research to indicate that alcohol, tobacco and drugs have direct negative effects on

metabolic functioning. In addition, use of alcohol and drugs increases the propensity to make decisions oriented toward short, rather than long-term consequences (e.g., Bailey, Camlin, & Ennett, 1998; Hoffman, Klein, Eber, & Crosby, 2000; Stein et al., 2000). Thus, impaired judgment due to alcohol and drugs may also have indirect effects on metabolic control through less attention to self-management (which has long versus short term benefits).

In addition to the relationship between disinhibition and substance use, adolescents in community samples who score higher on measures of disinhibition have been shown to be more likely to display norm-violating behavior and less consistent lifestyles (Sher & Trull, 1994). Therefore, one could presume that within a population of adolescents with diabetes, individuals with higher levels of disinhibition would be less likely to follow parental and physician recommendations regarding diabetes management, and to demonstrate an impaired ability to adhere consistently to regimen components (i.e., diet, exercise, insulin replacement).

In sum, there is considerable reason to believe that adolescents who are more disinhibited are more likely to engage in substance use and to demonstrate more problematic self-management. Surprisingly, however, these hypotheses have yet to be subjected to empirical scrutiny. Given the adverse impact of poor self-management and substance use on metabolic functioning in adolescents with diabetes, it is important to examine whether personality variables such as disinhibition are associated with an increased vulnerability to engage in such behaviors. However, it is important to note that there are several limitations to pursuing such a line of research. First, similar to many risk assessment tools, many existing measures of diabetes self-management do not account

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for the multidimensional nature of regimen components, do not account for different insulin delivery systems (e.g., pump), and do not correlate well with metabolic control. Recently, however, a structured interview for self-management behaviors has been developed (DSMP, Harris et al., 2000). This measure examines adherence across various regimen components and can be modified to account for recent advances in insulin therapy. In addition, unlike other measures, results correlate with metabolic control (Harris et al., 2000).

In addition to limitations regarding measurement of self-management, blood glucose levels are also a fallible indicator of self-care behaviors. Much of the variance in metabolic control can be attributed to factors largely outside an individual's control (e.g., genetic, biologic, demographic, characteristics of a patient's individual regimen; Hamilton & Daneman, 2002). Therefore, a good measure of self-management may only account for a modest proportion of variance in diabetic control. However, similar to other chronic illnesses such as heart disease, behavioral factors such as exercise, diet, and engagement in high risk behaviors significantly contribute to health outcome and have implications for educational and treatment programs.

Given the importance of understanding factors related to good metabolic control, the purpose of the current study was to examine whether disinhibition was related to metabolic control, and the extent to which self-management behavior and drug/alcohol use mediates this potential relationship. Results may have important implications for psychoeducational programs and treatment of uncontrolled diabetes in adolescents. For example, the current assumption that all teenagers need the same information presented

in the same fashion may not be warranted. Idiographic approaches that take into account level of disinhibition may be needed to address these individual differences.

Chapter 2: Method

<u>*Subjects*</u>

All subjects were recruited from diabetes clinics at Children's National Medical Center (CNMC) and its satellite clinics located in the greater Washington DC metropolitan area. All children saw the same physician for their diabetes appointments. Inclusion criteria included adolescents (ages 13-18 years) with Type 1 diabetes, diagnosed for 6 months or more, and able to read and understand English. Subjects with an identified developmental disability (i.e. pervasive developmental disorder, Down's syndrome) were excluded. Other identified psychiatric disorders were not excluded from the study.

<u>*Procedure.*</u>

Potential participants were identified from the CNMC log of diabetes clinic appointments. All individuals who met inclusion criteria (Type 1 diabetes, 13-18 years of age, diabetes diagnosis for at least 6 months, English speaking), had an appointment on a day the investigator was available, and who were not participating in other diabetes clinic studies were sent a letter which included a summary of study procedures (see Appendix C). Approximately 125 letters were sent to potential families. This letter was followed up by phone calls to potential study subjects inviting them to participate, following a brief screening to confirm eligibility and review of procedures. Two subjects were excluded based on phone screening, due to a PDD diagnosis and length of diagnosis less than 6 months. Five potential subjects could not be called due to wrong/disconnected phone numbers. Upon phone contact, both the adolescent and a parent/legal guardian were

asked to participate on the date of their regularly scheduled clinic visit. Individuals were informed that their participation was voluntary and would not affect treatment at any time. Administrative personnel at the participant's clinic site were contacted prior to their scheduled visit, and a private room in which to conduct study procedures was reserved.

Upon initial contact, study procedures were described simultaneously to both the parent and child. In the course of this description, it was emphasized that all study materials were confidential and therefore, parents would not have access to questionnaire responses. Parental consent and adolescent assent according to IRB requirements were obtained prior to conducting study-related procedures. Following an explanation of the study, the parent was directed to the waiting room to complete the demographic questionnaire, and adolescents completed study measures in a private room. Procedures were conducted either prior to or following their diabetes check-up appointment. Procedures took approximately 35-45 minutes. The order of administration of tasks (questionnaires, semi-structured interview, and computer task) was counterbalanced to minimize order effects. Questionnaires were self-administered and placed in envelopes labeled only with an ID number. The computer task (BART) was completed on a Dell Notebook computer with an attached mouse. The experimenter administering the BART was blind to participant responses on the self-report battery. Similarly, the experimenter administering the semi-structured interview was blind to participant responses on the BART and self-report measures. Given evidence that adolescents interviewed separately have statistically similar scores to adolescents who knew their parents were being interviewed (Harris et al., 2000), adolescents were interviewed alone to maximize truthful responding. All data were subsequently maintained in a locked file cabinet, with assent

forms maintained in a file separate from data to maintain confidentiality. Medical records were reviewed following their clinic visit to obtain A1c results.

Measures.

Four self-report questionnaires, one semi-structured interview, and one behavioral task were used in this study. These instruments and their psychometric properties are listed below:

Demographic Information

- **Demographic Questionnaire.** A brief questionnaire was used to collect data on age, gender, race, family income, education, duration of diagnosis, presence of diagnosed psychiatric disorders, and current insulin regimen. The caregiver who brought the teen to their clinic appointment was asked to complete this measure.

Diabetes Knowledge

- **Diabetes Knowledge Questionnaire (DKQ; Fitzgerald et al., 1998).** The DKQ is a 23-item measure that assesses factual knowledge about diabetes. Fitzgerald et al. (1998) reported coefficient alphas ≥ 0.70 for the general test and the insulin-use subscale in a sample of community and health department adult samples. On measures of validity, patients with Type 1 diabetes scored higher than patients with Type 2 diabetes, and patients who received diabetes education scored higher than patients who did not receive diabetes education. It was modified for this study to apply to adolescents. The coefficient alpha for the current study was .73 for the general test.

Measures of Disinhibition

- **Zuckerman-Kuhlman Personality Questionnaire (ZKPQ; Zuckerman et al., 1993).** Impulsive sensation seeking (ImpSS) involves a lack of planning and the tendency to act impulsively without thinking. ImpSS was measured using the ZKPQ self-report questionnaire. The entire questionnaire consists of 99 questions and consists of five subscales that correspond to the Alternative Five Factor Model of Personality (Zuckerman et al., 1991). In the interest of time, only the ImpSS subscale, which consists of 19 forced choice items, was administered. These items do not assess specific activities; rather they describe a lack of planning and a general need for excitement and unpredictability. Zuckerman (2000) reported a 4-week test-retest coefficient alpha of .80 in a large sample of young adults. Internal reliability coefficients were good, ranging between .70-.80. The results of validity analyses indicated a high degree of convergence between

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factors represented by the ZKPQ, NEO-PI-R, and EPQ-R, with loadings ranging from .72-.90. For the current study, the internal reliability coefficient for the test was good (α=.71).

Behavior Analogue Risk Task (BART; Lejuez et al., 2002). This behavioral task has been successfully used to describe currently occurring risk behaviors in young adults (Lejuez et al., 2002) and adolescents (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Lejuez, Aklin, Zvolensky, & Pedulla, 2003). The BART has demonstrated predictive value above and beyond that provided with demographics and self-report personality measures. In the first two preliminary studies on adolescents (Aklin, et al., 2005; Lejuez, et al., 2003), the BART was related to an aggregate of risk taking behaviors taken form the CDC Youth Risk Behavior Survey (*r's* ranged from .30 to .50; all p's < .05). Riskiness on the BART was related to illicit drug use in both studies and unsafe sexual practices in one of the studies. Therefore, preliminary data indicate that substance use is related to riskiness on the BART (r = .35). For the current study, reliability estimates were good. When broken down into the first, second and third sets of 10 balloons, there was no significant difference between the number of pumps per set (p > .05).

This task was administered on the computer. The computer screen displayed a small simulated balloon accompanied by a balloon pump, and a reset button labeled "Collect Points." The left side of the screen showed a prize meter that was labeled, "small prize", "middle prize", "big prize" and "bonus". See Figure 1 for an illustration. Each pump of the balloon produced points that accumulated in a temporary bank. At any point during each balloon trial, the participant could stop pumping the balloon and click the "Collect Points" button. Clicking this button transferred all points from the temporary bank to the permanent bank and the prize meter bar was updated by incrementally increasing while a slot machine payoff sound effect played. If a balloon was pumped past its individual explosion point, an "explosion" sound effect was generated from the computer, all points in the temporary bank were lost, and the next uninflated balloon appeared on the screen. There were a total of 30 balloons (i.e., trials). These 30 balloons all had the same probability of exploding. Prior to task administration, subjects were seated in front of the computer screen, which displayed all task images. They were then read the following instructions:

> *Throughout the task, you will be presented with a number of balloons, one at a time. You can click on the button labeled "Click this Button to Pump Up the Balloon" to increase the size of the balloon. Each click on the mouse pumps up the balloon a little more. You will receive points for each pump that will be kept in a temporary bank. At any point, you can stop pumping up the balloon and click on the button labeled "Collect Points." Clicking this button will start you on the next balloon and will transfer the money from your temporary bank to your permanent bank. It is*

*your choice to determine how much to pump up the balloon, but be
aware that at some point the balloon will explode. The explosion
point varies across balloons, ranging from the first pump to
enough pumps to make the balloon fill the entire computer screen.
Each balloon can explode between 1 and 128 pumps, but the
average balloon will pop at 64 pumps. If the balloon explodes
before you click on "Collect Points", then you move on to the next
balloon and all the money in your temporary bank is lost.
Exploded balloons do not affect the money in your permanent
bank. In total there will be 30 balloons. The prize you get at the
end will be determined by how high the prize meter is. Any
questions?*

Subjects were then shown a bulleted summary of these instructions on the
computer screen. They were then directed to press the "ready to begin" button to
start the program. At this time, the experimenter left the room. Each click on the
pump inflated the balloon one degree (about .125" in all directions). The
probability that a balloon would explode is arranged by constructing an array of N
numbers. The number "1" was designated as indicating a balloon explosion. With
each pump of the balloon, a number was selected without replacement from the
array. The balloon exploded if the number 1 was selected. For this experiment, N
equaled 128. Thus, the probability that the balloon would explode on the first
pump was 1/128. If the balloon did not explode after the first pump, the
probability that the balloon would explode was then 1/127 on the second pump,
1/126 on the third pump and so on up until the 128th pump at which the
probability of an explosion was be 1/1 (i.e., 100%). According to this algorithm,
the average breakpoint was 64 pumps. Modeling real-world situations in which
excessive risk often produces diminishing returns and increasing threats to one's
health and safety, each successive pump on any particular balloon trial (a)
increased the amount to be lost due to an explosion and, (b) decreased the relative
gain of any additional pump.

Upon completion of 30 balloon trials, the computer program closed automatically,
and resulting data stored by an ID number. The position of the prize meter was
supposed to determine the final prize. In order to treat participants in the most
equivalent way possible, all subjects were provided with their choice of either one
$10 Blockbuster certificate or one $10 Target certificate. The intent of this design
was to maximize level of effort on the task with an equitable distribution of prizes
to the subjects.

Substance Use

- **Drug Use Diagnostic Identification Test (DUDIT; Babor & Del Boca, 1992).**
  A quantity/frequency measure of all drugs (including nicotine) and alcohol was
  assessed with a standard self-report questionnaire adapted from the Alcohol Use
  Diagnostic Identification Test (e.g., Babor & Del Boca, 1992). Specifically,

participants responded to questions regarding use of a particular drug in their lifetime, use of it in the past 30 days, and frequency of drug use during the period of their life when they were using it most. Development of a composite score was guided by the work of Kirischi et al. (2002), who recommends adding the number of drug classes used (lifetime use) as a useful index of substance use involvement. For the current study, the internal reliability coefficient of the test was good (α=.75).

Diabetes Self-Management

- **Glycosylated Hemoglobin Test (HbA1C)**. Glycemic control was assessed using the HbA1C, which is a widely accepted measure of average blood glucose levels over the prior 2-3 months (Wysocki et al., 2003). It is generally recommended that patients with diabetes have a quarterly HbA1C test in order to document the degree of glycemic control (ADA, 2004). Studies indicate that complication risks increase linearly with HbA1C levels (DCCT, 1994; See Figure 2). Typically, an HbA1C of <7% is recommended to avoid the risk of myocardial infarction and neuropathy (ADA, 2004). Blood draws were conducted as part of the child's regular clinic visit following standard protocol and safety guidelines.

- **Diabetes Self-Management Profile (DSMP; Harris et al., 2000).** The DSMP is a 23 item semi-structured interview that was designed to assess self-management behaviors over the previous 3 months in youths 11 years or older. The interview assessed behaviors across 5 domains: exercise, hypoglycemia management, diet, blood glucose testing, and insulin administration/dose adjustment. Higher total scores indicate better self-management. The interview may be administered to parents, children or parent-child dyads. Given evidence that adolescents interviewed separately have statistically similar scores to adolescents who knew their parents were being interviewed (Harris et al., 2000), adolescents were interviewed alone to maximize truthful responding. The total score has demonstrated adequate internal consistency (Cronbach's α = .76), and test-retest reliability (3 month Pearson correlation, r = .67). In addition, unlike other measures, DSMP total scores have correlated significantly with HbA1C (r = -.28). The interview was administered by the experimenter, and began with a statement indicating that imperfect diabetes self-management is common and that few patients consistently do all that is asked of them. Unlike other measures of self-care, questions could be adapted to accommodate various insulin delivery methods such as basal-bolus therapy and injection therapy. Twenty percent of the interviews in the current study were coded by a trained research assistant in order to assess inter-rater agreement. Although a kappa could not be computed, inter-rater correlations were good with Pearson r's above .80 for the total score and related subscales. In addition, the measure of internal consistency for the measure as a whole was good (α=.74). However, the alpha coefficients for individual subscales were less than .70, which is consistent with results obtained by the Harris et al (2000) study. Thus, individual subscales may be unreliable when administered separately, and they were not analyzed as such in subsequent

analyses.

Chapter 3: Results

<u>*Sample Characteristics*</u>

Forty-four subjects with Type I diabetes participated in this study. One subject was excluded because she had Type II diabetes, leaving 43 valid subjects. The average age of the subjects who participated was 15 years ($SD = 1.5$). Subjects had an average duration of illness of 6 years, 6 months ($SD = 4.3$). Approximately two-thirds were Caucasian (65%) with African-Americans representing the second largest racial group (20%), followed by Latinos (9.3%), and Native-American/Bi-racial children (4%). A little over half of the sample was male (56%). Of those who reported their income, approximately one-third came from households with a yearly income of $100,000 or more, approximately 28% with a yearly income between $40,000-100,000, and 10% with a yearly income less than $40,000 per year. A small percentage of the total sample were diagnosed with a psychiatric disorder, most commonly depression (7%), ADHD (7%), and anxiety (2%). Approximately 6% of children who had any psychiatric diagnosis had at least one co-morbid diagnosis. Subjects were on a variety of insulin regimens with approximately 45% of participants on conventional injection therapy (2-3 shots per day), 30% on basal-bolus therapy, and 23% on an insulin pump.

Descriptive Statistics

To examine relationships between primary variables of interest and demographics, and identify potential confounding variables, descriptive statistical analyses were conducted for the primary measures included in the current study.

The average total score on the diabetes knowledge questionnaire (DKQ) was 17.5 (*SD* = 2.9). The DKQ correlated significantly with race and insulin regimen type although it did not significantly correlate with gender, age, income, parental education, age at initial diagnosis, or duration of illness. In general, teens who were on more sophisticated insulin delivery systems (i.e. basal/bolus and insulin pump versus conventional injections) demonstrated greater diabetes knowledge (*M* basal/pump = 16.1, *M* conventional = 18.5; $F(1, 42) = 9.1$, $p < .01$). In addition, white teenagers were much more likely to be on basal-bolus or insulin pump systems than were non-white teens ($\chi^2 = 22.5$, $p < .01$) and to score higher on diabetes knowledge than nonwhites (*M* whites = 18.1, *SD* = 2.6; *M* nonwhites = 16.3, *SD* = 2.9; $F(1, 42) = 3.8$, $p = .05$). White teenagers in the sample were also more likely to come from families with higher yearly incomes [$F(1, 35) = 5.6$, $p < .05$], although not education levels [$F(1,40) = .87$, $p = $ ns]. Lastly, males in the current sample were significantly more likely to be white than non-white (white males n = 18, nonwhite males n = 6; $\chi^2 = 3.2$, $p = .05$). There were no differences between white and non-whites with respect to age or duration of illness.

Metabolic Control

As previously noted, hemoglobin A1c is a measure of average BG levels over the previous 3 months, with lower numbers correlating with lower BG levels and better metabolic control. The average A1c for the sample as a whole was 8.3% (*SD* = 1.1). As illustrated in Figure 3, there was one significant outlier, with one subject having a significantly higher A1c than the rest of the sample (12.5%) that resulted in a negatively skewed distribution (skewness = 1.1). When this individual's data was removed from

analyses, the data more closely approximated a normal distribution (skewness = .24, range = 5.9% - 10.3%). However, this individual's data was included in subsequent analyses, as it did not produce a significant difference in results, unless otherwise noted. When averaged over the 3 time periods (6 and 3 months prior to the study date) the average A1c was largely equivalent to the day of the evaluation (M = 8.5%, SD = 1.2) and repeated measures analyses indicated no significant effect of time period (p > .05). Therefore, the A1c on the day of the evaluation was used in subsequent analyses of metabolic control.

Metabolic control, as measured by A1c, was not significantly associated with age, length of diagnosis, parental education, parental income, diabetes knowledge, or the presence of psychiatric diagnoses. Importantly, however, metabolic control was strongly associated with race, with white teenagers in this sample having lower A1c levels than non-whites (M whites = 7.9, SD = .90; M non-whites= 9.1, SD = 1.3; $F(1, 42)$ = 12.3, p < .01, η^2 = .23). In addition, metabolic control was significantly associated with gender, with boys being more likely to have lower A1c levels (M males = 7.9, SD = .88; M females = 8.8, SD = 1.3; $F(1, 42)$ = 6.9, p = .01, η^2 = .15). As would be expected, metabolic control was also significantly correlated with insulin regimen in that teens who were on the insulin pump and basal-bolus therapy had lower A1c levels than teens who were on conventional injection therapy (M conventional = 8.8, SD = 1.3, M basal/pump = 7.9, SD = .86; $F(1, 42)$ = 7.3, p = .01, η^2 = .15). See Tables 2 and 3 for correlation matrix and tests of significance.

Given that A1c was related to race, insulin regimen, and gender, linear regression analyses were conducted with these as independent variables. The model as a total

accounted for approximately 32% of the variance in A1c level ($R^2 = .32$). Results

indicated that race predicted A1c level even when controlling for the effects of gender

and insulin ($sr^2 = .34$, $p < .05$). On the other hand, the relationship between A1c and

gender was no longer significant after the other two variables were controlled for ($sr^2 =$

$.05$, $p = ns$), which is likely due to the fact that race was related to gender, with boys in

this sample more likely to be white. Similarly, the relationship between A1c and insulin

regimen was no longer significant after controlling for the other two variables ($sr^2 = .08$,

$p = ns$), which is likely due to the fact that whites were more likely to be on more

sophisticated insulin delivery systems.

Measures of Disinhibition

Following the procedures outlined in Lejuez, 2002, instead of using an absolute

average number of pumps on the BART, we decided a priori to use only adjusted values

for all analyses. These adjusted values, defined as the average number of pumps

excluding balloons that exploded (i.e., the average number of pumps on each balloon

prior to prize collection), were preferable because the number of pumps was necessarily

constrained on balloons that exploded, thereby limiting between subjects variability in the

absolute averages. In addition, other potential dependent variables, such as number of

explosions and unadjusted number of pumps, did not produce a different pattern of

results. As noted in Table 4, the average adjusted number of total pumps for the sample

as a whole was 40.66 ($SD = 15.5$). As illustrated in Figure 4, there were no significant

outliers in terms of the total number of pumps on the BART made by individual subjects.

The BART was not significantly correlated with age, diabetes knowledge as

measured by the DKQ, parental income, age at initial diagnosis, psychiatric diagnoses or

parental education. However, it was significantly negatively associated with gender, with males making a higher number of pumps than females (M males = 46.2, SD = 14.3; M females = 35.1, SD = 14.0; $F(1, 42)$ = 6.5, p = .01, η^2 = .14). Similarly, the BART was significantly associated with race with whites making a higher number of pumps than non-whites (M whites = 46.0, SD = 12.9; M nonwhites = 32.6, SD = 14.3; $F(1, 42)$ = 9.1, $p < .01$, η^2 = .18). The number of pumps on the BART was also significantly associated with the teen's type of insulin regimen with adolescents using the pump and basal bolus insulin replacement making a higher number of total pumps than those on conventional injection therapy (M conventional = 32.8, SD = 12.7; M basal/pump = 48.1, SD = 13.3; $F(1, 42)$ = 14.5, $p < .01$, η^2 = .26).

Given that BART was related to these other variables, linear regression analyses were conducted with gender, race, and insulin regimen as independent variables. The model as a total accounted for approximately 35% of the variance in number of average pumps made (R^2 = .35). Results indicated that neither gender nor race was significantly related after controlling for the other two variables. However, insulin regimen was associated with the BART after controlling for gender and race, (sr^2 = .43, $p < .05$, partial r = .35).

Contrary to expectations, the total score on the self-report measure of impulsive-sensation seeking (IMPSS scale) did not significantly correlate with the total (adjusted average) number of pumps on the BART (r = .086, p = ns). It also did not significantly correlate with age, race, gender, age at diagnosis, insulin regimen, parental income or education, or diabetes knowledge as measured by the Diabetes Knowledge Questionnaire (refer to Table 5 for correlation coefficients, all ps > .05). When the IMPSS scale was

broken down into component subscales; (impulsivity and sensation seeking) the equivalent pattern of results was found for each.

Measures of Self Management

As previously noted, the DSMP measures the degree to which individuals have managed various components of their diabetes regimen over the previous three months. It has a range between 0-79, with higher scores reflective of better management. The mean total score on the self-management questionnaire in the current sample was 52.83 ($SD =$ 10.3). Twenty-five percent of the DSMP interviews were audiotaped for inter-rater reliability analyses. However, due to poor sound quality, 23% of the interviews were ultimately coded. Results indicated high inter-rater agreement for the total management score (r = .94).

The total score on the DSMP did not significantly correlate with gender, age, presence of psychiatric diagnoses, or highest degree obtained. It did correlate significantly with race (r = .40, $p = .01$), and insulin regimen (r = .39, $p < .05$). In the current sample, white teenagers reported a higher degree of self-management on the DSMP than nonwhite teenagers (*M* whites = 56.4, $SD = 8.4$; *M* nonwhites = 46.3, $SD =$ 10.5; $F(1, 41) = 11.7$, $p < .01$, $\eta^2 = .23$) and teens who were on conventional injection therapy demonstrated management to a lower extent ($F(1, 42) = 12.8$, $p < .01$, $\eta^2 = .24$). In addition, the correlation between the total score on the DSMP and diabetes knowledge approached significance (r = .27, $p = .08$) in that the teens who scored better on the diabetes knowledge questionnaire had a tendency to report a higher degree of diabetes self-management.

As shown in Table 9, approximately two-thirds of the sample (65%) reported that they had never used tobacco, alcohol, illegal drugs or abused prescription drugs. Approximately 28% reported that they had used between one to three different classes of substances in their lifetime; primarily tobacco (14%), alcohol (23%), and inhalants (11%). Due to the relatively low frequency of drug use, the total number of drugs used over the child's lifetime was used as a proxy for engagement in substance use. The mean number of types of drugs used for the sample was 0.8 ($SD = 1.32$) with a range between 0 and 5. Drug use did not significantly correlate with gender, age, race, parental income, or length of diagnosis (all $ps > .05$). There was also no significant relationship between drug use and self-management behaviors as reported on the DSMP. However, the correlation between drug use and diabetes knowledge approached significance ($r = -.27$, $p = .07$), in that teens who scored better on the diabetes knowledge questionnaire had a tendency to report less drug use. Due to low frequency of drug use, the relationships were further explored by splitting subjects into two groups; those who had never used drugs ($n = 28$) and those who had ever used drugs ($n = 15$). There was no difference in any of the relationships between drug use and variables of interest, including gender, race, age, self-management behaviors, or diabetes knowledge.

Tests of Hypotheses

Hypothesis 1. Subjects who demonstrate greater levels of disinhibition (measured by self-report and BART) will have poorer glycemic control (HbA1C) after controlling for diabetes knowledge.

The self report measure of impulsivity/sensation seeking was not correlated with the behavioral measure of risk taking. Therefore, the two measures could not be combined into a single disinhibition construct as proposed, and analyses for each are

conducted separately. In addition, diabetes knowledge was not significantly correlated

with HbA1c. Therefore, gender, race and insulin regimen, which were significantly

correlated with the primary outcome measure, were included as control variables instead

of diabetes knowledge. Results of partial coefficient analyses indicated that self-reported

ratings of disinhibition were not significantly correlated with HbA1c ($r = .09$, $p = $ ns)

after controlling for gender, race, and insulin regimen. Similarly, the total number of

average pumps on the behavioral measure of disinhibition (BART) was not significantly

correlated with HbA1c ($r = -.12$, $p = $ ns) after controlling for gender, race, and insulin

regimen. This profile of results did not change when using the average A1c over the three

time periods, when removing the subject who presented the A1c outlier from the analysis,

or when breaking the self-report measure into its component subscales. When the

variability of A1c levels over three time periods were examined (to explore whether any

changes in A1c levels were related to disinhibition), there continued to be no association

between the self report measure ($r= -.06$, $p = $ ns) or the behavioral measure ($r= .22$, $p = $

ns).

Hypothesis 2. Subjects who demonstrate greater levels of disinhibition (measured by self-report and BART) will be more likely to engage in a pattern of behavior that is detrimental to their health across the following domains: a) substance use and b) poor engagement in self-management behaviors directly related to diabetes care (measured by the DSMP) after controlling for diabetes knowledge.

Again, as the self report measure of impulsivity/sensation seeking was not

correlated with the BART, partial correlation analyses are conducted separately for each

measure. In addition, as substance use and self-management were not correlated with

diabetes knowledge, control variables included gender, race, and insulin regimen.

Results indicated that the total (adjusted average) number of pumps on the BART did not

significantly correlate with use of drugs either when examined continuously (total drug classes used; $r = .17$, $p =$ ns), or when the drug use variable was divided into two groups: no use and any use of drugs ($r = .07$, $p =$ ns).

The number of pumps on the BART did not correlate with self-management total score ($r = .23$, $p =$ ns). In contrast, the self-report measure of impulsive-sensation seeking did significantly correlate with drug use after controlling for race, gender, and insulin delivery type ($r = .44$, $p < .01$), with teens who reported higher levels of disinhibited behavior engaging in drug use to a higher degree. However, it did not correlate with the self-management total score ($r = -.02$, $p =$ ns). The measure continued to not correlate with the DSMP when subscales (impulsivity and sensation seeking) were analyzed separately.

Hypothesis 3. The pattern of self-care behaviors in Hypothesis 2 will be related to poorer glycemic control (HbA1C) after controlling for diabetes knowledge and controlling for disinhibition.

HbA1c was not significantly correlated with use of drugs ($r = -.001$, $p =$ ns) or the total score on the self-management questionnaire ($r = -.15$, $p =$ ns) after controlling for race, gender, type of insulin regimen, and disinhibition measures.

Hypothesis 4. The relationship between disinhibition and glycemic control will be close to zero when controlling for self-management behaviors described in Hypothesis 2.

Due to the lack of the correlation between measures of disinhibition, variables were analyzed separately. Results of partial correlation analyses indicated that there was no significant relationship between disinhibition and glycemic control after controlling for self-management behaviors (*ps* > .05).

Chapter 4: Discussion

Preliminary Analyses:

The findings of preliminary analyses indicated that race was significantly associated with several key variables including diabetes health knowledge, type of insulin regimen the teens were placed on, diabetes self-management, and the measure of metabolic control (A1c). Specifically, white teens scored higher on diabetes knowledge than non-whites, were more likely to be placed on more complex insulin delivery systems, and were significantly more likely to have lower A1c levels and demonstrate more engagement in diabetes self-management. The fact that children who scored higher on diabetes knowledge, were more adherent to regimen components, and had better metabolic control were more likely to use basal-bolus/pump therapy is perhaps not surprising, given that knowledge and behavioral adherence are frequently prerequisites for determining this transition. But why would white adolescents be presenting with lower A1c levels and better diabetes specific knowledge? Results indicated that neither diabetes knowledge nor self-management correlated significantly with metabolic control and did not mediate this association to a substantial degree. The fact that diabetes knowledge in and of itself did not significantly associate with metabolic control is consistent with previous research. While there is clearly a minimum threshold of knowledge required to manage the disease, it is not a sufficient predictor of metabolic control. This phenomenon is particularly salient during adolescence where longitudinal studies indicate deteriorating behavioral adherence over the course of adolescence despite increases in diabetes-related health knowledge (Du Pasquier-Fediaevsky, Chwalow, & Tubiana-Rufi, 2005). Similarly, much of the variance in metabolic control can be attributed to factors largely outside an individual's control (e.g., genetic, biologic,

demographic, characteristics of a patient's individual regimen; Johnson, 1998) and thus may not necessarily correlate with self-management behaviors

In contrast, the insulin delivery method accounted for a significant proportion of variance in the relationship between race and metabolic control, suggesting that this variable is an important factor in mediating this association. However, the causal direction of association is unclear. The more sophisticated delivery systems, such as the insulin pump, are designed to more closely mimic normal pancreatic functioning (e.g., Castellanos, 2005). On the other hand, children who have better metabolic control to begin with and who demonstrate responsible behavioral adherence are also more likely to be placed on these systems by their physicians. Thus, more research is needed to disentangle this relationship.

It is possible that socio-economic factors associated with race may be potential mediators of the relationship between race and metabolic control. Although whites and non-whites in the current sample were statistically equally likely to fall in the middle income groups ($40-80 thousand yearly income) and to have similar educational backgrounds, white teens in this sample were far more likely to be in families with incomes over $100,000 per year, and less likely to be in families with yearly incomes less than $40 thousand ($\chi^2$=8.3, p < .05). However, the relationship between race and metabolic control was present even when the effect of income and education was controlled for.

Thus, it is unclear why white adolescents in the current sample presented with greater health knowledge and also improved metabolic control. There has been relatively little research examining ethnic minority populations with Type 1 diabetes. However,

results on effects of race in the current study are consistent with emerging research in this area that indicate that minority youth are more likely to exhibit poorer glycemic control and recurrent episodes of DKA (Auslander, Thompson, Dreitzer, White, & Santiago, 1997; Delamater et al., 1999). One study indicated that black youth are more likely to have poorer glycemic control even after controlling for insulin dosage, diabetes duration, and socioeconomic status (Delamater, Albrecht, Postellon, & Gutai, 1991). Fewer studies have examined the course of type 1 diabetes with other ethnic minority groups. One study in the U.S. found that in comparison to Latino youth, black youths were at highest risk of poor metabolic control even when there were no significant differences with respect to insulin dosage, body mass index (BMI), or Tanner pubertal stage (odds ratios indicated that blacks were 3.9 more likely than whites and 2.5 times more likely than Hispanics to be classified as being in poor glycemic control; Delameter, et al., 1999). Similarly, another study of seventy-four minority adolescents indicated that regimen adherence problem and poor glycemic control were higher in black youth relative to Hispanic youth (Patino et al., 2005). In a study conducted from a national register of children in Denmark, results indicated that ethnic minorities of any type were more likely to have worse glycemic control compared to their Danish counterparts (Povlsen, Olsen, & Ladelund, 2005).

Health care disparities for minority youths, especially those of lower SES, have been well documented (e.g., Airhihenbuwa, 2006). Children from racial and ethnic minorities encounter more health problems and impact disproportionately on the health care system (Furino & Munoz, 1991; U.S. Dept of Health & Human Services, 1991) In examining mechanisms that may underlie this phenomenon, Naar-King et al (2006)

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suggests that in addition to individual factors (i.e. mental health symptoms) and family factors (i.e. parental involvement) that have been commonly linked to poor outcomes for children with Type 1 diabetes, the social-ecological theory posited by Bronfenbrenner (1979) may be a useful framework in which to understand illness management. Using this framework, minority youth may be more likely to experience worse metabolic control as they are more likely to have inadequate access to health care, less support in school systems, and more likely to have public health insurance (Delamater, 1999). Furthermore, there are often language barriers, cultural differences in health beliefs, higher parental stress, and lower education levels that may all impact an adolescent's ability to manage their diabetes. Thus, although the reasons are unclear, we do observe the same pattern here as in other studies, suggesting that some relationship between race and diabetes management exists. It is likely that an unknown third variable, possibly related to family or cognitive factors (i.e. self-efficacy or health beliefs) that have been shown to be related to outcome, are associated with race and may accounts for the differences observed here. It would be interesting for future research to collect such information so that the mechanism underlying this relationship can be better explored.

Self-management

The mean total score on the self-management questionnaire (DSMP) in the current sample was 52.83. This is consistent with research that shows more reduced treatment compliance as children reach adolescence. In our sample, there was no significant difference in behavioral adherence by younger or older cohorts. Again, race and insulin regimen were significant factors in determining the extent to which

adolescents adhered to their regimen, with whites and those not on conventional insulin therapy reporting more consistent participation in self-management.

In the current study, there was a trend for diabetes knowledge to be associated with behavioral adherence as measured by the DSMP; however, this relationship did not reach the level of statistical significance. Although it is possible that a larger sample size may have been able to detect a significant difference, other studies have indicated that deteriorating behavioral adherence over the course of adolescence occurs despite increases in diabetes-related health knowledge (e.g., Dumont et al., 1995; Du Pasquier-Fediaevsky, Chwalow, & Tubiana-Rufi, 2005). Thus, diabetes knowledge appears to be more important in younger samples, but not necessarily to older adolescents, who are more likely to engage in risk behaviors despite knowledge of consequences.

Somewhat surprisingly, the total score on the DSMP did not significantly correlate with metabolic control. Although much of the variance in metabolic control can be attributed to factors largely outside an individual's control (e.g., genetic, biologic, demographic, characteristics of a patient's individual regimen; Johnson, 1998), and a good measure of self-management may only account for a modest proportion of variance in diabetic control, previous studies examining psychometric properties of the DSMP have yielded significant correlations between the DSMP total score and A1c level (Harris et al., 2000; Lewin et al., 2005). The lack of association may relate to differences in sample characteristics as these previous studies had larger sample sizes ($n > 100$) and slightly younger children on average. In addition, similar to previous studies, the five subscales on the DSMP demonstrated poor internal consistency, with all alphas below .70. This is consistent with a recent psychometric study of the DSMP (Lewin et al., 2005)

in which confirmatory factor analysis of the rationally derived five subscales yielded poor fit indexes and subsequent exploratory factor analysis supported a two-factor solution for both the parent and adolescent adherence ratings, one relating to food and insulin schedule adherence (FISA) and the other related to adherence to blood sugar testing and adjustments (ABST). To further explore the utility of this framework, the 2-factor model was analyzed in the current study. Results supported increased internal consistency with these two factors (FISA factor alpha = .70, and the ABST factor alpha = .68). However, the associations between these factors and measures of disinhibition and metabolic control remained nonsignificant. It would be interesting for future research to examine the association between these subscales and metabolic control to explore whether specific subscales can more consistently predict A1c levels.

Substance use reported by subjects in the current sample was somewhat less than that reported in other studies of adolescents. As previously noted, in an epidemiological study of substance use among teens in the 12th grade, approximately 76% reported alcohol use and 51% other drug use (Monitoring the Future Study [MTF], 2003). In the current sample, only 26% reported that they had used any substances in their lifetime; primarily tobacco (14%), alcohol (23%), and inhalants (11%). It is important to note, however, that this epidemiological research is based on samples of older teens (12th graders). However, the rate was still lower than that found in a sample of teens with diabetes among the same age range (Glasgow et al., 1991). It is possible that rates of drug use reported could reflect a social desirability effect, as all measures were completed in the doctor's office environment.

Self-reported substance use in this study did not significantly correlate with gender, age, race, parental income, or length of diagnosis. There was a trend for those who were more knowledgeable about their conditions to use drugs to a lesser degree, which suggests that diabetes knowledge may be an important component in the decision to engage in substance use. However, the directionality cannot be attested for due to the cross-sectional study design.

Disinhibition

The average adjusted total number of pumps on the BART behavioral measure was used as a measure of disinhibition. The total pumps for the sample as a whole was 40.66. Given that subjects were informed that the average balloon would explode at 64 pumps, this indicates that on average, subjects responded more cautiously. The BART was significantly associated with gender and race, with males making a higher number of pumps than girls and whites making more pumps than non-whites. Previous research using the BART in adolescent samples (e.g., Aklin, 2005; Lejuez, 2003) has not yielded differences with respect to gender and it appears that the gender effect in the current study was primarily accounted for by the fact that males in the study were more likely to be white. In addition, it was unexpected that the self report measure of impulsivity/sensation seeking was not correlated with the BART. However, a recent study examining the reliability and validity of the BART for inner-city adolescent samples indicated that it did not correlate with self-reported impulsivity, but was associated with sensation seeking and real world risk behaviors (Lejuez et al., in press). In our sample, the sensation seeking subscale, when partialled out from the impulsivity subscale, also did not significantly associate with the BART. It is unclear why results are

discrepant from previous research. One potential reason is that the adolescents in the current sample were given information about the point at which the balloon would explode, which is a method that was not consistently used in other studies. It addition, previous research on adolescents using the BART have primarily focused on African-American youth in an inner-city environment; and results may not generalize to the characteristics of the current sample. Finally, the size of the payout was a bit more modest than in previous studies with adolescents, using a range up to $25 in prizes.

Tests of Hypotheses

In general, data from the current sample did not support the study hypotheses. Results indicated that self-report and behavioral measures of disinhibition were not significantly correlated with metabolic control after controlling for gender, race, and insulin regimen. This finding suggests that individual factors related to disinhibition were not directly related to glycemic control. In examining the relationship between disinhibition and behavioral management, results were more inconsistent. As hypothesized, the self-report measure of impulsive-sensation seeking (IMPSS) did significantly correlate with substance use. However, the behavioral measure of risk propensity was not associated with engagement in risk behaviors such as substance use. This finding varies with the results of several other studies indicating that in adolescent populations, the BART is strongly related to engagement in real-world risk behaviors such as substance use and shows incremental predictive value above and beyond that provided by self-report measures (e.g., Aklin et al., 2003, 2005, Lejuez et al., 2005). Again, it is not clear why the BART did not correlate with substance use in the current

study, but it is possible that it is related to the relatively low use of substances, small sample size, and differences in demographic characteristics mentioned previously.

In addition, although the IMPSS measure was correlated with substance use, it was not significantly correlated with diabetes self-management behaviors after controlling for gender, race and insulin type. Similarly, performance on the BART did not correlate with diabetes self-management. Contrary to our hypothesis, self-management, as measured by the DSMP, was not correlated with either metabolic control or with substance use. The fact that the self-management did not correlate with glycemic control is not altogether surprising, as these two are inconsistently related in previous research due to confounding variables such as biological changes that occur in adolescence. In addition, there appears to be a more complex, bidirectional relationship between adherence and glycemic control (Fediavsky, 2005).

Conclusions

In sum, the results of the current study indicate that disinhibition is not directly related to behavioral adherence, engagement in health incompatible behaviors, or glycemic control. Rather, results suggest that sample characteristics, particularly race and insulin regimen, are the key variables in assessing overall management in adolescence. However, results of this study should be interpreted with caution as there were several limitations including a relatively small sample size, relatively limited drug use, and cross-sectional design. In addition, like most studies, we used a retrospective account of management behaviors and relied on adolescent report. Twenty-four hour recall interviews, conducting a parent interview, or use of online systems may increase accuracy of reporting. Given the increased salience of risk-taking behaviors and non-

adherent diabetes management in older adolescence (i.e. Iannotti et al., 2006), it is possible that effects of disinhibition may not be apparent until this time. Although there were no effects by age in the current study, there may not have been an adequate number of children or sufficient power to detect an effect. Furthermore, the current study utilized a normative sample of children presenting for clinic visits, which resulted in a limited range of A1c levels. It is possible that domains of disinhibition may be more salient for those on the extreme end of poor metabolic control (i.e. those who would likely be referred for behavioral services). Unfortunately, our data did not contain enough individuals from this end of the spectrum to conduct such analyses. However, it may be useful for future research to examine disinhibition in clinic referred samples, particularly those with ADHD, who demonstrate high levels of impulsive responding.

Given that impulsivity relates to the reduced ability to withhold approach behavior in the presence of reward-related stimuli and that disinhibition diminishes the ability to consider consequences of behavior, it would be interesting to explore the impact of disinhibited personality styles on the management of chronic illnesses that have more immediate adverse consequences. Research supports the notion that generally, appraisal of short-term health risks play a more important role in determining behaviors than longer-term consequences (e.g., Patino, 2005). Often, the effects of high blood sugar are long-term in nature and serious effects such as kidney, vascular, and eye problems manifest after several years. Therefore, the lack of immediate consequences may be a central driving force, regardless of personality characteristics, for this type of condition. It would be interesting to see whether there is a stronger relationship between risk-

propensity and self-management for illnesses where the effects of nonadherence are more immediate and certain, such as may occur for other conditions like epilepsy.

The study also had a number of strengths, including adding to the literature an examination of individual temperamental characteristics and diabetes management. In addition, unlike other studies on diabetes management, we utilized a behavioral tool rather than relying on self-report alone. Furthermore, the demographic characteristics of the study sample, including race and gender, are similar to the characteristics of adolescents seen through CNMC diabetes clinics. Overall, current estimates indicate that the population of outpatients seen in the CNMC diabetes clinics are composed of approximately 50% female, 30% African American, 2% Hispanic, and 1% Asian/ Native American/ Pacific Islander. In the current sample, there were slightly fewer females (44%) and African-American children (22%) and slightly more Hispanic children (10%) represented. Thus, the current sample appears to be generally representative of adolescents seen through the CNMC diabetes clinics.

In general, the current study illustrates the need for research to examine the complexity of diabetes management in adolescence. Specifically, longitudinal studies are needed to examine the course of management behaviors and assist clinicians with predicting individuals at greatest risk of demonstrating health management problems. By identifying those who are vulnerable, prevention efforts and intervention programs can be best directed toward this population. In addition, the different pattern of correlations obtained between the behavioral (BART) and self-report measure of impulsivity (IMPSS) with engagement in risky health behaviors suggest that these two measures are tapping into unique variance across a range of risk behaviors and highlights the need to include

both in future research. Most striking is the finding that race was an important component of many of the key variables, which highlights the importance of social-ecological factors that may outweigh individual factors. The increased morbidity documented in adult blacks with diabetes (e.g., Tull, Makame, & Roseman, 1994) may begin during this age period. Unfortunately, this finding is consistent with other research in pediatric psychology and medicine that document marked disparities for ethnic minorities and disadvantaged populations in the current health care system (e.g., Airhihenbuwa, 2006). It is important for future research to examine the effects of dispositional and social-ecological factors in determining health behaviors for youth with diabetes so that policy, prevention, and intervention efforts can be best utilized.

Figure 1. Illustration of the BART Task

Bonus Prize →

Large Prize →

Medium Prize →

Small Prize →

Press to Collect

Press this button to Pump up the balloon
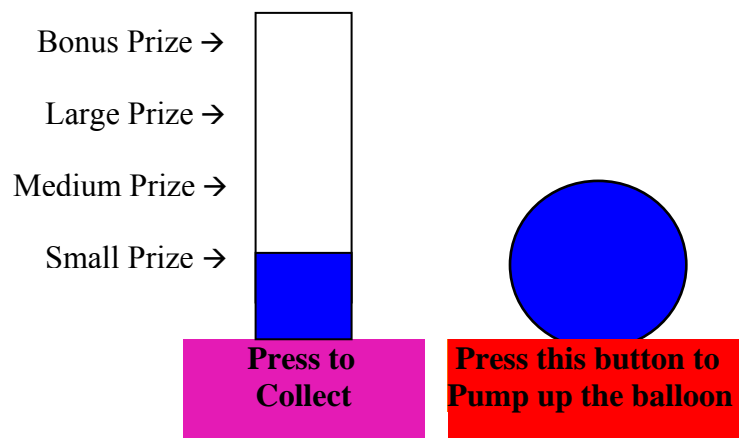
Figure 2. Relationship Between Hemoglobin A1c Levels and Risk of Complications
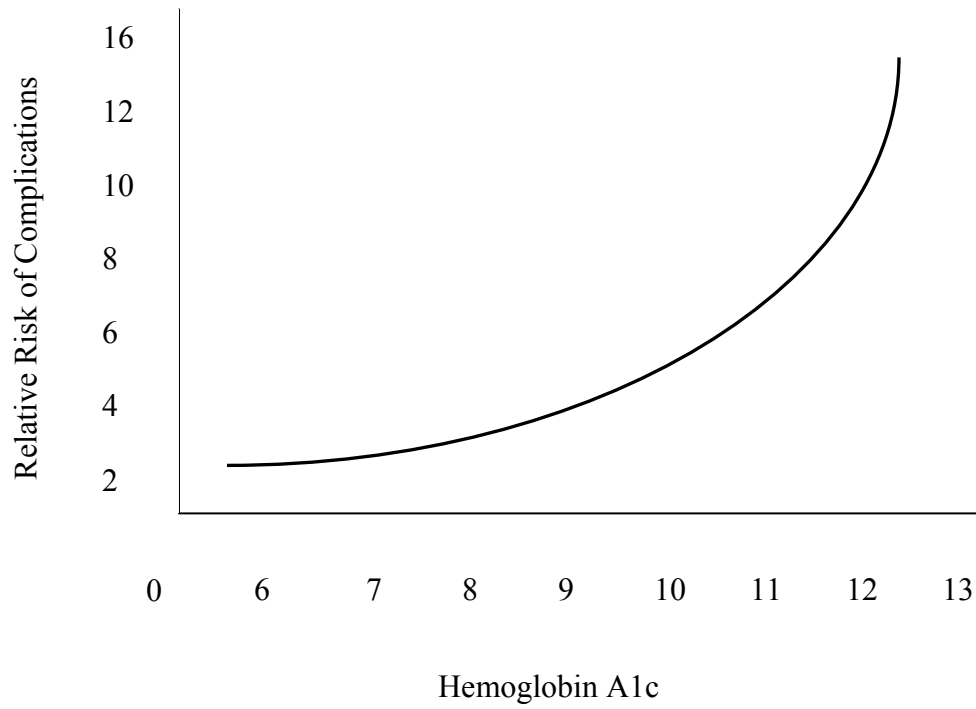
DCCT, 1993; UKPDS, 1998

Table 1

Demographic Characteristics of the Study Sample

Variable	Frequencies (Total $N = 43$)
Age (years)	$M = 15.1$, $SD = 1.5$
Gender	
Male	24
Female	19
Race	
White	28 (65.1%)
Black	9 (20.9%)
Latino	4 (9.3%)
Native American	1 (2.3%)
Bi-racial	1 (2.3%)
Average Household Income[a] (per year, in thousands)	
$20-39	5 (10.2%)
$40-69	6 (12.2%)
$70-99	8 (16.3%)
$100 or more	16 (32.7%)
Insulin Regimen	
2 injections/day	5 (11.6%)
3 injections/day	14 (32.6%)
Basal/bolus	13 (30.2%)
Pump	10 (23.3%)
Age at Diagnosis (years)[b]	$M = 8.3$ years, $SD = 4.1$
Duration of Illness (years)[b]	$M = 6.6$ years, $SD = 4.3$
Psychiatric Diagnoses[c]	
ADHD	2 (4.1%)
Depression	3 (6.1%)
Anxiety	1 (2.0%)
More than one dx	3 (6.1%)
None	31 (63.3%)
Psychiatric medication	
Stimulant	2 (4.1%)
Mood stabilizer	2 (4.1%)
Antidepressant & stimulant	1 (2.0%)
None	32 (65.3%)

Note. [a] Five subjects did not report income level. [b] Four subjects did not report age at diagnosis. [c] Three subjects did not report psychiatric diagnosis.

Figure 3. Scatter Plot of A1c Levels on the Day of the Evaluation
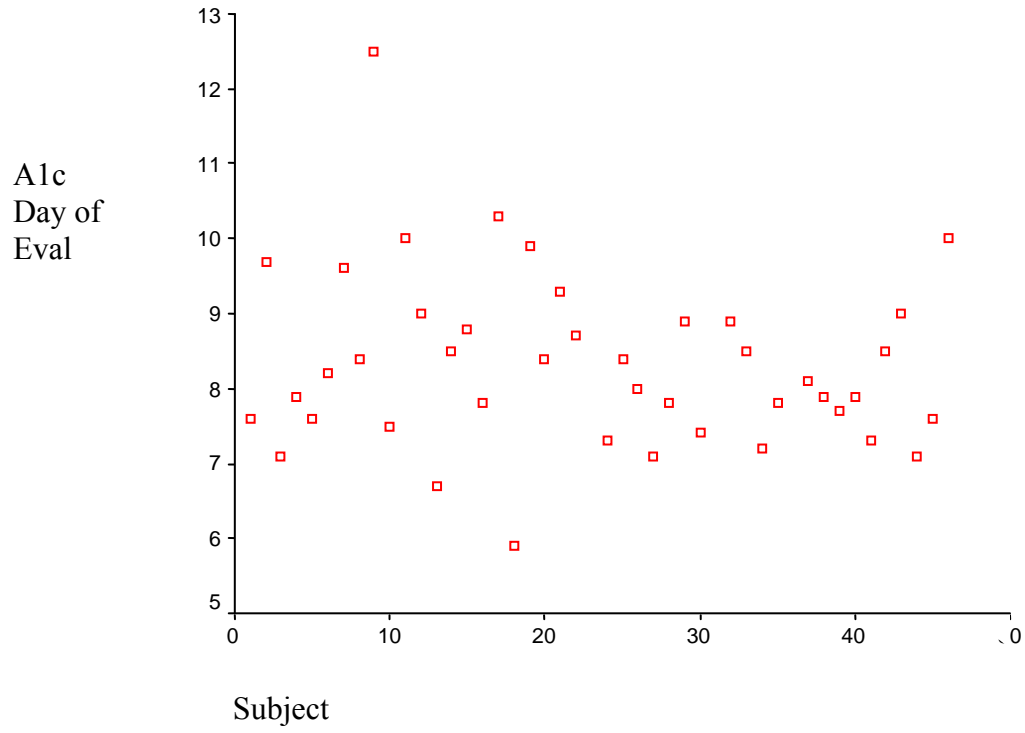
Table 2

Tests of Significance for Hemoglobin A1c and Demographic variables

	Mean	*SD*	Test Statistic	Measure of Association (η^2)
Total Sample	8.3	1.1		
Gender			*F*(1,42)= 6.9, *p*=.01	.15
Males (n=24)	7.9	.88		
Females (n=19)	8.8	1.3		
Race			*F*(1,42)=12.3, *p*<.01	.23
Whites (n=28)	7.9	.84		
Non-Whites (n=15)	9.1	1.3		
Insulin Regimen				
Conventional (n=19)	8.8	1.3	*F*(1,42) = 7.3, *p*=.01	.15
Basal/pump (n=23)	7.9	.86		

Table 3

Pearson r Intercorrelations Between Hemoglobin A1c Levels and Demographic Variables

Variable	A1c day of eval	DK total # correct	Age	Agedx	Race	Gender	Insulin regimen	Highest degree	Yearly income	Psyc dx
A1c day of eval	__	-.265	-.152	.260	-.538**	.381*	-.496**	.080	-.088	-.125
DK total # correct		__	.247	.050	.378*	.102	.472**	.106	.251	.067
Age			__	-.098	-.049	.036	.088	.149	.037	.157
Agedx[a]				__	-.179	.281	-.299	-.180	.092	-.077
Race					__	-.339*	.578**	.166	.554**	.224
Gender						__	-.133	.255	.052	-.085
Insulin regimen							__	.171	.429*	.307
Highest degree								__	.597**	.066
Yearly income[b]									__	.302
Psycdx[c]										__

Note.   * Correlation is significant at the 0.05 level (2-tailed).
        ** Correlation is significant at the 0.01 level (2-tailed).
        [a] Four subjects did not report age at diagnosis [b] Five subjects did not report income level. [c] Three subjects did not report psychiatric diagnosis.

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Table 4

BART Descriptive Statistics

	Mean	SD
Total # pumps – adjusted average	40.7	15.5
# of pumps 1st set of 10 (adjusted ave)	43.2	19.2
# pumps – 2nd set of 10 (adjusted ave)	39.7	17.5
# pumps – 3rd set of 10 (adjusted ave)	40.8	15.9

Figure 4. Scatter Plot of Total Pump Frequency (adjusted average) on the BART
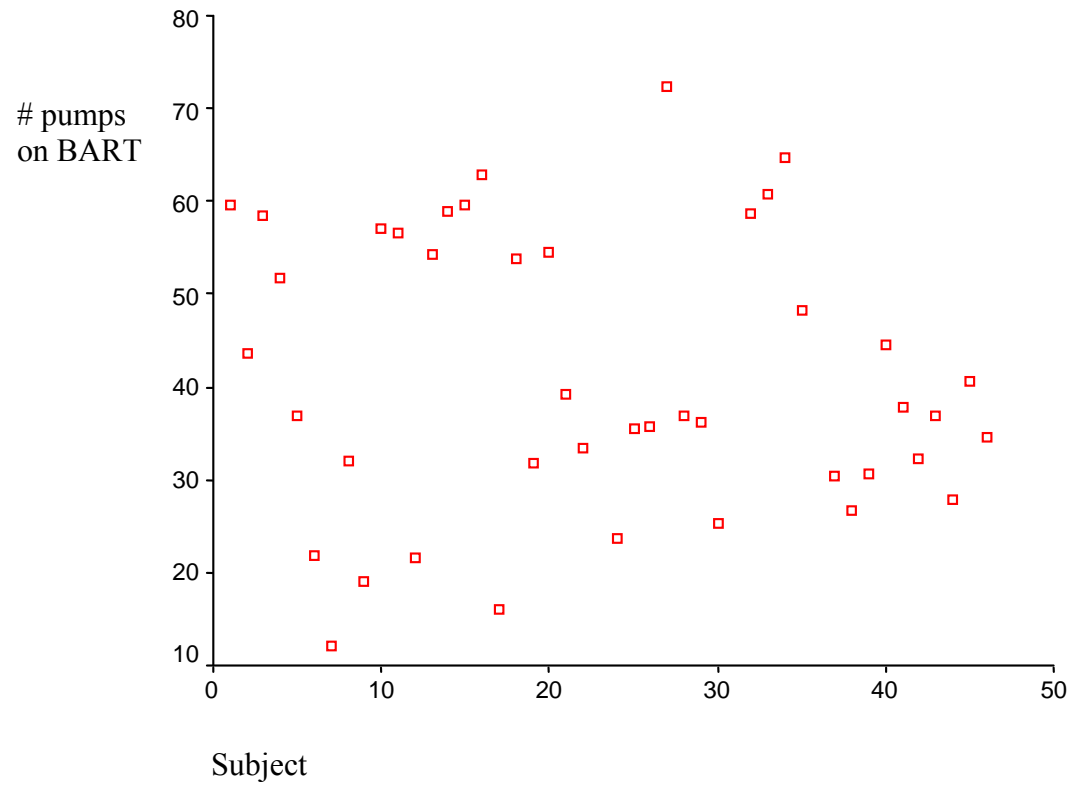
Table 5

Pearson r Intercorrelations Between Measures of Disinhibition and Demographics

Variable	# pumps - adj ave total	DK- total # correct	Age	Age Dx	Race	Gender	Insulin Regimen	highest degree	Income	Psyc dx
# pumps - adj ave total	__	.284	-.027	-.235	.484**	-.371*	.385*	-.038	.197	.126
IMPSS	.086	-.226	-.189	-.013	.148	-.079	-.138	.258	.084	-.179
DK- total # correct		__	.247	.050	.378	.102	.472**	.106	.251	.067
Age			__	-.098	-.049	.036	.088	.149	.037	.157
Age Dx[a]				__	-.179	.281	-.299	-.180	.092	-.077
Race					__	-.339	.578**	.166	.554**	.224
Gender						__	-.133	.255	.052	-.085
Insulin regimen							__	.171	.429*	.307
Highest degree								__	.597**	.066
Yearly[b] income									__	.302
Psyc dx[c]										__

Note.   ** Correlation is significant at the 0.01 level (2-tailed).
*   * Correlation is significant at the 0.05 level (2-tailed).
[a] Four subjects did not report age at diagnosis [b] Five subjects did not report income level. [c] Three subjects did not report psychiatric diagnosis.

Table 6

Tests of significance for BART by demographics

	Mean	*SD*	Test Statistic	Measure of Association (η^2)
Gender			$F(1,42)= 6.5, p=.01$	.14
Males (n=24)	46.2	14.3		
Females (n=19)	35.1	14.0		
Race			$F(1,42) = 9.1, p < .01$	.18
Whites (n=28)	46.0	12.9		
Non-Whites (n=14)	32.6	14.3		
Insulin Regimen			$F(1,42) = 14.5, p < .01$	.26
Conventional (n=19)	32.8	12.7		
Basal/pump (n=23)	48.1	13.3		

Table 7

Intercorrelations Between Measures of Self-Management and Demographics

		DSMP														
	Total # drugs	Exercise	Hypogly cemia	Nutrition	Glucose checks	Insulin admin	Total	DK- total # correct	Age	Gender	Race	Age dx	Insulin regimen	Psyc dx	Highest degree	Income
Total # drugs	__	.101	.196	-.036	-.182	-.014	-.015	-.275	-.019	-.109	.087	.041	-.298	-.314	-.013	.000
Exercise		__	.231	.196	.389	-.383	.441	.263	-.088	.030	.147	.085	.195	.175	.234	.124
Hypogly Cemia			__	.203	.247	.249	.462	-.060	-.085	-.284	.146	.139	.083	.120	.035	.290
Nutrition				__	.377	.375	.872	.292	.149	-.229	.427**	-.333*	.483**	.253	-.032	.296
Glucose checks					__	.099	.658	.206	-.085	-.156	.367*	-.275	.258	.265	.019	.120
Insulin						__	.460	-.047	.244	-.214	-.067	-.314*	-.138	-.066	-.278	-.054
DSMP total							__	.271	.092	-.260	.400**	-.306	.385*	.277	-.012	.282
DK - total # correct								__	.247	.102	.378	.050	.472	.043	.106	.251
Age									__	.036	-.049	-.098	.088	.130	.149	.037
Gender										__	-.339	.281	-.133	-.151	.255	.052
Race											__	-.179	.578	.259	.166	.554
Age dx												__	-.299	-.057	-.180	.092
Insulin regimen													__	.251	.171	.429
Psyc dx														__	.073	.324
Highest Degree															__	.597
Income																__

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 8

Tests of Significance for Total Score on DSMP

	Mean	*SD*	Test Statistic	Measure of Association (η^2)
Race			$F(1,41)= 11.7, p<.01$	.23
Whites (n=28)	56.4	8.4		
Non-Whites (n=14)	46.3	10.5		
Insulin Regimen			$F(1,42)= 12.8, p<.01$	.24
Conventional (n=19)	47.3	11.1		
Basal/pump (n=23)	57.4	6.9		

Table 9

Frequency of Lifetime Substance use

Drug	Frequency (*n*)	Percent
Tobacco	6	14
Alcohol	10	23.3
Marijuana	2	4.7
Inhalants	5	11.6
Cocaine	0	0
MDMA	0	0
Stimulants	0	0
Hallucinogens	1	2.3
Prescription Drugs		
Tranquilizers	1	2.3
Sedatives	1	2.3
Opiates	0	0
Other	0	0

Note. Frequencies are from a total sample of 43 subjects

Table 10

Number of Drug Classes Used over Lifetime

# Classes of Drugs	Frequency (*n*)	Percent
0	28	57.1
1	6	12.2
2	2	4.1
3	5	10.2
4	1	2.0
5	1	2.0
Total	43	87.8

Appendices

Appendix A. Type 1 Diabetes: Medical Management

Prior to the discovery of insulin in 1922, diabetes was a terminal illness. Without the ability to metabolize carbohydrates, individuals with diabetes would literally starve to death despite consumption of food. Upon the availability of insulin, diabetes changed from a fatal illness to a chronic disorder that could be medically managed (Johnson, 1997). However, life expectancy for children diagnosed with diabetes remains only 75% of normal (Travis, Brouchard, & Shiner, 1987).

Children with Type 1 diabetes depend on exogenous insulin to survive. There are a variety of insulin types available that vary by absorption rate, peak action, and duration. They can be prescribed alone or in combination with other types, and are available in concentrations of 100 or 500 units/ml (ADA, 2004). Conventional treatment involves subcutaneous insulin injections with a syringe or pen-like device 2 or 3 times per day. For this type of treatment, intermediate-acting insulin (i.e. NPH, Lente) is commonly prescribed in combination with short-acting insulin (Regular) in order to minimize peaks in BG levels (Davidson, 1991). Injection sites can include the tissue of the upper arm, thigh, buttocks, and abdomen, with variable rates of absorption from each site. Rotation of the injection site is important to prevent hypertrophy (ADA, 2004). The disadvantage of this type of treatment is that it does not permit rapid changes in insulin availability in response to increases or decreases in BG levels (Johnson, 1998). Thus, the patient must adhere to a diet of specified carbohydrates and regimented mealtimes. In addition, because NPH insulin action peaks 6-10 hours after administration with activity

diminishing after that time, there is a greater risk of hypoglycemia in the early morning hours, and normal BG levels are harder to maintain (Chase, 2002).

In addition to the convention injection treatment described above, another method of insulin replacement is known as basal-bolus therapy. This treatment involves one daily injection of a long-acting (background) insulin (i.e. Lantus®) combined with pulses (boluses) of rapid acting insulin (i.e. NovoLog, Humalog). The advantage of this therapy is that Lantus has no pronounced peaks and a nearly 24-hour duration of action (Chase, 2002). The rapid acting insulin, which peaks between 30-60 minutes, can be taken prior to meals to cover extra carbohydrate intake and to correct high BG levels. Therefore, there is increased dietary flexibility and improved metabolic control. The disadvantage of this treatment is that individuals are required to engage in more frequent injections and BG checks, and count carbohydrates. Therefore, individuals on basal-bolus therapy must demonstrate increased attention to diabetes self-care (Wang, Carabino, & Vergara, 2003).

Recently, the insulin pump, or continuous subcutaneous insulin infusion (CSII), has been offered as an alternative to multiple daily injections (Hanas, 2001). The pump is a microcomputer that allows insulin to be delivered continuously (through preprogrammed basal infusion rates) to mimic normal physiological functioning. Additional intermittent insulin doses (bolus) must be given at meal and snack times, and to correct abnormal glucose levels (Chase, 2002; Kaufman, Halvorson, Fisher & Pitukcheewanot, 1999). Individuals using the insulin pump also are required to engage in intensive BG monitoring, record keeping, and carbohydrate counting. In addition, patients must make daily complex decisions, and understand mathematical concepts related to insulin corrections and carbohydrate to insulin ratios. Due to the complexity of

this regimen, it is often recommended that patients demonstrate the appropriate motivation, skills and cognitive maturity prior to being placed on the pump (ADA, 1998). In addition, there is an increased risk of weight gain and hypoglycemia, particularly if patient management is inadequate (Tamborlane & Ahern, 1997). However, the pump has significant advantages over conventional therapy including less variability in insulin absorption, better matching of insulin to food intake, marked dietary flexibility and better control of BG levels (Leichter, Reynolds, & Bolick, 1985; Wredling, Hannerz & Johansson, 1997).

However, it is important to note that all insulin replacement systems only approximate normal pancreatic function. Therefore, both hyperglycemia and hypoglycemia can regularly occur and must be managed to avoid complications. Diabetes is associated with serious complications that typically occur 15-20 years after disease onset. For example, it is the primary case of new cases of blindness among those aged 20-74 (Winer, 2004), accounts for approximately 25% of all new cases of end-stage renal disease (Daneman, 2006), and 40-45% of all non-trauma caused amputations in this country (Rayman, 2004). Fortunately, the results of a large clinical trial have indicated that intensive management can decrease mean BG levels and prevent or slow the progression of many complications, including retinopathy, nephropathy (kidney disease) and neuropathy (nerve disease; DCCT, 1994).

Appendix B: Type 1 Diabetes: Psychological and Behavioral Considerations

Because there is no cure, diabetes management requires daily attention over the course of one's lifespan. As Johnson (1998) notes, a disease that is characterized by both chronicity and complexity presents numerous behavioral challenges, particularly in adolescence. Clearly, appropriate medical management of diabetes is essential for survival. However, behavioral factors such as adherence to medical regimens, coping skills, and family systems also play an important role in maintaining good metabolic control. In addition, having a chronic illness such as diabetes may place children with this condition at increased risk for the development of psychological problems (Lavigne & Faier-Routman, 1992). Given the importance of behavioral and psychological factors to overall management, the purpose of the next section is to review psychological aspects of diabetes in children and adolescents.

Numerous studies have attempted to identify psychosocial factors that place children at risk for poor metabolic control. As previously noted, age is one of the key predictors of poor self-management, with adolescence representing the developmental period of least adherent behavior (e.g., Hamilton & Daneman, 2002). Demographic characteristics, including race and income, have been related to increased hospitalizations for DKA and poor metabolic control (Auslander et al., 1997; Cohen et al., 2002). Family factors have been widely studied, and several variables related to family functioning have been linked with regimen adherence and metabolic control. For example, there is increasing evidence that parental involvement is predictive of improved glycemic control (e.g., Anderson, Brackett, & Ho, 2000). During adolescence, it is developmentally appropriate for children to become more autonomous and self-sufficient. Thus, it is also a

time when parents start to withdraw their involvement in diabetes management. However, LaGreca and colleagues (1995) noted that adolescents who had greater responsibility for insulin administration were in poorer metabolic control and families who provided support for regimen tasks had adolescents who demonstrated better treatment adherence. In addition, family communication, problem solving skills, and conflict resolution skills are also correlated with treatment adherence and metabolic control in cross sectional studies (Hauser et al., 1990; Wysocki, 1993) and associated prospectively with outcomes in longitudinal studies (Hauser et al., 1990; Jacobson et al., 1994).

In addition to support from family members, social support from peers is particularly important during adolescence. This increased significance can have potentially adverse or beneficial effects on adherence and metabolic control. For example, adolescents may demonstrate poor dietary adherence when with friends (Delamater et al., 1988), and succumb to peer pressure to experiment with drugs, tobacco, and nicotine (Walker, 2002). On the other hand, peers may provide positive emotional support with respect to diabetes care that may be reflected in better adherence. Although assessment of peer support has received limited attention, one controlled study reported benefits on adjustment and knowledge following a peer group intervention (Greco, Pendley, McDonell, & Reeves, 2001).

Children with diabetes usually function normally in the classroom setting, and have IQ scores consistent with the general population (Johnson, 1998). However, diabetes is associated with neuropsychological effects that may interfere with diabetes management (Ryan & Williams, 1993). Although it is beyond the scope of this paper to

provide a comprehensive review of neuropsychological sequelae of diabetes, there is evidence that in some children, diabetes is associated with adverse acute and chronic cognitive effects, particularly in children diagnosed before the age of 5. For example, Type 1 Diabetes is associated with poorer performance on selective neurocognitive tasks, including tasks that tap visual-motor, memory, and attentional skills (see Rovet, 2000; Ryan & Williams, 1993, for reviews). Although no consistent pattern of neuropsychological findings has emerged, it is important to note that children with diabetes may be more likely to display selective executive functioning deficits that may adversely impact diabetes management (Wysocki, Greco, & Buckloh, 2003). Such findings highlight the importance of studying the impact of variables related to executive functioning (i.e. impulsivity) on self-management behaviors and metabolic control.

There is also increasing evidence that children with diabetes are at increased risk for psychological problems such as depression, anxiety, and eating disorders compared to the general population. For example, Kovacs et al. (1997) indicated that 27% of diabetic youths in their sample had an episode of major depressive disorder (MDD) and 13% had a diagnosable anxiety disorder during the 10 years after the onset of diabetes. This rate compares with 20% for MDD and 8% for anxiety disorders in community samples (lifetime prevalence prior to the age of 18; Lewinsohn et al., 1993). The incidence of psychopathology in this population is problematic because disorders such as depression and anxiety have been linked with poorer glycemic control (Grey, Cameron, & Thurber, 1991; Lustman et al., 1996). Interestingly, however, other studies have linked internalizing problems such as depression and negative attributional cognitive styles with better glycemic control (Cohen et al., 2004; Brown et al., 2001).

In addition, adolescents with diabetes (particularly adolescent girls) may be at higher risk for the development of eating disorders (Wysocki et al., 2003) and is associated with worse metabolic control. It is estimated that as many as 31% of female adolescents and adults purposefully omit insulin (to avoid weight gain associated with insulin treatment or to compensate for binge-eating; Polonsky et al., 1994; Takii et al., 1999) and 10% meet diagnostic criteria for an eating disorder, a rate which is twice as high as in girls without diabetes (Jones et al., 2000; Rydall et al., 1997).

In general, child psychopathology and behavior problems have been associated with poorer adherence and metabolic control (Liss et al., 1998). Kovacs et al (1995) identified risk factors for multiple hospitalization related to diabetes in school-aged children and found that higher levels of externalizing behavior problems, younger age at diagnosis, and low SES were significant predictors of admissions. Although longitudinal studies are needed to examine the nature of this association, there is likely a bidirectional relationship between diabetes and behavior problems. This research highlights the importance of assessing psychological problems and family functioning in working with children with Type 1 diabetes.

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