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## Relation of Child Feeding Behaviors & Caregiver Qualities to Adherence to Nutritional Therapy in Type 1 Diabetes Management

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Relation of Child Feeding Behaviors & Caregiver Qualities to Adherence to Nutritional Therapy  
in Type 1 Diabetes Management

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**Dissertation submitted  
to the Eberly College of Arts and Sciences  
at West Virginia University**

**in partial fulfillment of the requirements for the degree of**

**Doctor of Philosophy in  
Psychology**

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**Morgantown, West Virginia  
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## ABSTRACT

### Feeding Behaviors and Parenting Characteristics as Factors in Type 1 Diabetes Management

Corrine N. Ahrabi-Nejad

Type 1 diabetes (T1D) is a chronic illness, typically diagnosed within childhood, that affects the ability of the pancreas to produce insulin. Significant daily self-management behaviors are required to maintain metabolic control for patients with T1D. Nutritional therapy, including adequate intake of macronutrients, is one self-management behavior necessary to optimize health. Adherence to such nutritional guidelines is associated with improved glycemic control, decreased instances of acute health complications (e.g., hyperglycemia, hypoglycemia), and can also prevent insulin resistance. Despite the critical importance of nutritional therapy, adherence to these guidelines remains low within pediatric populations. Therefore, it is important and necessary to better understand relevant factors related to nutritional adherence. Child feeding behaviors is one factor that may influence nutritional therapy, as some literature has identified childhood selective eating to be related to dietary intake quality. The parent-child dynamic also presents unique challenges for achieving diabetic adherence. Some studies indicate that parents of children with T1D report more mealtime stress. However, it is unknown whether specific parent characteristics, such as parent stress or parenting style, influence child nutritional adherence. The current study investigated variables associated with nutritional adherence and health outcomes in children with T1D. Sixty-three children with T1D and their primary caregiver were recruited from in-person and tele-based endocrinology appointments in a pediatric endocrinology clinic in West Virginia. Participants completed self-report questionnaires remotely and researchers extracted relevant health information (HbA1c, diabetes regimen, date of diagnosis) via chart review. Linear regression modeling was used to determine the extent to which child feeding behaviors predicted (a) nutritional adherence and (b) glycemic control. Moderation analyses were used to identify the extent to which parent factors, including authoritative parenting style and parent stress, moderated the relation of child feeding behaviors to nutritional adherence and glycemic control. Problematic child feeding behavior was negatively associated with nutritional adherence to vegetable and protein intake while no association between child feeding behavior and glycemic control was observed. Caregivers with low degrees of parent stress and high degrees of authoritative parenting moderated the relationship between problematic feeding behavior and nutritional adherence. Increased use of Continuous Glucose Monitor (CGM) therapy was associated with low HbA1c levels. Continuing research on factors influencing health outcomes for pediatric T1D patients is needed, with more objective measures of parenting characteristics. Parent-based behavioral interventions and increased access to diabetes technology are recommended to optimize pediatric health outcomes. Recommendations for clinical-based program development surrounding behavioral health interventions are presented and healthcare policy recommendations are discussed.

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## **Feeding Behaviors and Parenting Characteristics as Factors in Type 1 Diabetes Management**

Type 1 Diabetes (T1D) is an autoimmune disease that causes an absolute insulin deficiency within the pancreas, leading to deficits within the carbohydrate and lipid metabolism systems (Centers for Disease Control and Prevention [CDC], 2014; Cooke & Plotnick, 2008). Unlike type 2 diabetes, the exact cause of T1D is unknown (Cooke & Plotnick, 2008). Research speculates the autoimmune reaction to be secondary to an environmental trigger (e.g., toxins, diet, infections), that with a potential genetic predisposition results in pancreatic insufficiency (Cooke & Plotnick, 2008; Jahromi & Eisenbarth, 2006). Previously referred to as juvenile diabetes, T1D is most commonly diagnosed within childhood, with peak incidence rates between ages 2 and 6 years, and again between ages 10 and 14 years (Cooke & Plotnick, 2008). Globally, incidence rates of T1D have increased in the past three decades, with an estimated 20 per 100,000 cases in the United States (Cooke & Plotnick, 2008; Mayer-Davis et al., 2017). National U.S. Census data from 2002 to 2012 identified an increase in incidence rates of 1.4% annually, with significant increases in T1D among Hispanic populations (Mayer-Davis et al., 2017). The exact cause for such increase is unknown, though research speculates this rise to be due to a multifactorial process possibly involving hygiene, viral triggers, vitamin deficiencies, and environmental exposures (Ergo, 2013).

### **Managing Type 1 Diabetes**

Pancreatic insufficiency involved in T1D leads to an inability to effectively metabolize carbohydrates and lipids (Cooke & Plotnick, 2008). Individuals with T1D require daily adherence behaviors to maintain metabolic control including multiple daily insulin injections, carbohydrate calculations, exercise monitoring, and blood glucose monitoring. Individuals with

T1D can no longer produce their own insulin, and need to administer insulin via injection (Cooke & Plotnick, 2008). Insulin ratios are determined by the individual's endocrinologist, with pediatric populations typically requiring between 0.5 to 1.2 units/kg per day (Cooke & Plotnick, 2008; Silverstein et al., 2005). Individuals can control blood glucose using several different insulin regimens including daily insulin injections, split/mixed regimens (injections of short and intermediate-acting insulin, two to three times daily), or basal/bolus (long acting insulin paired with short-acting insulin) (Cooke & Plotnick, 2008; Silverstein et al., 2005). Research within the endocrinology field has led to substantial technological advances in the management of T1D, and individuals can now manage insulin injections via an insulin pump; though regardless of technology use, all individuals administer insulin daily (Cooke & Plotnick, 2008).

Individuals with T1D also require daily blood glucose monitoring to maintain appropriate glycemic control, preventing both acute and chronic complications stemming from poor glucose control (Cooke & Plotnick, 2008; Silverstein et al., 2005). Several technologies exist to measure blood glucose levels including meters using a traditional finger stick approach or continuous blood glucose monitors, pocket-sized devices that continually measure blood glucose levels using a sensor placed on the skin (Cooke & Plotnick, 2008). National guidelines recommend at least four blood glucose checks per day, including prior to meals, snacks, before bedtime, and during the night, though many individuals check between 8 and 10 times per day (Cooke & Plotnick, 2008; Jahromi & Eisenbarth, 2006). Blood glucose monitoring can lead to better glycemic control and school-aged children with T1D are recommended to have daily blood glucose levels between 90 to 180 mg/dL (Juvenile Diabetes Research Foundation [JDRF], 2017). Glycated hemoglobin (HbA1c) is a measure of average blood glucose over the preceding 2-month period and is an indicator of an individual's general glycemic control; national guidelines



recommend school-aged children to have an HbA1c less than 7.5% (Cooke & Plotnick, 2008; Silverstein et al., 2005).

Exercise is recommended for individuals with T1D, to promote a healthy life style, and is thought to improve metabolic control; however, it requires additional precautions to reduce morbidity (Cooke & Plotnick, 2008; JDRF, 2017). During activities of exercise, individuals with T1D may require additional calories or modifications of insulin dosages (e.g., less insulin to prevent hypoglycemia during exercise) (Cooke & Plotnick, 2008; Dabelea et al., 2014). Frequent blood glucose monitoring (through finger sticks or the use of a continuous blood glucose monitor) is necessary to determine such modifications (Cooke & Plotnick, 2008; Silverstein et al., 2005). Further, exercise during periods of hyperglycemia or when ketones are present is not recommended as this can lead to further metabolic deterioration (Cooke & Plotnick, 2008).

Just like typically developing youth, children with T1D require daily nutritional needs to support adequate growth, including a diet composed of complex carbohydrates, protein, and fats low in cholesterol and saturated fat (Cooke & Plotnick, 2008; Monaghan et al., 2015). To prevent blood glucose variability, insulin dosing is timed around mealtimes, and is calculated based on carbohydrate intake (Cooke & Plotnick, 2008; JDRF, 2017). Therefore, daily carbohydrate monitoring is necessary to determine proper insulin-to-carbohydrate ratios (Cooke & Plotnick, 2008). Additionally, to prevent drops in blood glucose and hypoglycemia, individuals may need to eat timed snacks during the day (Cooke & Plotnick, 2008).

Without proper adherence to this complex diabetes regimen, depletion of insulin production can cause hyperglycemia (high blood sugar levels), which when unmanaged can lead to diabetic ketoacidosis (DKA) (Cooke & Plotnick, 2008). DKA is a serious, sometimes fatal, diabetic health complication that occurs when too little insulin is in the body, leading to the

acidic buildup of ketones (ADA, 2017). Left untreated, the buildup of ketones leads to blood toxicity within the body, which can cause acute health complications including coma and death (ADA, 2017). As such, individuals in DKA may require hospitalization to receive insulin therapy and fluids (ADA, 2017). Chronic hyperglycemia can also lead to long term morbidity (e.g., kidney disease, renal disease, blindness, stroke, heart attack) and mortality (Cooke & Plotnick, 2008). Further, improper diabetes adherence and inaccurate insulin-to-carbohydrate calculations can lead to insufficient blood sugar levels resulting in hypoglycemia (blood sugar < 60mg/dL), where there is more active insulin in the body than needed (Cooke & Plotnick, 2008). Episodes of hypoglycemia can result in acute complications including headaches, dizziness, seizure, and coma (Cooke & Plotnick, 2008). Fear of hypoglycemia is frequently reported by individuals and their caregivers, as hypoglycemic episodes can occur suddenly, are frightening, and can be fatal (Amiri et al., 2018; Monaghan et al., 2015). Daily adherence to a T1D medical regimen is imperative to prevent acute and chronic morbidity and mortality (Cooke & Plotnick, 2008). Overarching adherence goals generally seek to achieve metabolic homeostasis (glycemic control) by manipulating carbohydrate intake alongside insulin administration (Cooke & Plotnick, 2008).

In sum, effectively managing T1D involves a complex medical regimen with nuances. For individuals with T1D to maintain glycemic control, it is vital to adhere to the myriad of daily health behaviors - blood glucose monitoring, nutrition management, insulin administration, and exercise monitoring (Cooke & Plotnick, 2008; JDRF, 2017). Further, maintaining glycemic control is necessary to prevent short term and long term health complications (Cooke & Plotnick, 2008). Given the complex regimen, caregivers (parents) take primary responsibility for self-management behaviors and monitoring metabolic control for children with T1D (Silverstein et al., 2005), particularly for preschool- and school-aged youth. Because of the complexities

involved in maintaining diabetic health, paired with the challenges involved in the parent-child relationship, this population is an important group to study to better understand factors influencing health outcomes.

### **Nutrition & T1D**

Nutritional management, also referred to as nutritional therapy, is a key component of achieving metabolic control in the T1D regimen (Aslander-van Vliet et al., 2007). The International Society for Pediatric and Adolescent Diabetes (ISPAD) has developed clinical practice guidelines for managing childhood diabetes including appropriate eating behaviors (e.g., sitting upright at a table), scheduled mealtimes, adequate nutritional intake, prevention and treatment of diabetic complications (i.e., hypoglycemia, hyperglycemia), and supportive parent-child mealtime interactions (Aslander-van Vliet et al., 2007). However, nutritional therapy is often difficult to follow during childhood and adolescence (Aslander-van Vliet et al., 2007; Cooke & Plotnick, 2008; Smart et al., 2009). Because of the intensive demands of nutritional therapy, research has found adherence rates among pediatric T1D populations to be relatively low, with one study finding only approximately 21 to 56 percent of youth maintaining dietary adherence (Davison et al., 2014). A systematic review of 23 studies assessing adherence to nutritional therapy among youth with T1D found that between 21 and 95 percent of youth maintain adequate nutritional adherence (Patton, 2011). Given this large range, it is difficult to conceptualize actual adherence rates to nutritional therapy and identify populations who may benefit from targeted behavioral interventions.

Caregivers are often responsible for food purchasing and preparation, and need to provide meals that cater to both the child's dietary preferences and fulfill necessary carbohydrate needs (Silverstein et al., 2005), all while meeting the preferences and needs of other family members as

well. Further, parents have the unique challenge of balancing their child's food intake with metabolic requirements and insulin ratios (Smart et al., 2009). It is recommended that individuals with T1D consume a diverse range of foods, including complex carbohydrates, proteins, and unsaturated fats (Aslander-van Vliet et al., 2007; Cooke & Plotnick, 2008). Despite the importance of adequate nutritional intake on T1D health outcomes, the pediatric T1D population has poor nutritional adherence rates, with feeding difficulties being one cause (Cooke & Plotnick, 2008)

Poor nutritional adherence can create significant barriers to obtaining metabolic control (Silverstein et al., 2005). For example, unpredictable and potentially erratic carbohydrate consumption can lead to challenges in administering accurate amounts of needed insulin (Silverstein et al., 2005). Insufficient carbohydrate intake, which occurs when actual carbohydrate consumption is less than predicted, can lead to hypoglycemia due to excessive active insulin in the body (Silverstein et al., 2005). Episodes of hypoglycemia can then be exacerbated by food refusal, when parents are unable to treat low blood sugar using appropriate snacks (Silverstein et al., 2005). Further, frequent snacking on low nutrient foods (e.g., candy, donuts) among school-aged children can lead to spikes in blood glucose levels or hyperglycemia as well as increased risk for diabetic ketoacidosis (Silverstein et al., 2005). Therefore, irregular feeding behaviors present challenges for maintaining desired metabolic control and can compound acute health complications.

Øverby and colleagues (2007) conducted a longitudinal study with 550 Norwegian children and adolescents ages 2 to 19 with T1D, assessing the association between dietary factors and HbA1c. Children and adolescents who self-reported higher intakes of fiber, fruits, and vegetables were found to have improved metabolic control when compared to individuals with

lower intake of fiber, fruits, and vegetables (Øverby et al., 2007). Additionally, children who consumed higher intakes of added sugar or soft drinks were more likely to have suboptimal glycemic control (Øverby et al., 2007). Results from this study suggest that adherence to nutritional recommendations, high in whole foods and low in added sugars and trans-fats, may be associated with improved nutrient intake and glycemic control. However, the study reported a statistically significant difference between the HbA1c of individuals who participated in the study compared to individuals who declined enrollment or dropped out prior to study completion. Therefore, selection bias or attrition may have resulted in skewed results between the relation of dietary intake and HbA1c (Øverby et al., 2007).

A later cross-sectional study of 252 youth (aged 8-18 years) with T1D assessed the relation between diet quality and HbA1c (Nansel et al., 2012). Results from the study showed significant non-adherence to nutritional guidelines, with only 3% to 12% of the participants meeting dietary recommendations for fruit, vegetable, or whole grain intake and twice the recommended amount of saturated fat consumption (Nansel et al., 2012). Additionally, fruit and whole-grain intake was negatively associated with HbA1c and body weight, while vegetable intake did not influence glycemic control (Nansel et al., 2012). Study findings were consistent with previous literature (i.e., Øverby et al., 2007), showing an association between nutritional intake and improved health outcomes. Nansel and colleagues (2012) may have also more accurately measured nutritional intake, using a less subjective three-day weighted food log, compared to previous studies (e.g., Øverby et al., 2007), which relied on retrospective self-report. A second analysis using the same sample of 252 youth with T1D ages 8 to 18 revealed a diet of excess saturated fats and insufficient fiber (Katz et al., 2014). Further, youth with poor nutrient adherence were more likely to have an HbA1c greater than 8.5%. Poor nutritional

adherence within pediatric diabetes populations, including excessive saturated fat and minimal vegetable intake is further corroborated by various other studies within the field (e.g., Helgeson et al., 2006; Maffeis et al., 2012; Nansel et al., 2016; Øverby et al., 2006; Rovner & Nansel, 2009).

In adolescents with T1D, however, some researchers found better dietary intake than that of typically developing children (Lodefalk & Åman, 2006; Maffeis et al., 2012). Lodefalk and Åman (2006) assessed the dietary intake of 174 adolescents with T1D and 160 age- and sex-matched typically developing control participants using a study-specific food frequency questionnaire (FFQ) (a self-report measure of the frequency of food intake for a variety of foods, across a one year period). A smaller subset of the matched pairs completed an objective measure of dietary intake using a real-time, four-day food log. The diabetic sample showed higher intakes of fruits, vegetables, meats, and fish compared to age- and sex-matched peers. Similarly, in an Italian study of 114 youth ages 6 to 16 with T1D and 448 controls, youth with T1D consumed lower dietary intake of lipids, simple carbohydrates, and saturated fats as well as higher intakes of fiber (Maffeis et al., 2012). Results indicated that the diets of youth with T1D were closer to national dietary guidelines compared to the control group (Maffeis et al., 2012). It is important to note that both studies identifying improved dietary adherence among T1D populations were conducted outside the United States, in Sweden (Lodefalk & Åman, 2006) and Italy (Maffeis et al., 2012), respectively. When assessing dietary intake by region, individuals in the United States, on average, have diets higher in fats and carbohydrates compared to many European countries (Elmadfa & Kornsteiner, 2009). Such cultural factors may hinder diabetic adherence, specifically for youth living in the United States, and may indicate that international research is less generalizable to U.S. pediatric populations. Further, conceptions about nutritional therapy

differ by country, with many Americans with T1D favoring a diet higher in fat and cholesterol compared to a diet higher in carbohydrates, as a mechanism to avoid hyperglycemia (Särnblad et al., 2006). This method of metabolic control is less commonly observed in countries outside of the United States.

Though Lodefalk and Åman (2006) concluded that adolescents with T1D maintained a healthier diet than typical peers, further inspection of results find weaknesses in such claims. For example, adolescents with T1D still consumed higher than recommended saturated fats (Lodefalk & Åman, 2006). Additionally, adolescents with T1D consumed less sweets than age- and sex-matched peers, though they consumed more sugar free sweets than these peers (e.g., diet soda, artificial sweeteners). As discussed by Mehta and colleagues (2009) the consumption of sugar free snacks is often misinterpreted as healthier, though such conclusions are not necessarily true. In fact, such differences in eating habits of individuals with and without T1D highlight the differences between healthy eating practices and beneficial diabetic eating practices (Davison et al., 2014). In line with other studies, Lodefalk and Åman (2006) identified that the intake of fruits, vegetables, and fish was negatively correlated with glycemic control and Maffeis et al., (2012) found that for every 1 percent increase in saturated fat, youth have a 53 percent chance of having an HbA1c above 7.5%. Despite differences in findings regarding dietary adherence to nutritional guidelines among youth with T1D, general findings indicate a negative correlation between diets high in saturated fats and metabolic control (e.g., Davison et al., 2014; Katz et al., 2014; Lodefalk & Åman, 2006; Maffeis et al., 2012; Øverby et al., 2007).

Though dietary guidelines, including the consumption of a healthful diet and carbohydrate counting, have been established as a method of promoting overall diabetic health, some research speculates that individuals with T1D may only maintain partial nutritional

adherence to such recommendations (Nansel et al., 2012; Mehta et al., 2009). Qualitative focus groups with caregivers and youth/young adults ages 8-21 with T1D identified unhealthful compensatory strategies implemented to avoid episodes of hyperglycemia. For example, some parents limited their child's consumption of fruits and whole grains during meals to prevent blood sugar spikes (postprandial hyperglycemia), though this was a less common practice for individuals on basal-bolus insulin regimens (Mehta et al., 2009). These qualitative findings are consistent with other studies that have found individuals with T1D to categorize fruit as unhealthy due to its impact on glucose levels (American Diabetes Association, 2002). Most families also reported high consumption rates of "diet foods" (e.g., diet Coke, sugar free drinks) as methods to prevent hyperglycemia (Mehta et al., 2009). Though the rates of nutritional non-adherence were high within this study sample (Mehta et al., 2009), the study also indicated many beneficial nutritional adherence strategies. For instance, to avoid additional insulin administration, some individuals consumed low-carb alternatives, such as vegetables, for between-meal snacking (Mehta et al., 2009). Such findings are important to better understand nutritional non-adherence; nevertheless, methodological limitations impede the generalizability of these findings. Specifically, focus groups were conducted at a single medical center in an urban setting, and thus feeding practices discussed may not be generalizable to all pediatric T1D populations.

Overall, despite the positive health outcomes associated with nutritional adherence (e.g., improved glycemic control) (Katz et al., 2014; Øverby et al., 2007), the existing literature across U.S. based samples demonstrates low adherence to nutritional therapy among youth with T1D (Davison et al., 2014; Nansel et al., 2012; Patton, 2011). Non-adherence feeding behaviors, including overconsumption and underconsumption of recommended carbohydrates, can result in



acute health complications (e.g., hyperglycemia, hypoglycemia) (Silverstein et al., 2005). High incidence rates of other unhealthful feeding practices, including, between-meal snacking, is also commonly observed (Mehta et al., 2009; Nansel et al., 2016). The burdensome nature of recommended nutritional guidelines may be one reason for this observed non-adherence (Aslander-van Vliet et al., 2007). Additionally, many youth with T1D may also intentionally engage in non-adherence feeding behaviors (e.g., restricting carbohydrate and fruit intake, increased consumption of artificial sweeteners) as compensatory strategies for reducing fluctuations in blood glucose levels (Nansel et al., 2012; Mehta et al., 2009). Such high rates of non-adherence to nutritional guidelines is concerning and highlights the importance of seeking a better understanding of how feeding behaviors contribute to these concerns.

### **Measures of Nutrition Adherence**

Understanding the role of nutrition in T1D management is critical to enhancing health outcomes for youth. However, the literature currently lacks consensus on the current state of non-adherence, and its definition, among youth with T1D. A systematic review involving 23 studies assessing nutritional adherence among youth with T1D (Patton, 2011) illustrated that studies varied drastically in their conceptualization of nutritional adherence, defining it as macronutrient intake, adherence to carbohydrate-to-insulin ratios, and adherence to scheduled mealtimes (Patton, 2011). Review of these studies also revealed wide ranges of adherence, identifying rates from poor (21%) to excellent (95%) (Patton, 2011). Such inconsistencies across the literature suggest barriers in both defining nutritional non-adherence as well as reliably measuring true nutritional adherence.

One barrier to reliable and valid measurement of nutritional non-adherence may be reporter characteristics. Measuring dietary intake is a complex and demanding task, which often

requires individuals to report on numerous factors (e.g., name/brand of food, details on food preparation, time of consumption, portion size) (Pérez-Rodrigo et al., 2015). An individual's abilities and characteristics (e.g., motivation) need to be taken into account when considering the reliability of dietary recall across a range of reporters. Developmental and cognitive abilities, including literacy skills, attention span, abstract understanding of time, and memory capacities are all factors required in the reporting of dietary intake (Pérez-Rodrigo et al., 2015). Therefore, children may not developmentally possess the cognitive abilities required to reliably report their dietary intake. Additionally, because caregivers are primarily responsible for food purchasing and preparation, children may have limited insight into portion sizes, food preparation knowledge, or ingredients added (Pérez-Rodrigo et al., 2015).

As children age, they begin to develop the cognitive capacity needed to reliably report on their own dietary intake. Some research suggests that once children reach the age of seven, their ability to self-report food intake drastically improves (Domel et al., 1994; Livingstone & Robson, 2000) and by the age of 8-10, children's ability to accurately report dietary intake from a 24-hour period is as reliable as a caregiver (Achterberg et al., 1991; Livingstone & Robson, 2000; Lytle et al., 2000). Despite this developmental advancement, school-aged children may still demonstrate difficulty reporting irregular or inconsistent dietary intake (e.g., unscheduled meals during weekends or events) and food intake over more than a 24-hour period (Livingstone & Robson, 2000; Pérez-Rodrigo et al., 2015). However, a general consensus on children's ability to accurately report dietary intake does not yet exist, with some research suggesting that accurate dietary reporting does not occur until age 12 to 14 (Pérez-Rodrigo et al., 2015).

Surrogate reporting of dietary intake, by a parent or other adult caregiver, also presents barriers to accurate reports of nutritional adherence (Pérez-Rodrigo et al., 2015). Social

desirability can lead surrogates to under or over report food intake of their child. In addition, surrogates may have limited insight into dietary intake of their child for out-of-home eating (e.g., meals at school) or variable food habits (e.g., snacking, grazing) (Pérez-Rodrigo et al., 2015). Due to the divide in the literature, there are no definitive recommendations on who, caregivers or children themselves, are best reporters on dietary intake for school-aged children (ages 8-12) (Burrows et al., 2010; Pérez-Rodrigo et al., 2015).

Several measures exist within the literature to measure nutritional intake. The 24-hour diet recall has individuals reflect upon and then report on all food and drink consumed within the previous 24-hour period (National Institutes of Health, National Cancer Institute. (n.d.)). In contrast, Food Frequency Questionnaires (FFQ) measure dietary intake over a defined period (day, week, month, year) using a structured questionnaire format of specified food/beverages and a frequency response section (National Institutes of Health, National Cancer Institute. (n.d.)). Both the 24-hour diet recall and FFQ are methods, rather than validated interviews or questionnaires, which are then tailored to the particular needs of a given study. In a systematic review, Olukotun and Seal (2015) assessed the validity of pediatric dietary assessment tools. They identified nine studies, including those using FFQ, 24-hour diet recalls, 3-day food records, and weighted food records (WFR). They concluded that the FFQ method is the most reliable and valid measure of energy intake among children ages 11 and younger (Olukotun & Seal, 2015). When used with pediatric populations, the 24-hour diet recall led to overreporting of food intake. It is important to note that compared to adult populations, there is a dearth of validated measures of dietary intake for use among pediatric populations (Olukotun & Seal, 2015). Because measurement of dietary intake in children is vital to identify those at risk for poor nutritional

adherence and address their needs, more validation studies are needed in pediatric feeding assessment (Olukotun & Seal, 2015).

### **Selective Eating and Negative Feeding Behaviors**

Several factors may influence why children with T1D do not adhere to nutritional guidelines, one being behavioral feeding problems. Feeding challenges are common among young children, and research suggests 14-50% of all young children (ages 0 to 5) experience some form of feeding problem (Cano et al., 2015; Tully et al., 2018). Feeding challenges can include selective eating (i.e., limited food variety), food refusal (i.e., refusing to eat specific foods), mealtime disruption, and avoidance behaviors (Cano et al., 2015; Tully et al., 2018). Along with the wide range of feeding problems, the severity of such behaviors can range from minor selective eating to complete food refusal (Carruth et al., 2004; Tully et al., 2018). These feeding behaviors are often negatively reinforced by parents, as parents limit food exposure to only the child's preferred foods, restricting the quality and variability of the child's diet (Cardona Cano et al., 2015; Tully et al., 2018).

Research suggests that incidence rates of feeding problems within pediatric T1D populations is also high (Patton et al., 2009; Powers et al., 2002). Parents of young children with T1D report longer mealtimes (> 20 minutes), poor appetite, child resistance to mealtimes, and lack of mealtime enjoyment (Powers et al., 2002). Such feeding concerns in young childhood are common but often transient. However, feeding problems that persist into later childhood and adolescence are often pervasive and can cause clinically significant developmental concerns (e.g., malnutrition, failure to thrive, constipation) (Cardona Cano et al., 2015; Chisholm et al., 2010; Williams et al., 2010). Therefore, it is important to study mealtime behavior among older children, as feeding problems are developmentally less appropriate.

Mealtimes are a critical component to diabetic adherence, with three key adherence behaviors occurring during mealtimes: blood glucose monitoring, insulin administration, and carbohydrate calculations (Patton et al., 2006; Patton et al., 2009). Therefore, feeding problems during mealtimes can lead to difficulty maintaining diabetic control, as food refusal and selective eating can interrupt important adherence behaviors (Cooke & Plotnick, 2008; Smart et al., 2009). Further, children may not comprehend nutritional intake as a method of diabetes management and may not understand the relation between food refusal and hypoglycemia (Silverstein et al., 2005). Food refusal can make it difficult to accurately count carbohydrates when children do not eat all of the planned meal, something common in children with feeding difficulties (Streisand & Monaghan, 2014). When compared to typically developing children, families of children with T1D report worse child mealtime behavior, indicating a significant barrier to nutritional therapy adherence for these families (Borge et al., 2004; Patton et al., 2009; Piazza-Waggoner et al., 2008).

Patton and colleagues (2009) used qualitative video coding of child mealtime behavior across 35 families with children ages 2 to 8 years, assessing the impact of child feeding problems on nutritional adherence (Patton et al., 2009). Child disruptive behavior was associated with decreased carbohydrate intake, and such disruptive behavior occurred nearly half the duration of total mealtime (Patton et al., 2009). These findings are important, as decreased carbohydrate intake leads to increased risk for hypoglycemia when preprandial insulin is administered (Patton et al., 2009; Silverstein et al., 2005). However, the small sample was recruited from one medical center, limiting the generalizability of these findings to the larger pediatric T1D population. It is important to note that this study assessed child mealtime behavior for young children, ages 2 to 8 (Patton et al., 2009). Younger children have more in-home eating and are more easily influenced

by parents while older school-aged children and adolescents have more out-of-home eating and are more influenced by their peers (Pérez-Rodrigo et al., 2015). Further, problematic mealtime behavior is more common in young children, and may differ in clinical presentation compared to older children (Tully et al., 2018). These findings might not generalize to school-aged children and thus, it is necessary to study mealtime behaviors among older school-aged children with T1D to understand how age may be a factor in the relation of this behavior to nutritional adherence.

A study of 252 youth with T1D, ages 8 to 18, measured the relation between pediatric food neophobia (i.e., fear of anything new) and diet variety using a 3-day diet recall and parent-report questionnaires (Quick et al., 2014). Child food neophobia was negatively associated with nutritional intake as indicated by food variety intake (Quick et al., 2014). Children, on average, consumed foods from 8 out of 20 identified food groups, indicating limited diet variety (Quick et al., 2014). Despite the strong relation between child feeding behaviors and nutritional adherence, the study did not identify factors influencing this relation. It is important to understand what factors moderate the relation between food neophobia and dietary intake among children to inform intervention strategies to improve T1D dietary adherence.

Given the negative impact that selective eating can have on health behaviors, researchers have devised helpful interventions to increase food acceptance among children with T1D (Nansel et al., 2017). For example, Nansel and colleagues (2017) conducted a longitudinal (18 months) randomized controlled trial with 8- to 16.9-year-olds with T1D, measuring diet quality using a 3-day diet log at four separate time points. Participants were randomly assigned to the control group (treatment as usual) or the experimental group (behavioral feeding intervention). Families in the experimental group participated in six educational sessions and three booster sessions

incorporating motivational interviewing, problem-solving, and nutrition education to increase food acceptance. Youth identified as picky eaters in the experimental group showed an increase in consumption of accepted foods; however, picky-eaters did not demonstrate an increase in acceptance of non-preferred foods (Nansel et al., 2017). Given the dearth of randomized controlled trials to assess selective eating among older children with T1D, these promising findings suggest that behavioral interventions can improve diet quality and decrease the severity of selective eating in these youth. However, only 24% of invited and eligible families participated in the study (Nansel et al., 2017), which highlights concerns for selection bias in the final sample as well as possible concerns regarding family acceptability of behavioral feeding interventions.

### **Parenting Factors**

Current guidelines set by the American Diabetes Association suggest that children do not begin to learn the short term and long term benefits of maintaining diabetic control until the ages of 8 to 11 (Silverstein et al., 2005). Therefore, school-aged children require significant parental assistance in managing their diabetes, including nutritional adherence (Silverstein et al., 2005). Given the complexities of managing T1D, parents of children with T1D are responsible for almost all diabetes management behaviors (Silverstein et al., 2005). This is necessary because children lack the developmental skills necessary to accurately implement required behaviors such as calculating insulin ratios, engaging in long-term planning, and monitoring blood glucose levels (Silverstein et al., 2005). However, as children develop, they begin to take on more management responsibilities (Silverstein et al., 2005). As such, management of T1D becomes a collaborative relationship, between the parent and child. Within this relationship, both parent and child characteristics can help or hinder diabetes management (Aslander-van Vliet et al., 2007).

Therefore, it is important to study the unique parent-child dynamics surrounding pediatric T1D management.

For decades, research has identified parenting style to be an influential factor on childhood outcomes (Baumrind, 1966). Baumrind (1966) first identified three core parenting styles – authoritative, authoritarian, and permissive – and identified how such parenting characteristics may influence child behavior. Authoritative parenting, which values both child freedom and parental control, was found to be associated with improved child behavior (Baumrind, 1966). Alternatively, problematic parenting styles, including permissive parenting (high child freedom and low parental control) and authoritarian parenting (low child freedom and high parental control), have been associated with poorer child behavior (Baumrind, 1966).

Recently, research has assessed parenting styles within the context of childhood feeding. A study by Arlinghaus and colleagues (2018) measured parenting style and dietary quality among 131 health preschoolers. Qualitative coding during family mealtimes identified authoritative parenting to be associated with improved nutritional intake (Arlinghaus et al., 2018). Research has not yet assessed parenting style within pediatric T1D feeding behaviors, but such research could be informative in identifying and addressing factors potentially influencing nutritional therapy adherence.

Positive parenting behaviors have been found to enhance T1D adherence behaviors outside of feeding (Aslander-van Vliet et al., 2007). Guidelines established by the International Society for Pediatric and Adolescent Diabetes have identified factors that promote such positive parent-child relationship including parental trust, empathy, and emotional support (Aslander-van Vliet et al., 2007). Increased parental trust, empathy, and support can promote a collaborative parent-child interaction (Chisholm et al., 2010). Unsurprisingly, an association has been found



between parents who engage in positive parenting behaviors (e.g., warmth, praise, affection) and child compliance within a diabetic medical regimen (Chisholm et al., 2010).

Parenting style has also been shown to be associated with child health outcomes. A four-year longitudinal study of 61 children ages 9 to 16 with T1D assessed the relation between family psychosocial factors and glycemic control, using self-report and objective measurement (Jacobson et al., 1994). Children with parents high in expressiveness and cohesiveness (e.g., spoke openly, expressed emotions) showed reduced glycemic deterioration over time, even when controlling for other variables, such as gender, socioeconomic status, and diabetes regimen (Jacobson et al., 1994). In addition, male children with poor family cohesion and parent conflict experienced glycemic worsening (Jacobson et al., 1994). Similarly, Patton and colleagues (2009) identified that children with caregivers who exhibited appropriate expressions of emotions and emotion regulation during mealtimes experienced fewer episodes of hypoglycemia. These findings further indicate that parent functioning plays a key role in pediatric diabetes adherence and health outcomes and suggests that characteristics outside of child behavior may influence metabolic control. Consequently, future research should investigate such variables in the context of nutritional adherence.

Parenting stress may also be an important factor in understanding child feeding behaviors and nutritional adherence. Due to the impact that inconsistent carbohydrate intake can have on children's health, parents of children with T1D face heightened mealtime stress (Monaghan et al., 2015). In fact, parents who report increased fear of hypoglycemia have been shown to have worse psychological well-being (Silverstein et al., 2005). Parent stress is often further maintained by fear of poor diabetic health outcomes. Due to the acute complications that can arise from hypoglycemia and hyperglycemia, parents may engage in unhelpful feeding strategies,

manipulating food consumption or insulin doses to reduce the likelihood that extreme glycemic experiences occur (Smart et al., 2009). For example, parents may use coercion or force a child to eat if concerns for hypoglycemia arise or restrict food access during an episode of hyperglycemia (ADA, 2002; Patton et al., 2009; Smart et al., 2009). To avoid hypoglycemia, parents may overtreat and seek to maintain a higher than average blood sugar in their child (Silverstein et al., 2005). However, maintaining a consistently high blood glucose level can lead to long term metabolic deterioration (Silverstein et al., 2005). Although these feeding strategies may be an attempt to cope with parental stress in caring for a child with T1D, these strategies unfortunately not only can exacerbate poor feeding behaviors but may increase negative parent functioning during mealtimes.

Powers and colleagues (2002) measured feeding behaviors among 80 young children (ages 1 to 6) with and without T1D, finding that parents of children with T1D experience heightened mealtime stress due to the fear of hypoglycemia (Powers et al., 2002). Consequentially, parents of children with T1D were more likely to make alternative preferred meals for their child to ensure food consumption (Powers et al., 2002). This behavior can lead to child directed meals and decrease a parent's control over their child's mealtime behaviors. Though this may decrease the chance of immediate hypoglycemia, this permissive parenting style can lead to long-term difficulties including limited child food acceptance and food selectivity. Similarly, in another study (Chisholm et al., 2010), mothers who engaged in more authoritarian parenting, including frequent demands and rigid mealtime expectations, experienced higher rates of child mealtime non-compliance and child behavior problems in a sample of young children (ages 2-8) with T1D. Authoritarian parenting may take away child autonomy, and such lack of shared decision making appears to hinder adherence behaviors.

Authoritative parenting may be a beneficial approach to enhance child adherence in T1D, including nutritional adherence (Chisholm et al., 2010). Such authoritative parenting may encourage child participation in and responsibility around diabetes management and thereby improve child nutritional intake (Chisholm et al., 2010). Further, children are more likely to comply to parental directives and respond in a positive manner when positive parenting characteristics are observed (Pérez-Rodrigo et al., 2015; Seckold et al., 2019). However, stress in the pediatric diabetes caregiving role may impede parents' ability to engage in positive parenting techniques, leading to potentially maladaptive parenting interactions around feeding and other diabetes management tasks.

### **Summary and Rationale for Current Study**

In brief, T1D is a complex chronic illness that requires intensive adherence to daily health behaviors including blood glucose monitoring, proper insulin dosing and administration, regular exercise, and nutritional therapy (Cooke & Plotnick, 2008; Silverstein et al., 2005). Such a regimen, that is both time intensive and cognitively demanding, is necessary to maintain metabolic control and prevent morbidity and mortality (Cooke & Plotnick, 2008). Adherence to such behaviors can predict long term glycemic control, as indicated by routine HbA1c levels (Silverstein et al., 2005).

Adhering to the complexities of a T1D regimen presents unique challenges for parents of children with T1D (Smart et al., 2009), particularly as children age and begin to assume some responsibility for their diabetes care. As a result, the role the parent-child dynamic has on diabetes health outcomes is an important area to study. Though parents are generally responsible for managing their child's diabetes, problematic child behaviors can create barriers for parents to engage in effective adherence (Smart et al., 2009). As children age, they develop more autonomy

and engage in behaviors that may compromise metabolic control, including problematic feeding behaviors (e.g., selective eating, food refusal) (Borge et al., 2004; Patton et al., 2009; Piazza-Waggoner et al., 2008). Children's nutritional non-adherence in T1D has been reported as problematic, with a diet high in saturated fats and low in vegetable and fruit intake (Helgeson et al., 2006; Maffei et al., 2012; Nansel et al., 2016; Øverby et al., 2006; Rovner & Nansel, 2009). Consequently, non-adherence can result in poor metabolic control, making it important to understand factors that may predict dietary intake.

Problematic child feeding behaviors have emerged as influential on nutritional intake and metabolic control for children with T1D (Patton et al., 2009). Feeding behaviors, including selective eating, disruptive mealtime behaviors, and food refusal may be impactful on these outcomes, as nutritional adherence is a key component for establishing effective insulin doses and regulating blood glucose levels. Mealtime disruption has been shown to be associated with worse HbA1c in children ages 2 to 8 (Patton et al., 2009). Research on the influence of feeding behaviors and health related outcomes is readily available for young children with T1D (ages 2 to 8) (e.g., Patton et al., 2009; Powers et al., 2002). However, limited research exists assessing the relation between child feeding behavior and health outcomes in school-aged children with T1D. Yet, behavioral feeding problems (e.g., selective food preferences; high intake of sugary, low nutritive snacks) have been found to be pervasive in older children, and often remain problematic across their lifetime (Cardona Cano et al., 2015; Williams et al., 2010). Therefore, further research is needed to assess the association between behavioral feeding problems and health outcomes for older children with T1D.

Because parents manage many of the health behaviors for children with T1D, parental factors may also play a role in nutritional adherence and health outcomes. Parenting styles,

specifically authoritative parenting, have been associated with decreased problematic child behavior (Arlinghaus et al., 2018). Research has yet to identify how parenting style (i.e., authoritative) is associated with problematic mealtime behavior for children who require nutritional adherence, like those with T1D. Further, problematic child mealtime behavior has been associated with increased parental stress (Monaghan et al., 2015). Such parental stress may exacerbate the effects of problematic mealtime behavior, worsening the impact it has on health outcomes. However, research has not identified how parent stress and problematic feeding behaviors interact for this population. The goal of the current study was to examine how caregiver factors influenced the association of child feeding behaviors on nutritional intake and health outcomes among school-aged children with T1D. Using a cross-sectional study design, the aims of the study were as follows:

**Aim 1.** The first aim of the project was to determine the association between child feeding behavior and nutritional intake, specifically measuring nutritional adherence. Informed by the current literature, it was hypothesized that problematic child feeding behavior would be negatively associated with nutritional adherence (Nansel et. al., 2012).

**Aim 2.** The second aim of the study was to assess the association between child feeding behavior and glycemic control for school-aged children with T1D. Previous research has identified an association between picky eating and diets high in processed food (Øverby et al., 2007). Based on the existing literature, it was hypothesized that problematic child feeding behavior would be positively associated with glycemic control, as indicated by HbA1c.

**Aim 3.** The third aim of the current study was to observe whether parent factors, including parent stress and parenting style, moderate the relation between child feeding behavior and child health outcomes. Based on research assessing parent-child interaction and problematic

child behavior, it was hypothesized that authoritative parenting would moderate this association. Authoritative parenting may reduce the impact of problematic child feeding behaviors on diabetes health behaviors (Arlinghaus et al., 2018). Further, parent mealtime stress has been linked to maladaptive feeding practices (i.e., coercion, short order cook). Therefore, it was hypothesized that parent stress would moderate the association of problematic child feeding behavior on health outcomes (Powers et al., 2002).

## **Method**

### **Participants**

Sixty three children with T1D and their parents/primary caregivers were recruited from a pediatric endocrinology center in an academic medical center that serves a largely rural population. Institutional Review Board was obtained prior to recruitment. Inclusion criteria included children: (1) between the ages of 7 and 13 years, (2) who had been diagnosed for at least 6 months with T1D; and (3) who had a parent/caregiver willing to participate. Participants with limited English language abilities or cognitive deficits that would create comprehension and completion barriers for study questionnaires were identified by clinic staff and excluded from recruitment.

### **Procedure**

Potential participants were identified by research staff using an online medical record system (EPIC). They were recruited during a routine in-person or telehealth clinic visit. Clinic staff provided a brief description of the study purpose and procedures to eligible participants and families to solicit possible interest in their participation. Those families who were potentially interested in taking part provided verbal consent for research staff to contact them. Research staff obtained written consent from caregivers and assent from pediatric patients prior to data

collection. The consenting process took place remotely over a secure web-based browser (REDCap™). The purpose of the study, subsequent procedures, benefits, risks, and confidentiality were provided through the secure web-based browser (REDCap™), followed by completion of all study measures, also via REDCap™. The average time between consent to contact and study completion was 7.59 days (SD = 9.41). See Consort Figure 1 for recruitment details. A total of 103 potential participants were contacted during a clinic visit. Of potential participants contacted, two refused participation and 101 (98%) completed consent to contact forms. Of the 101 participants who consented to be contacted, 63 families (63.4%) provided consent (parent) and assent (child) and completed all study measures. The remaining 38 families were categorized as “lost to follow-up” after three attempts of contact were made with no response. No participants dropped out after consenting/assenting and/or starting completion of study measures.

Caregivers and their child were instructed to collaborate to complete the *Block Kids Food Screener (BKFS)*, self-reporting the frequency of consumption of a variety of foods over the past week. Caregivers then independently completed the following measures: *Family Information Form*, *About Your Child's Eating-Revised (AYCE-R)*, *Parent Stress Scale (PSS)*, and *The Parenting Styles and Dimensions Questionnaire (PSDQ)*. Measures were presented in the same order to all participants, as listed above. Each participating family received a digital \$30 gift card upon completion of all study measures.

## **Measures**

### ***Family Information Form***

Caregivers completed the *Family Information Form*, a measure devised for this study to gather participant demographics and medical history. Information collected included the child's

age, race, ethnicity, education, insurance status, date of diagnosis, diabetes medical regimen, and family medical history.

***Block Kids Food Screener (BKFS; Hunsberger et al., 2015)***

The *BKFS* is an online 41-item, self-report or caregiver-report food frequency questionnaire. The measure assesses nutritional intake for youth (ages 2-17) across a one-week period for the following categories: (1) fruits, (2) vegetables, (3) dairy, (4) whole grains, (5) protein sources, (6) saturated fats, and (7) added sugar. Respondents reported their frequency of specified food consumption using a scale of 1 = *none* to 5 = *every day*. Administration took approximately 10 to 12 minutes to complete. *BKFS* scores were calculated through the NutritionQuest software system, and nutritional adherence was determined based on the U.S. Department of Agriculture (USDA) recommendations of macronutrient intake using MyPlate standards (Hunsberger et al., 2015).

The *BKFS* was validated using a sample of 99 youth, ages 10 to 17 (Hunsberger et al., 2015). It was found to have acceptable convergent validity for food intake ranging from  $r = 0.53$  to  $r = 0.88$  across food groups when compared to the 24-hr recall (Hunsberger et al., 2015). Convergent validity for nutritional intake, including intake of saturated fat, added sugar, glycemic load, and glycemic index, ranged from  $r = 0.47$  to  $r = 0.77$  when compared to the 24-hr recall. To promote overall health, national standards (USDA.gov, 2019) recommend a diet made up of the five core food groups: vegetables, fruits, whole grains, dairy, and protein. Such recommendations are disseminated to the public using the MyPlate standards and an example of the MyPlate dietary guidelines is provided in Figure 6. However, methods for maintaining nutritional adherence while optimizing glycemic control in managing T1D has emphasizes the importance of diets high in vegetable and protein intake (Lennerz et al, 2018). Specifically,



vegetables and protein have little impact on blood sugar while optimizing macronutrient intake (Lemmerz et al., 2018). The three other food domains (fruits, multigrain, and dairy) have a larger glycemic impact and can have a negative effect on overall diabetic health outcomes (i.e., glycemic control) (Lemmerz et al., 2018). Thus, this study defined nutritional adherence as the percent adherence to USDA recommended protein and vegetable intake. A nutritional adherence score was first calculated for protein intake (i.e., *protein adherence*), defined as the total ounces of protein consumed per day divided by the USDA Dietary Guidelines of daily protein intake based on age/gender, multiplied by 100. *Vegetable adherence* was defined as the daily vegetable intake (in cups) divided by the USDA Dietary Guidelines of daily vegetable intake based on age/gender, multiplied by 100. A *total nutritional adherence score* was generated summing the protein adherence score with the vegetable adherence score, divided by two.

***About Your Child's Eating-Revised (AYCE-R; Davies et al., 2007)***

The *AYCE-R* is a 25-item caregiver report measure of child mealtime behavior and parent-child feeding interactions. Caregivers rated the frequency of feeding behaviors using a 5-point Likert scale ranging from 1 (*never*) to 5 (*nearly every time*), yielding three subscale scores of child mealtime behavior: Child Resistance to Eating (e.g., “My child refuses to eat a planned meal;” “My child hates eating”), Positive Mealtime Environment (e.g., “Mealtime is a pleasant, family time;” “The family looks forward to meals together”), and Parent Aversion to Mealtime (e.g., “There are arguments between me and my child over eating;” “I dread meal times”). Some items are reverse scored to ensure participants read each item carefully. Subscale *AYCE-R* scores are generated by averaging items within subscales, with higher scores indicating increased frequency of the related subscale. A total score is generated by averaging all 25-items, with higher scores indicating increased mealtime disturbance. Of note, all items in the Positive

Mealtime Environment subscale (5 items) are reverse scored when calculating the total score on the *AYCE-R* so that its score reflects higher frequency of negative mealtime behavior.

The measure has been validated for children ages 2 to 16 and across diverse populations (e.g., sickle-cell disease, single ventricle following staged palliation, obese children, chronically ill patients) (Poppert et al., 2014) and has been noted to be a psychometrically appropriate measure of child feeding behavior (Davies et al., 2007). Convergent validity was documented via significant correlations with the *Family Environment Scale (FES)* subscales: Child Resistance to Eating  $r = 0.20$ , Positive Mealtime Environment  $r = .37$ , Parent Aversion to Mealtime  $r = 0.40$  (Davies, et al., 2007). Convergent validity was also documented for the *AYCE-R* Total Score as it significantly correlated to other pediatric feeding measures including the Mealtime Behavior Questionnaire ( $r = 0.44$ ) (MBQ; Berlin et al., 2010) and Feeding Strategies Questionnaire ( $r = 0.23$ ) (FSQ; Berlin et al., 2011). It also has satisfactory internal consistency for Child Resistance to Eating (Cronbach's  $\alpha = .89$ ), Positive Mealtime Environment (Cronbach's  $\alpha = .80$ ), and Parent Aversion to Mealtime (Cronbach's  $\alpha = .72$ ) subscales (Davies et al., 2007). A systematic review of mealtime behavior in chronic illness populations found the *AYCE-R* to be a well-established measure of feeding behaviors (Poppert et al., 2014). The current study used a total score to measure the independent variable, child feeding behavior, with higher scores indicating more problematic child feeding behavior. In the current study, the *AYCE-R* Total Score demonstrated good internal consistency (Cronbach's  $\alpha = .87$ ).

#### ***Parent Stress Scale (PSS; Berry & Jones, 1995)***

The *PSS* is a self-report (caregiver) questionnaire assessing parental stress for parents of children ages 0 to 18 years. The *PSS* measures both positive (e.g., “My child(ren) is an important source of affection for me”) and negative (e.g., “The major source of stress in my life is my

child(ren)”) aspects of parenting. Caregivers rate each of the 18 items using a 5-point Likert scale ranging from 1=*strongly disagree*, to 5=*strongly agree*. Eight items are reverse scored to reduce response set bias. A Parental Stress Score is generated by summing all responses. Total scores range from 18 to 90, with higher scores indicating higher levels of parental stress.

The *PSS* was developed using a sample of 1,276 mothers and fathers from diverse backgrounds and was found to have good psychometric properties (Berry and Jones, 1995). In particular, the *PSS* shows good convergent validity when compared to the *Parenting Stress Index* ( $r = 0.75$ ), acceptable internal consistency (Cronbach’s  $\alpha = .83$ ), as well as good test-retest reliability (6-week interval;  $r = 0.81$ ) (Berry and Jones, 1995). The current study used the total Parental Stress Score as the moderating variable in analyses; higher scores represent higher levels of parental stress. For this study, the *PSS* total score indicated good internal consistency (Cronbach’s  $\alpha = .81$ ).

***The Parenting Styles and Dimensions Questionnaire – Short Version (PSDQ; Robinson et al., 2001)***

The *PSDQ* is a 32-item self-report (caregiver) measure developed using Baumrind’s (1991) typology of parenting styles as a framework. The *PSDQ* assesses three dimensions of parenting: (1) authoritative, (2) authoritarian, and (3) permissive. The authoritative domain contains 15 items measured across the following three subscales: (1) Connection (e.g., “Responsive to child’s feelings or needs”); (2) Regulation (e.g., “Gives child reasons why rules should be obeyed”); and (3) Autonomy Granting (e.g., “Shows respect for child’s opinions by encouraging child to express them”). The authoritarian domain contains 12 items spanning the following three subscales: (1) Physical Coercion (e.g., “Spanks when our child is disobedient”), (2) Verbal Hostility (e.g., “Yells or shouts when child misbehaves”), and (3) Non-Reasoning/Punitive (e.g.,

“Uses threats as punishment with little or no justification”). The permissive domain contains 5 items measures across a single subscale of Indulgent (e.g., “States punishments to child and does not actually do them”). Parents rate each item using a 5-point Likert scale ranging from 1=*never*, to 5=*always*. A continuous score for each dimension of parenting is generated by averaging all associated subfactor responses. Higher scores indicate higher frequencies of the specified parenting practice.

The *PSDQ* was developed using a sample of 1,900 mothers and fathers with children between the ages of 4 and 12 (Robinson et al., 2001). Systematic review of the literature (Olivari et al., 2013) highlighted the widespread use of the *PSDQ* globally. Further, the *PSDQ* has been found to be a psychometrically sound measure of parenting style and practices (Locke & Prinz, 2002). Initial psychometric assessment suggests the *PSDQ* has acceptable internal consistency for authoritative (Cronbach’s  $\alpha = .86$ ), authoritarian (Cronbach’s  $\alpha = .82$ ), and permissive subscales (Cronbach’s  $\alpha = .64$ ) (Robinson et al., 2001). Given previous research suggesting associations between authoritative parenting and nutritional intake (Arlinghaus et al., 2018), this study used the authoritative score as the moderating parenting style variable in analyses. Higher scores on this subscale indicate higher levels of an authoritative parenting approach. In the current sample, the *PSDQ* authoritative subscale score demonstrated good internal consistency (Cronbach’s  $\alpha = .84$ ).

### ***HbA1c.***

Medical records were reviewed to determine each participant’s most recent HbA1c. HbA1c is collected via blood work during routine clinic appointments and is a measure of glycemic control calculated by averaging blood glucose levels over a period of approximately 3 months (Jeffcoate, 2004). The most recent HbA1c value would be most closely related to the

child's current adherence patterns, including dietary adherence. Guidelines set by the American Diabetes Association recommends blood glucose levels at or below 7.5% (ADA, 2017).

### **Analytic Plan**

#### **Aim 1 Analyses: Effects of Child Feeding Behavior on Nutritional Adherence**

A linear regression model was used to measure the predictive power of problematic child feeding behavior on child nutritional adherence. Linear regression models allow for assessment of the relationship between two continuous variables based on the linear equation fit to the data. The current study employed the *AYCE-R* total score, as an overall measure of child feeding behavior, to predict nutritional adherence, measured as the combined protein & vegetable percent adherence score.

#### **Aim 2 Analyses: Effects of Child Feeding Behavior on Glycemic Control (HbA1c)**

An additional linear regression model was used to assess the predictive power of problematic child feeding behavior on child glycemic control. Again, child feeding behavior was measured using the *AYCE-R* total score. Linear regression model assessed its ability to predict glycemic control as indicated by the most recent HbA1c level.

#### **Aim 3 Analyses: Effects of Parenting Factors on Child Feeding Behavior and Child Health Outcomes**

The third aim of the study used a moderation analysis to assess the degree to which parent stress and parenting style affect the strength of the relationship between the independent variable and dependent variables discussed above. Parent stress as a moderator was measured using the *PSS* total score. Parenting style, as a moderator, was assessed using the *PSDQ Authoritative* subscale total score. The first moderation analysis assessed the extent to which parenting stress (*PSS* total score ) moderated the relationship between child feeding behavior

(*AYCE-R* total score) and nutritional adherence (combined protein & vegetable percent adherence score). The second moderation analysis measured the extent to which parenting stress (*PSS* total score) moderated the relationship between child feeding behavior (*AYCE-R* total score) and glycemic control (most recent HbA1c level). The third moderation analysis measured the extent to which parenting style (*PSDQ Authoritative* subscale total score) moderated the relationship between child feeding behavior (*AYCE-R* total score) and nutritional adherence (combined protein & vegetable percent adherence score). The final moderation analysis assessed the extent to which parenting style (*PSDQ Authoritative* subscale total score) moderated the relationship between child feeding behavior (*AYCE-R* total score) and glycemic control (most recent HbA1c level).

## Results

### Preliminary Analyses

Statistical analyses were run using Statistical Package for the Social Sciences Version 23 (SPSS 23).

### *Power Analysis.*

An a priori power analysis, using G\*Power 3.1.9.2., was conducted using the aim with the greatest number of predictors to determine sufficient sample size for this study (Erdfeld et al., 1996). Based on the power analysis for a multiple regression model testing for significant  $R^2$  increase, with medium (0.5) to large-effect (0.8) size, alpha of .05 and 80% power, a minimum of 56 participants is required (Cohen, 1988). Thus, the current study, with a sample of 63 participants, appears to be adequately powered to detect a medium effect size.

### *Missing Data.*

Preliminary analyses were conducted to identify any missing data. Due to the format of the data collecting software (i.e., REDCap™), participants could not complete the study if any survey items were incomplete. Thus, the current data set did not have any missing data.

### ***Assumption Checks.***

Prior to analysis, assumptions of skew, kurtosis, and normal distribution were assessed. Glycemic Control (*HbA1c*) was found to be positively skewed (skew = 1.15, SE = .302) and a log transformation was conducted to adjust for skew. When reassessed, the transformed variable did not have any issues related to skew. Nutritional Adherence was not found to be skewed or kurtotic and no other transformations were needed.

Questionnaire scores were transformed into z-scores to assess for univariate outliers, and correlations of dependent variables were run to assess for bivariate outliers. No univariate or bivariate outliers were identified. To assess for multivariate outliers, a linear regression was performed. All variables yielded an acceptable tolerance value ( $>0.40$ ) and VIF ( $<4.0$ ), and no issues with multicollinearity were identified. Multivariate outliers were assessed using Mahalanobis distance and no outliers were identified.

### ***Descriptive Statistics.***

Descriptive statistics for all demographic and medical variables are provided in Table 1. Approximately two thirds of the participating children were female (62%) with the majority of caregivers being mothers (98%). Children were between the ages of 7 to 13 years old, with a mean age of 10.2 years (SD = 1.99). Approximately half of participants were using an insulin pump (63%) or CGM (68%) technology, with 51% of participants being on both pump and CGM technology. The average length of diagnosis was 3.8 years with a standard deviation of 3.06 years.

Table 2 presents descriptive data for all study measures. The average HbA1c of the study sample (8.5%) was above the recommended value of 7.5%. Only 33.3% of the study had an HbA1c of 7.5% or lower, indicating that a large portion of the sample did not maintain optimal glycemic control. Nutritional adherence ( $M = 74.7\%$  adherent) resulted in a large range (110.71), indicating that there was considerable variability across participants with respect to vegetable and protein intake. Only 21% ( $n = 13$ ) of the study sample achieved a nutritional adherence score of 90% or higher and 11% ( $n = 7$ ) of the study participants had a nutritional adherence score below 50%. Thus, the majority of the sample did not achieve nutritional adherence as it relates to vegetable and protein intake. The total scores for the *PSS* also resulted in a large range (34), suggesting wide variability in caregiver report of the degree of parent stress experienced. The *PSS* does not have a formal clinical cut-off score (Nærde & Hukkelberg, 2020), so it is not possible to detect caregivers experiencing clinically significant levels of stress. However, the *PSS* ranges in total scores from 18 to 90, and this study sample's mean score of 33.1 suggests that the average parent stress level was not high. Similarly, the average *AYCE-R* total score of 1.95 and the small range in scores (2) indicates that the overall sample experienced only mild to moderate problematic child feeding behavior. Additionally, the mean score of 4.1 on the *PSDQ Authoritative Scale* suggests the sample as a whole engaged in frequent use of authoritative parenting behaviors.

### **Covariates**

Pearson's correlation coefficients (continuous variables) and Spearman's correlation coefficients (categorical variables) were calculated to assess potential covariates in the model, with a focus on participant age, gender, and duration of T1D diagnosis. Use of Continuous Glucose Monitoring (CGM) was significantly negatively associated with glycemic control ( $r = -$



.36,  $p = .004$ ), showing that participants on CGM therapy were more likely to have lower HbA1c levels. Additionally, self-reported family income was negatively associated with glycemic control, ( $r = -.34, p = .007$ ), suggesting that higher family income was correlated to more optimal HbA1c levels. Finally, self-reported family income was positively associated with higher frequency of authoritative parenting ( $r = .30, p = .018$ ), suggesting that caregivers from higher income families are more likely to use authoritative parenting strategies. No other demographic variables were found to correlate to the dependent variables and no additional covariates were identified. Thus, income and use of CGM technology were determined to be potential covariates for analyses assessing glycemic control and related analyses will control for these variables (Hayes, 2017).

### **Aim 1 Analyses: Effects of Child Feeding Behavior on Nutritional Adherence**

A linear regression was calculated to examine whether Child Feeding Behavior (*AYCE-R*) predicted Nutritional Adherence (*BKFS vegetable and protein* percent adherence score). Child Feeding Behavior contributed significantly to the regression model, [ $F(1, 61) = 4.9, p = .03$ ] and accounted for 6.0% of the variance in nutritional adherence. Increased problematic Child Feeding Behavior ( $\beta = -.27, p = .03$ ) significantly predicted decreased nutritional adherence as indicated by a lower percent adherence score.

### **Aim 2 Analyses: Effects of Child Feeding Behavior on Glycemic Control (HbA1c)**

A linear regression was calculated to assess whether Child Feeding Behavior (*AYCE-R*) predicted Glycemic Control (*HbA1c*), controlling for family income and use of CGM technology. Covariates (family income, CGM technology) were entered in step one of the regression analysis and contributed significantly to the regression model [ $F(2, 60) = 6.84, p = .002$ ], accounting for 15.9% of the variance in glycemic control. Introducing the Child Feeding

Behavior variable explained an additional 4.0% of variation in Glycemic Control but this change in  $R^2$  was not significant [ $F(1, 59) = 3.06, p = .09$ ]. Results from the linear regression are reported in Table 4. A significant regression equation was found for the full model [ $F(3, 59) = 5.7, p = .002$ ] and accounted for 18.6% of the variance in HbA1c. In the full model, family income ( $\beta = -.24, p = .05$ ) and problematic child feeding behavior ( $\beta = .20, p = .09$ ) were not significant predictors of glycemic control. However, the presence of CGM technology ( $\beta = -.26, p = .04$ ) significantly predicted increased glycemic control as indicated by lower HbA1c level.

### **Aim 3 Analyses: Effects of Parenting Factors on Child Feeding Behavior and Child Health**

#### ***Moderation Model 1.***

Parent Stress was examined as a potential moderator between Child Feeding Behavior (*AYCE-R*) and Nutritional Adherence (*BKFS Percent Adherence Score*), using PROCESS (Hayes, 2017) (see Table 5 and Figure 2). The interaction term between Parent Stress and Child Feeding Behavior did not explain a significant amount of variance in Nutritional Adherence [ $b = 1.59, 95\% \text{ CI } [-0.05, 3.23], t(59) = 1.94, p = .06,$ ]. When the *AYCE-R* x low *PSS* interaction was entered, the main effect of the *AYCE-R* was significant [ $b = -21.62, 95\% \text{ CI } [-36.90, -6.34], t(59) = -2.83, p = .006$ ]. However, when *AYCE-R* x average *PSS* and *AYCE-R* x high *PSS* interactions were entered, the main effect of the *AYCE-R* was no longer significant [ $b = -7.33, 95\% \text{ CI } [-21.89, 7.23], t(59) = -1.01, p = .32;$   $b = 2.19, 95\% \text{ CI } [-18.77, 23.15], t(59) = 10.47, p = .84$ ]. Results indicate that moderate to high parent stress does not moderate the relationship between Child Feeding Behavior and Nutritional Adherence. For parents with low stress, problematic Child Feeding Behavior was negatively associated with Nutritional Adherence, suggesting that more problematic feeding behavior results in less nutritional adherence.

#### ***Moderation Model 2.***

Parent Stress was then evaluated as a moderator between Child Feeding Behavior (*AYCE-R*) and Glycemic Control (*HbA1c*), controlling for use of CGM technology and family income (see Table 5 and Figure 3). The interaction effect term between Child Feeding Behavior and Parenting Stress was not significant [ $b = 0.0004$ , 95% CI [-0.006, 0.007],  $t(57) = .12$ ,  $p = .90$ ], suggesting that Parenting Stress does not moderate the relation between Child Feeding Behavior and Glycemic Control. The interaction term between Parent Stress and Child Feeding Behavior did not explain a significant amount of variance in Glycemic Control, indicating that problematic Child Feeding Behavior was positively associated with HbA1c, regardless of Parent Stress status. Therefore, Parent Stress was not a significant moderator of the relation between Child Feeding Behavior and Glycemic Control.

#### ***Moderation Model 3.***

Parenting style, specifically the use of authoritative parenting, was assessed as a moderator between Child Feeding Behavior (*AYCE-R*) and Nutritional Adherence (*BKFS Percent Adherence Score*). (see Table 5 and Figure 4). The interaction term between Authoritative Parenting and Child Feeding Behavior did not explain a significant amount of variance in Nutritional Adherence [ $b = -15.3$ , 95% CI [-39.79, 9.29],  $t(59) = -1.24$ ,  $p = .22$ ]. However, for parents with high Authoritative Parenting, there was a relation between Child Feeding Behavior and Nutritional Adherence [ $b = -18.9$ , 95% CI [-33.53, -4.18],  $t(59) = -2.57$ ,  $p = .01$ ]. Therefore, Authoritative Parenting was a significant moderator of the relation between Child Feeding Behavior and Nutritional Adherence only for parents with a *PSDQ* score greater than 4.26.

#### ***Moderation Model 4.***

Parenting style, specifically the use of authoritative parenting, was examined as a moderator between Child Feeding Behavior (*AYCE-R*) and Glycemic Control (*HbA1c*), controlling for use of CGM technology and family income, (See Table 5 and Figure 5). The interaction term between Authoritative Parenting and Child Feeding Behavior did not explain a significant amount of variance in Glycemic Control, [ $b = -0.03$ , 95% CI [-0.65, 0.52],  $t(57) = -0.65$ ,  $p = .52$ ]. Therefore, Authoritative Parenting was not a significant moderator of the relation between Child Feeding Behavior and Glycemic Control.

### Discussion

Maintaining glycemic control is important for children with T1D. Glycemic control and health outcomes are influenced by a multitude of factors with nutritional adherence being a key component of the diabetes care regimen. Given the role child feeding has on nutritional intake and thus diabetes management, it is important to understand how problematic behavioral feeding may impact glycemic control. The present study examined the association between child feeding behavior and diabetes health outcomes, looking at both nutritional adherence and glycemic control. In addition, this study assessed the degree to which parenting factors, including parenting style and parenting stress, moderate the association between child feeding behaviors and diabetes health outcomes. Current literature has not investigated the relation between child feeding behaviors and health outcomes for older children with T1D. Thus, the current study aims to contribute to the field of research by identifying predictors of diabetes health outcomes in order to inform future interventions targeting behavioral feeding concerns within a pediatric T1D population.

Findings from the current study suggest that problematic child feeding behavior is negatively associated with nutritional adherence. Results were consistent with the study

hypothesis – that is, problematic feeding behaviors such as food refusal and disruptive mealtime behaviors, would prevent children from obtaining optimal nutritional adherence. However, problematic child feeding behavior only accounted for 6% of the variance in nutritional adherence scores, suggesting that other factors may play a significant role in child nutritional adherence. Individual and systems level factors may also influence health outcomes for youth with T1D and will be discussed.

### **CGM Therapy and Glycemic Control**

Linear regression modeling identified CGM therapy as a significant predictor of glycemic control but did not find child feeding behavior to significantly predict HbA1c. With CGM therapy being negatively associated with glycemic control, children that have a CGM are more likely to have optimal glycemic control. These findings are consistent with previous research that found a significant association between CGM use and improved glycemic control in pediatric T1D patients (Addala et al., 2020; Sheikh et al., 2018). Like previous research, current results could be explained by the increased ability to monitor and treat suboptimal blood sugar levels with CGM therapy compared to traditional blood glucose monitors. For example, children on CGM therapy can monitor elevations in blood sugar in real time, making it possible to administer insulin coverage sooner, preventing hyperglycemia. One randomized controlled trial (Juvenile Diabetes Research Foundation CGM randomized clinical trial) assessed the impact of CGM therapy on health outcomes for 451 adult and pediatric patients with T1D (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). Participants assigned to CGM therapy demonstrated a significant reduction in HbA1c levels compared to those in the control glucose monitoring group across the six month study period (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). CGM therapy allowed for real

time blood sugar monitoring, increasing the frequency and accuracy of treatment for out of range blood sugar values. Treating elevated blood sugar levels in a shorter time frame in turn improves overall glycemic control. Therefore, though children with problematic feeding behaviors may have more inconsistent mealtime blood sugar values due to food refusal or high carbohydrate consumption (e.g., preferred foods are higher carb foods), CGM therapy allows for patients and caregivers to immediately treat blood sugars, preventing a negative impact from the feeding behavior. Ultimately, CGM therapy provides patients and caregivers the ability to identify and treat an elevated blood sugar immediately, ameliorating the negative impact the feeding behavior may have on glycemic control.

These important research findings should be used to advocate for healthcare policies that increase access to CGM therapy for children with T1D as a method to promote more optimal health outcomes. One study by Addala and colleagues (2020) assessed health outcomes for pediatric T1D patients on public health insurance, specifically looking at how diabetes technology impacts health outcomes. Though CGM use was associated with improved HbA1c levels, this association was only observed for *uninterrupted* CGM use. Patients who's CGM use was interrupted due to gaps in insurance coverage exhibited *increases* in overall HbA1c levels (Addala et al., 2020). Hence, maintaining consistent access to CGM therapy is both beneficial for patient health outcomes and cost-saving for insurance companies, as optimal glycemic control reduces long-term healthcare costs (Addala et al., 2020).

Further, healthcare inequities perpetuate health disparities for pediatric T1D patients. Research assessing access to diabetes related technology for pediatric T1D patients identified that White, privately insured, English-speaking patients had significantly higher use of CGM technology (Sheikh et al., 2018). Further, public health insurance companies have historically

restricted coverage of CGM therapy for children with T1D, compared to privately insured patients (Prahalad et al., 2018). Healthcare reforms in 2016 resulted in wider coverage of CGM therapy for publicly insured patients by the Centers for Medicare & Medicaid Services (Petrie et al., 2017). However, restriction on authorizations of CGM therapy by public health insurance companies continue to result in barriers to CGM access. For example, public insurance companies often implement criteria that limits the availability of CGM coverage for low-income patients (e.g., requires a minimum of 4 blood sugar checks per day to obtain authorization for CGM therapy, to maintain long-term coverage patients must use the CGM for 5 out of 7 days) (Petrie et al., 2017; Prahalad et al., 2018). Barriers to CGM therapies perpetuates health disparities for low income patients and racial and ethnic minorities, as these communities face more restrictions in accessing CGM technology necessary for optimal diabetes control. Since CGM therapy is associated with improved glycemic control, vulnerable populations that experience barriers to CGM therapy in turn may experience worse glycemic control and poorer long term health outcomes.

### **Caregiver Qualities and Health Outcomes**

Moderation analysis suggests parenting factors do not moderate the relation between child feeding behaviors and HbA1c. However, parenting stress and authoritative parenting style were found to be associated with improved nutritional adherence for some families. For example, caregivers low in parent stress moderated the relation between problematic child feeding behavior and nutritional adherence, with more problematic behavior being associated with worse nutritional adherence. Additionally, caregivers high in authoritative parenting moderated the relation between problematic child feeding behavior and nutritional adherence. Thus, parent-based interventions could promote improved nutritional adherence for children with T1D. For

example, research by Burrows and colleagues (2010) assessed the effects of a feeding program on parent child-feeding practices for children with pediatric obesity. Children of parents who received coaching on behavioral feeding practices were observed to have significant decreases in problematic feeding behaviors (i.e., decreased mealtime pressure to eat, increased parental monitoring during mealtime) (Burrows et al., 2010). Results from this study suggest that child feeding behaviors are modifiable through parent-training interventions. Such parent-training interventions could be applied to other pediatric health populations, including T1D, to promote improvements in child feeding behaviors.

Given the implication caregiver stress has on nutritional adherence for children, identifying the degree of stress caregivers are experiencing may be important for clinicians to monitor. Monitoring the stress of caregivers within a regularly occurring endocrinology appointment may be one promising method of identifying caregivers who may benefit from parent-based interventions to reduce caregiver stress. For example, a pediatric gastroenterology clinic implemented a routine screener of caregiver stress using *The Pediatric Inventory for Parents*, a brief self-report questionnaire assessing caregiver functioning (Gray et al., 2013). The study found a positive association between caregiver stress and disease health outcomes for children with Chron's Disease. Caregiver stress was also associated with increased family dysfunction as well as increase child psychosocial concerns. Regularly screening for caregiver stress aided in targeting interventions to families and promoted improved mental and physical health outcomes (Gray et al., 2013). Given the clinical implications caregiver stress can have on both the child's mental and physical health outcomes, similar clinical interventions could be used in pediatric endocrinology clinics. A targeted caregiver intervention could then be implemented during the clinic appointment for caregivers that endorsed clinically significant stress levels.



Further, national diabetes standards recommend that all endocrinology teams have a registered dietitian and mental health provider. Thus, parent-based interventions focusing on identifying methods of reducing caregiver stress as well as increasing knowledge of effective parenting strategies surrounding the feeding environment could have a positive impact on caregiver stress overall.

In addition to monitoring parent stress levels, assessing the parenting style of caregivers in the clinic setting may also provide opportunities to implement targeted guidance for caregivers low in authoritative parenting techniques. Findings from this study are consistent with previous research which found a significant relation between authoritative parenting and increased diabetic adherence for youth age 8 to 11 with T1D (Monaghan et al., 2012). Though prior studies also did not find an association between parenting style and glycemic control (Monaghan et al., 2012), previous literature has identified that higher authoritative parenting is associated with increased child compliance and decreased caregiver stress (Monaghan et al., 2012). Thus, promoting increased use of authoritative parenting may indirectly influence glycemic control through promoting decreased parent stress and increased child compliance related to their diabetes regimen. Interestingly, in the current study self-reported family income was positively associated with higher frequency of authoritative parenting; in particular, caregivers from higher income families were more likely to report using optimal parenting strategies. This finding could be due to the increase resources available to higher income families, that permit caregivers to direct more cognitive demand towards child interactions.

Limitations in the method used for data collection may have also influenced the non-significant findings observed in the current study. The sample in the current study endorsed a relatively high use of authoritative parenting, with the mean score of 4.1, implying that

caregivers in our sample “very often” used authoritative parenting styles. Questions on the *PSDQ* also have high face validity (e.g., “Gives comfort and understanding when child is upset”), perhaps inducing some social desirability in caregiver responding. Further, given the self-report nature of the study measure, it is unclear whether caregivers perceived parenting style aligns with their observed parenting style. Implementing behavioral observations and coding of specific caregiver qualities may provide richer data and context for guiding targeted parenting interventions for T1D adherence. For example, Parent Child Interaction Therapy (PCIT) is a parent based behavioral intervention that promotes higher use of authoritative parenting practices (Zisser & Eyber, 2010). PCIT has increased the frequency of authoritative parenting through methods of increasing parent warmth using PRIDE skills (i.e., Praise, Reflections, Imitation, Description, and Enthusiasm) and limit setting (i.e., consistent use expectations and consequences) (Zisser & Eyber, 2010). These strategies are directly related to authoritative practices, which emphasize high caregiver warmth with consistent expectations. Applying brief targeted interventions like PCIT to caregivers lower in authoritative parenting may then contribute to increase child nutritional adherence for families with T1D.

### **Health Literacy and Diabetes Adherence**

Other factors may also be related to nutritional adherence within a pediatric T1D population. Previous research investigating barriers and facilitators to nutritional adherence have identified several other factors outside of child feeding behaviors that influence nutritional adherence. A national study of a cross-cultural sample of children and caregivers identified that health literacy (e.g., knowledge on meal preparation, knowledge of nutritional recommendations), behavior change problems (e.g., difficulty shifting maladaptive behavioral feeding patterns, picky eating), cost (e.g., higher cost of fresh foods), and food preferences (e.g.,

preference for sweet and fatty foods) presented as barriers to achieving nutritional adherence (Nicklas et al., 2013). Thus, behavioral feeding problems constitutes only one of many potential barriers to maintaining nutritional adherence. Research should continue to explore barriers and facilitators to maintaining nutritional adherence outside of child feeding behaviors to identify modifiable factors to enhance nutritional adherence.

Health literacy is one variable that may influence an individual's ability to achieve nutritional adherence. The current study did not explore the relation between health literacy and nutritional adherence. However, previous research has revealed that a large percentage of the U.S. population may not have adequate nutritional health literacy in regard to the Dietary Guidelines for Americans (DGA guidelines) (Fogli-Cawley et al., 2006). Similarly, a national study revealed that a majority of Americans did not understand national food recommendations presented in My Pyramid (Post, 2011), and on average, participants reported only two of the 13 nutritional recommendations (e.g., regarding daily intake of macro and micronutrients based on age and gender) (Goldberg et al., 2017). Further, only 15% of American parents demonstrated proficient health literacy in a national study assessing caregiver health knowledge (Yin et al., 2009). Though nutritional health literacy has not yet been studied within a pediatric T1D population, research investigating factors associated with pediatric Type 2 Diabetes and obesity found a negative association between caregiver health literacy and child weight status (Gibbs et al., 2016). Deficits in caregiver health literacy may be a barrier for caregivers of children with T1D to obtain, process, and understand nutritional guidelines pertinent for diabetes management. Thus, decreased nutritional adherence within study participants may also be related to health literacy. Given the relationship between caregiver health literacy and child health outcomes

across other pediatric populations, it will be important for future research to assess the association between caregivers' health literacy on nutritional adherence for children with T1D.

### **Cultural Factors and Diabetes Adherence**

It is important to note that cultural factors may moderate the relation between child feeding behavior and health outcomes, specifically in regard to nutritional adherence. The current sample of families was predominantly Caucasian. Research examining the dietary habits across cultures has identified variations in the types of foods consumed. For example, a study by Jefferson and colleagues (2010) identified that although African American participants demonstrated adequate levels of nutritional health literacy in regard to the benefits of fruits and vegetables, a diet rich in fruits and vegetables did not align well with traditional food culture for African American participants in the study. Thus, African American participants consumed less fruits and vegetables compared to their Caucasian counterparts (Jefferson et al., 2010). Results from this study suggest that health literacy alone does not promote nutritional adherence, and cultural values should be assessed to determine barriers to adequate nutritional intake.

Additionally, a study by Yeh and colleagues (2008) revealed that Hispanic immigrant families faced barriers to accessing traditional foods, impeding their ability to prepare and consume foods that were both in line with their culture and nutritious. Results from studies to date suggest there are cultural differences in the ability to achieve nutritional adherence (Nicklas et al., 2013; Yeh et al., 2008; Zenk et al., 2011); however, few studies have examined cultural variances in the ability to achieve nutritional adherence. Moreover, cultural factors also play a role in parenting practices. Across the United States and other Western countries, authoritative parenting practices have largely been viewed as the "better" way to parent. Yet, caution should be used when assessing the quality of others parenting style as these perspectives are largely based on social

norms from the dominant culture. For example, much of the parenting literature developed in the United States associates authoritative parents with more positive psychosocial outcomes for children (Febiyanti & Rachmawati, 2021). Nonetheless, cross cultural research has highlighted limitations in the generalizability of these findings. For example, East Asian communities have higher rates of authoritarian parenting, and authoritarian parenting is actually associated with positive psychosocial outcomes within East Asian communities (Bornstein & Bornstein, 2007). Thus, it is important for future studies to investigate how cultural factors influence methods of diabetes adherence.

### **Food Insecurity as a Barrier to Nutritional Adherence**

Further, inequities within food access are an important area that should be explored when examining nutritional adherence. Access to fresh foods, including fruits and vegetables, may predict nutritional adherence, with decreased access being associated with decreased nutritional adherence. Individuals living in food deserts, geographic locations in which food is expensive and unavailable, may engage in lower nutritional adherence due to limited access to a variety of food options (Cummins & Macintyre, 2002). Research exploring nutritional adherence across a heterogeneous cultural sample in the United States assessed barriers to nutritional adherence through qualitative interviews. Results from this study suggested that in addition to health literacy, behavioral feeding problems, and food preferences, safety while grocery shopping was identified as a barrier to nutritional adherence among low-income Black individuals (Nicklas et al., 2013; Zenk et al., 2011). Further, research exploring barriers to food security indicates three barriers to food access: 1) geographic, 2) economic, and 3) informational (McEntee & Agyeman, 2010). The current sample is largely rural Appalachian; therefore, participants may face geographic barriers to food security. In fact, communities in over 40 counties across West

Virginia experience at least one barrier to food access (i.e., low vehicle access, greater than 20 miles from a supermarket (Coleman-Jensen, 2016). Self-reported demographic characteristics suggest that many participants in the current study experienced economic barriers to food access. For example, 28% (n=17) of participants reported difficulty paying bills at least half the time. Additionally, 10% of our study participants (n=6) reported a family income below the poverty line (i.e., less than \$25,000 annually). With poverty status being directly related to food insecurity (Baker et al., 2006; Nord, 1999), the relatively high percentage of participants experiencing financial challenges suggest that many families are food insecure. In addition to financial barriers, many of the study participants lived in rural communities across West Virginia, suggesting their geographic location may negatively impact food access. Given the effect that food security has on an individual's ability to achieve nutritional adherence, it will be important for future research to consider environmental factors, including food security, in relation to nutritional adherence.

### **Limitations**

It is important to note limitations to the current study that may impact the generalizability and clinical utility of the findings. First, all study measures were self-report and may have been influenced by participant desirability. Respondents may have other biases unrelated to item content. They might tend to embrace or avoid extreme responses, or they might exhibit acquiescence, a tendency to agree with statements. These threats can be reduced by requiring respondents to choose one answer from a list. Results may be influenced by variability in caregiver perceptions of child feeding behaviors. Thus, obtaining objective coding of child feeding behaviors in future studies will be beneficial. Data collection also occurred remotely, with all participants completing study measures in a location of their choice. Because study

personnel could not observe or monitor measure completion, effort put forth by participants could not be assessed. Participants were instructed to complete the *BKFS* collaboratively (caregiver and child), but due to the remote nature of data completion, this study is unable to determine if study procedures were followed. Additionally, social desirability may have influenced child and caregiver responses in regard to dietary intake, parenting practices, and problematic child behavior. In particular, children may have reported a more favorable dietary intake on the *BKFS* to prevent negative caregiver reaction (e.g., sneaking unhealthy snacks).

Additionally, study outcomes may be influenced by historical events, as all data collection occurred during the COVID-19 pandemic. Recruitment occurred across a five month period, including summer, fall, and winter. Thus, participants who were recruited during the summer may have differences in dietary intake comparative to those who were recruited during the academic year. Further, there was variability in the school status of participants, ranging from fully-remote to fully (five days) in-person. The duration of time participants spent in the home setting may have changed their eating habits and overall nutritional adherence. For example, 78% of caregivers in this study reported their child's time spent at home had increased since the start of the COVID-19 pandemic. Additionally, 51% of caregivers reported their child had less structured eating routines and 51% reported the number of snacks their child ate per day increased. Thus, results from this study may be strongly impacted by the current global pandemic and future studies should compare nutritional adherence of children when a typical school-home routine is in-place.

Demographic variability limits the generalizability of the results. All participants were recruited from one clinic in a rural setting. Thus, the sample was largely WEIRD (Western, Educated, Industrialized, Rich, Democratic) and results may not generalize across diverse patient

populations (Muthukrishna et al., 2021). Given bias and systemic racism present in the medical setting, it will be important for future studies to assess child feeding behaviors across a racially and ethnically diverse sample. Alongside this, dietary intake varies across cultures; consequently, nutritional adherence established in the United States may not be representative of cultural values and dietary habits globally. Finally, other factors can shape overall glycemic control. For example, pubertal status can influence both daily blood sugars and overall glycemic control (Chowdhury, 2015). However, the current study did not measure the pubertal status of participants and this could not be included in study analyses. Finally, the current study utilized a cross-sectional study design, and longitudinal conclusions cannot be made.

### **Strengths**

The current study has several methodological and theoretical strengths which are important to note. First, the current study expanded on previous research, measuring problematic child feeding behavior among school aged youth. Previous research has largely assessed child feeding behavior among young children (e.g., Patton et al., 2009; Powers et al., 2002). Thus, the broad age range (7-13) included in this study supports the expansion of feeding related research across the developmental spectrum. Secondly, this study utilized psychometrically sound measures to assess all variables. Finally, despite the homogenous racial demographics of the current sample, variability was observed in the sample characteristics in relation to socioeconomic status, child age, use of diabetes technology (i.e., Continuous Glucose Monitors, Insulin Pumps), age at diagnosis, and current HbA1c levels.

### **Implications**

The significant relationship between child feeding behaviors and health outcomes is an important area of research. Clinical interventions aimed at increasing nutritional adherence may



benefit from identifying behavioral interventions that improve child mealtime behaviors. Per American Diabetes Association recommendations, all pediatric endocrinology clinics should have a registered dietitian on the team (Silverstein et al., 2005). Findings suggest that it may be beneficial for dietitians to assess both nutritional adherence as well as behavioral feeding concerns to increase diabetes health outcomes. However, the small effect size suggests that child feeding behavior alone may not be sufficient for improving nutritional adherence and more comprehensive interventions targeting the family system may have a larger impact on child health outcomes. Successful adherence to a diabetes regimen is influenced by a multitude of factors at the individual, family, and systems levels. Individual psychosocial functioning of the child along with the caregiver can influence accurate understanding of the regimen, motivation, and subsequent adherence. Disease management may be further influenced by family characteristics, including the parent-child relationship, family dynamics, and cultural factors. Finally, systems level factors including access to affordable health care and coverage of necessary medications and technology (e.g., insulin, CGM therapy) play a role in health outcomes for patients with T1D. Therefore, research needs to continue evaluating individual, family, and systems level barriers present in pediatric T1D, and interventions need to occur within endocrinology clinics as well as in healthcare policy to reduce disparities and optimize pediatric health.

### **Future Research**

Given the impact child feeding behaviors have on diabetes health outcomes, future studies should identify behavioral interventions that may enhance child feeding behaviors. Future studies should assess the role of child feeding behaviors through observational coding to obtain objective measures of child feeding behaviors. Parent training interventions can be modified to

fit to a diabetic population. For example, Stark and colleagues (1994) developed a parent training intervention to reduce problematic mealtime interventions for children with cystic fibrosis.

Similar techniques could be used within a T1D population, with nutritional education focusing on protein and vegetable intake.

Given the role of the dietitian in pediatric diabetes clinics, future studies should assess the utility of implementing training for dietitians to promote behavioral modifications within the feeding environment. A systematic review by Matvienko-Sikar and colleagues (2018) examined the effects of healthcare delivered feeding interventions on pediatric feeding practices. Results varied across studies but suggest clinical utility in disseminating behavioral feeding practices within a clinic setting. Further, results supported the effectiveness of psychoeducation on effective mealtime parenting strategies. Future research should assess the effectiveness of using brief psychoeducation surrounding feeding practices within a diabetes clinic to promote nutritional adherence. It will also be important for future feeding related research to investigate how feeding behavior in older children and young adults relates to diabetes adherence. Previous studies on behavioral feeding problems (e.g., picky eating) has identified selective eating to be pervasive across the developmental spectrum (Cardona Cano et al., 2015; Chisholm et al., 2010; Williams et al., 2010). However, much of the research on behavioral feeding problems is done with young children. Longitudinal research, though challenging to design and conduct, would ideally help shed more light into risk and resiliency factors across time that could promote healthy eating and effective diabetes management in youth.

## **Conclusion**

Child feeding behavior is an important area to study within the field of pediatric psychology, and factors influencing child feeding should be investigated in order to promote

diabetes health outcomes. Results from this study suggest the child feeding behaviors influence nutritional adherence, with reduced problematic child feeding behaviors being associated with improved nutritional adherence. Thus, it is important to continue to explore the influence child feeding behavior has on health outcomes, in order to promote health outcomes for pediatric patients with T1D. Mealtime behavioral observations and coding should be used to assess factors that may influence problematic child feeding behaviors (e.g., maladaptive parenting strategies, coercion, punishment). Finally, further research within this area is needed to promote health equity within pediatric T1D populations. Research should explore communities' access to nutritious foods and patients access to diabetes technology, to inform local and national policy to enhance health outcomes for the most vulnerable communities.

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## Tables &amp; Figures

**Table 1***Descriptive Statistics of Demographic and Medical Variables*

Variable	M (SD)/n (%)	
	Child (n= 63)	Parent (n= 63)
Age	10.24 (1.99)	43.71 (8.4)
Race		
White/Caucasian	60 (95.2%)	60 (95.2%)
2 or more races	2 (3.2%)	2 (3.2%)
Prefer Not to Answer	1 (1.6%)	1 (1.6%)
Ethnicity		
Hispanic/Latino	1 (1.6%)	0 (0.0%)
Non-Hispanic/Latino	58 (92.1%)	60 (95.2%)
Prefer Not to Answer	4 (6.4%)	3 (4.8%)
Gender		
Male	24 (38.1%)	1 (1.6%)
Female	39 (61.9%)	62 (98.4%)
Caregiver		
Biological Parent		59 (93.7%)
Adoptive Parent		2 (3.2%)
Grandparent		2 (3.2%)
Highest Education Level		
High School/GED		15 (26.3%)
Some College		21 (36.8%)
Bachelor's		12 (21.1%)
Master's/Doctoral		9 (15.8%)
Marital Status		
Single		5 (7.9%)
Separated		2 (3.2%)
Divorced		6 (9.5%)
Married		47 (74.6%)
Living Together		3 (4.8%)
Income		
< \$10,000		3 (4.8%)
\$10,000-\$14,999		0 (0.0%)
\$15,000-\$24,999		3 (4.8%)
\$25,000-\$34,999		3 (4.8%)
\$35,000-\$49,999		16 (25.4%)
\$50,000-\$74,999		10 (15.9%)
\$75,000-\$99,999		7 (11.1%)
\$100,000-\$149,999		10 (15.9%)
	M (SD)/n (%)	

Variable	Child (n= 63)	Parent (n= 63)
> \$150,000		7 (11.11%)
Prefer Not to Answer		3 (4.8%)
T1D Duration (years)	3.84 (3.1)	
T1D Regimen		
Multiple daily insulin Injection	23 (36.5%)	
Insulin pump	39 (61.9%)	
Basal/bolus insulin	1 (1.6%)	
Blood Sugar Monitoring		
CGM	43 (68.3%)	
Glucose Meter	20 (31.8%)	

**Table 2***Descriptive Statistics of Study Measures*

	<i>n</i>	Mean	SD	Min	Max
<i>Measure</i>					
AYCE-R Total Score <sup>a</sup>	63	1.95	0.44	1.16	3.16
PSDQ Authoritative Score <sup>b</sup>	63	4.07	0.48	2.93	5.00
PSS Total Score <sup>c</sup>	63	33.13	7.43	19.00	53.00
Nutrition Adh. <sup>d</sup>	63	74.74	22.95	21.39	132.10
HbA1c	63	8.48	1.76	5.50	14.40

*Note.* \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

<sup>a</sup>About Your Childs Eating-Revised

<sup>b</sup>Parent Styles and Dimensions Questionnaire, Authoritative subscale

<sup>c</sup>Parent Stress Scale

<sup>d</sup>Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake

**Table 3***Descriptive Statistics and Correlations among Covariates and Variables*

	1	2	3	4	5	6	7
1. Income	---						
2. CGM <sup>a</sup>	.31*	---					
3. AYCE-R <sup>b</sup>	-.10	-.13	---				
4. Nutrition Adh. <sup>c</sup>	.09	.06	-.27*	---			
5. HbA1c	-.34**	-.36**	.26*	-.08	---		
6. PSS <sup>d</sup>	-.04	-.05	.21	-.10	.17	---	
7. PSDQ <sup>e</sup>	.30*	-.12	-.009	.21	-.08	-.33**	---

Note. \* p < .05, \*\* p < .01, \*\*\* p < .001

<sup>a</sup>Continuous Glucose Monitor

<sup>b</sup>About Your Childs Eating-Revised

<sup>c</sup>Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake

<sup>d</sup>Parent Stress Scale

<sup>e</sup>Parent Styles and Dimensions Questionnaire, Authoritative subscale

**Table 4***Hierarchical Linear Regression (N = 63)*

<i>Predictor Variables</i>	Outcome Measure									
	Nutritional Adherence					HbA1c				
	<i>F</i>	<i>df</i>	Adjusted <i>R</i> <sup>2</sup>	$\beta$	<i>t</i>	<i>F</i>	<i>df</i>	Adjusted <i>R</i> <sup>2</sup>	$\beta$	<i>t</i>
Regression 1	4.93	(1,61)								
Step 1			.060*							
AYCE-R				-0.27	-2.22*					
Regression 2						5.74	(3,59)	0.19**		
Step 1						6.84	(2,60)	0.16**		
CGM									-0.28	-2.30*
Income									-0.25	-2.05*
Step 2						3.06	(1,59)	0.04		
CGM									-0.26*	-2.14*
Income									-0.24	-1.98
AYCE-R									0.20	1.75

Note. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

<sup>a</sup>Continuous Glucose Monitor

<sup>b</sup>About Your Childs Eating-Revised

<sup>c</sup>Parent Stress Scale

<sup>d</sup>Parent Styles and Dimensions Questionnaire, Authoritative subscale

Regression 1 assessed the relation between child feeding behaviors and nutritional adherence

Regression 2 assessed the relation between child feeding behaviors and glycemic control

**Table 5***Summary of Regression Analyses for Testing the Moderation Models (N = 63)*

<i>Predictor variable</i>	<i>F</i>	<i>df</i>	<i>R</i> <sup>2</sup>	<i>β</i>	<i>SE</i>	<i>t</i>
Model 1 <sup>e</sup>	2.99*	3, 59	0.13			
AYCE-R <sup>b</sup>				-61.31	25.36	-2.42*
PSS <sup>c</sup>				-3.32	1.69	-1.97
AYCE-R <sup>b</sup> x PSS <sup>c</sup>				1.59	0.82	1.94
Model 2 <sup>f</sup>	3.54**	5, 57	0.24			
CGM <sup>a</sup>				-0.046	0.023	-1.96
Income				-0.0092	0.0047	-1.94
AYCE-R <sup>b</sup>				0.024	0.094	0.25
PSS <sup>c</sup>				0.0005	0.0063	0.076
AYCE-R <sup>b</sup> x PSS <sup>c</sup>				0.0004	0.0031	0.12
Model 3 <sup>g</sup>	3.21*	3, 59	0.14			
AYCE-R <sup>b</sup>				51.06	52.84	0.97
PSDQ <sup>d</sup>				41.21	25.82	1.60
AYCE-R <sup>b</sup> x PSDQ <sup>d</sup>				-15.25	12.27	-1.24
Model 4 <sup>h</sup>	3.47**	5, 57	0.23			
CGM <sup>a</sup>				-0.046	0.023	-2.00
Income				-0.008	0.005	-1.58
AYCE-R <sup>b</sup>				0.17	0.20	0.84
PSDQ <sup>d</sup>				0.052	0.10	0.55
AYCE-R <sup>b</sup> x PSDQ <sup>d</sup>				-0.03	0.05	-0.65

*Note.* \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

<sup>a</sup>Continuous Glucose Monitor

<sup>b</sup>About Your Child's Eating-Revised

<sup>c</sup>Parent Stress Scale

<sup>d</sup>Parent Styles and Dimensions Questionnaire, Authoritative subscale

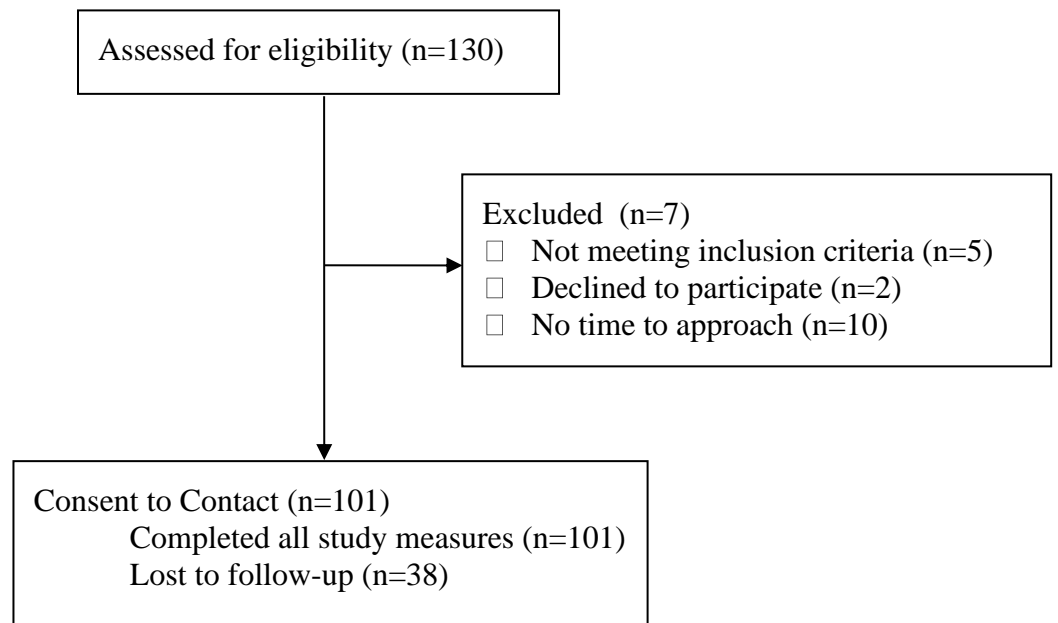
Model 1<sup>e</sup> assessed the degree to which parenting stress moderated the association of child feeding behaviors and nutritional adherence

Model 2<sup>f</sup> assessed the degree to which parenting stress moderated the association of child feeding behaviors and glycemic control

Model 3<sup>g</sup> assessed the degree to which authoritative parenting moderated the association of child feeding behaviors and nutritional adherence

Model 4<sup>h</sup> assessed the degree to which authoritative parenting moderated the association of child feeding behaviors and glycemic control

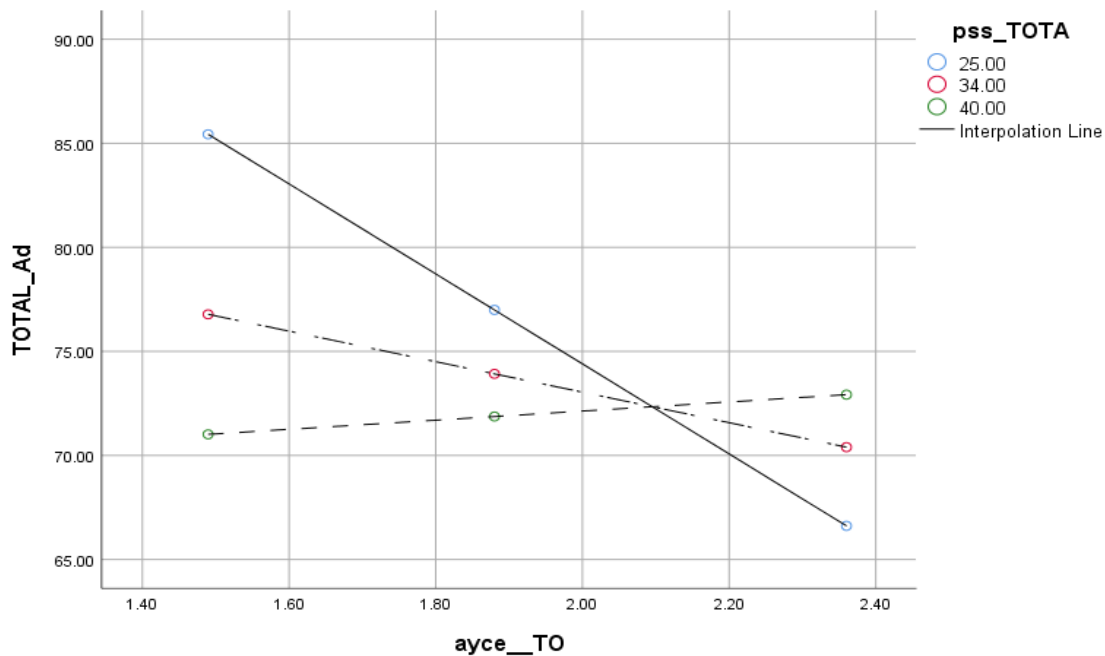


**Figure 1***Consort table of participant recruitment*

*Note.* This figure visualizes the number of eligible participants identified, the number of individuals excluded from the study, and the total number of participants enrolled in the study.

**Figure 2**

*Moderation analysis of parenting stress as a moderator in child feeding behaviors predicting nutritional adherence*



*Note.* This figure visualizes the degree to which Parent Stress Scale moderates the relationship between About Your Childs Eating-Revised and Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake. Solid-Line: Low Parent Stress Score ( $b = -21.62^{**}$ ), Dashed-line: Moderate Parent Stress Score ( $b = -7.33$ ), Dotted-Line: High Parent Stress Score ( $b = 2.19$ ).

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

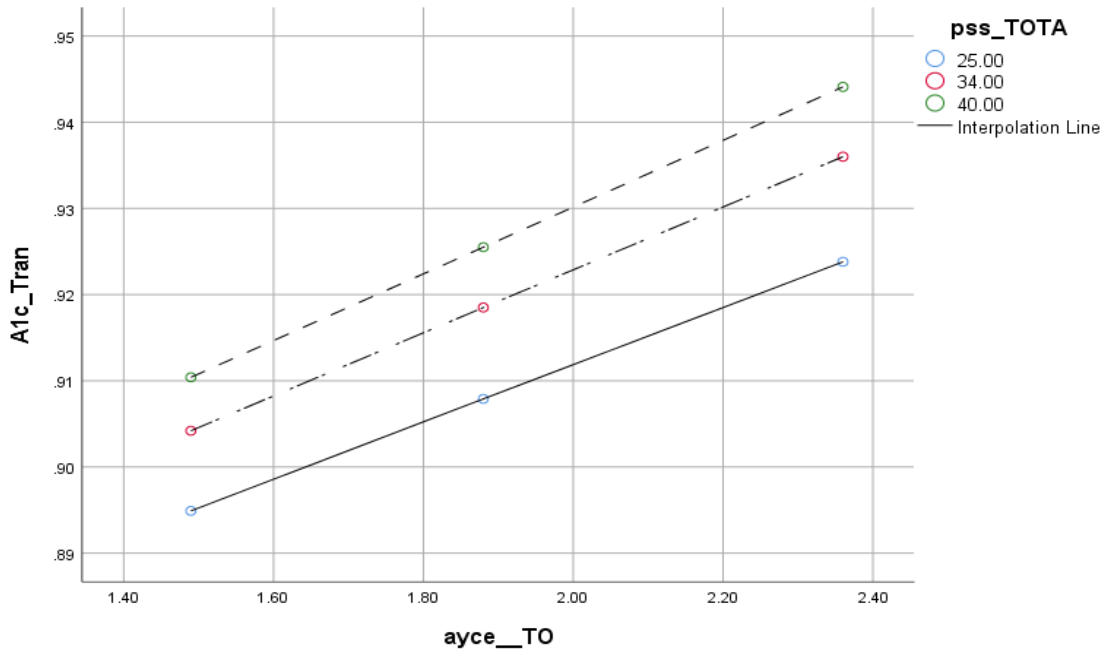
AYCE\_TO = About Your Childs Eating-Revised

TOTAL\_Ad = Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake

PSS\_TOTA = Parent Stress Scale

**Figure 3**

*Moderation analysis of parenting stress as a moderator in child feeding behaviors predicting glycemic control*



*Note.* This figure visualizes the degree to which Parent Stress Scale moderates the relationship between About Your Childs Eating-Revised and HbA1c. Solid-Line: Low Parent Stress Score ( $b = 0.03$ ), Dashed-line: Moderate Parent Stress Score ( $b = 0.04$ ), Dotted-Line: High Parent Stress Score ( $b = 0.04$ ).

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

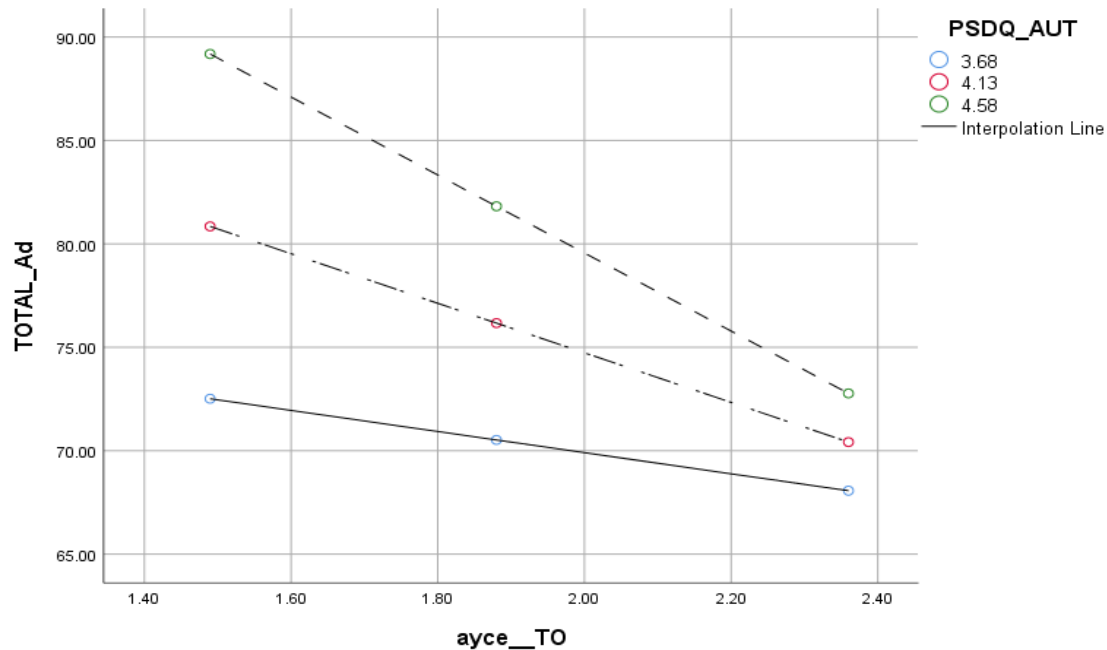
AYCE\_TO = About Your Childs Eating-Revised

A1c\_Tran = Hemoglobin A1c

PSS\_TOTA = Parent Stress Scale

**Figure 4**

*Moderation analysis of parenting style as a moderator in child feeding behaviors predicting nutritional adherence*



*Note.* This figure visualizes the degree to which Parent Styles and Dimensions Questionnaire, Authoritative subscale moderates the relationship between About Your Childs Eating-Revised and Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake. Solid-Line: Low Use of Authoritative Parenting ( $b = -5.12$ ), Dashed-line: Moderate Use of Authoritative Parenting ( $b = -11.98$ ), Dotted-Line: High Use of Authoritative Parenting ( $b = -18.85^*$ ).

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

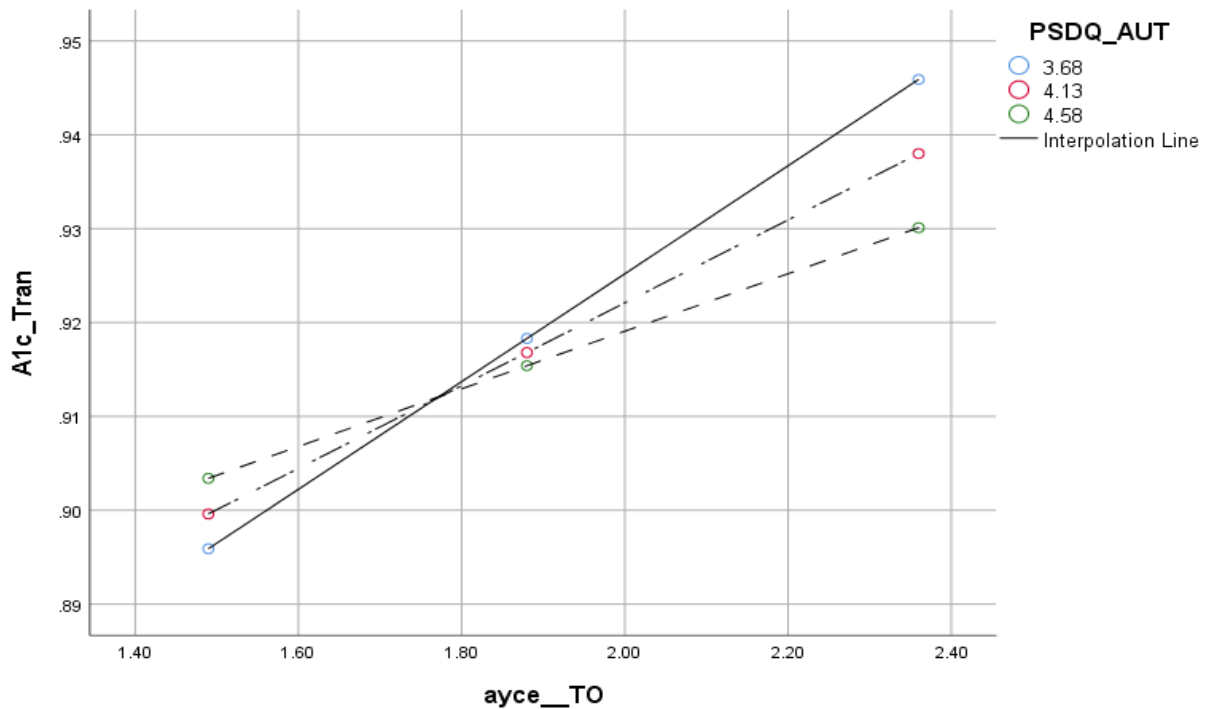
AYCE\_TO = About Your Childs Eating-Revised

TOTAL\_Ad = Nutritional Adherence based on Block Kids Food Screener percent adherence to protein and vegetable intake

PSDQ\_AUT = Parent Styles and Dimensions Questionnaire, Authoritative subscale

**Figure 5**

*Moderation analysis of parenting style as a moderator in child feeding behaviors predicting glycemic control*



*Note.* This figure visualizes the degree to which Parent Styles and Dimensions Questionnaire, Authoritative subscale moderates the relationship between About Your Childs Eating-Revised and HbA1c. Solid-Line: Low Parent Stress Score ( $b = 0.06$ ), Dashed-line: Moderate Parent Stress Score ( $b = 0.04$ ), Dotted-Line: High Parent Stress Score ( $b = 0.03$ ).

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

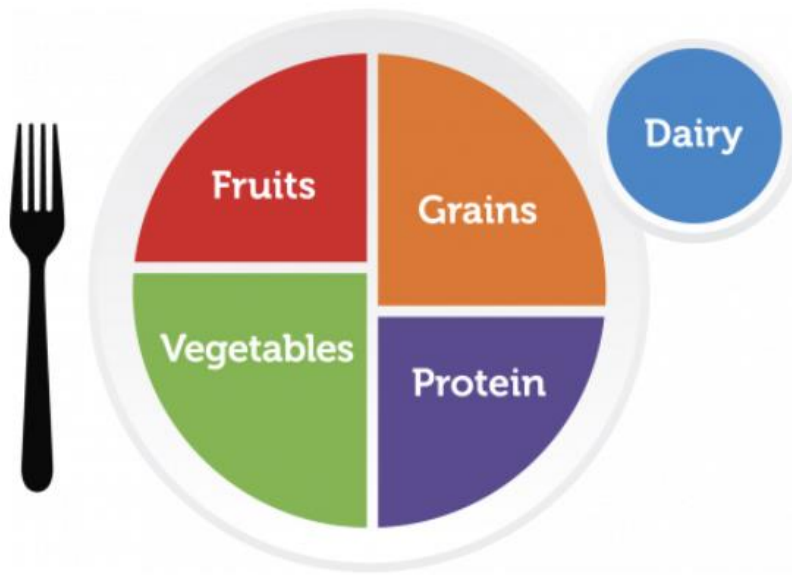
AYCE\_TO = About Your Childs Eating-Revised

A1c\_Tran = Hemoglobin A1c

PSDQ\_AUT = Parent Styles and Dimensions Questionnaire, Authoritative subscale

**Figure 6**

*USDA dietary guidelines using MyPlate*



*Note.* This figure visualizes dietary guidelines established by the U.S. Department of Agriculture.