Child temperament and differential susceptibility to parenting: implications for pediatric type 1 diabetes care

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Child Temperament and Differential Susceptibility to Parenting:
Implications for Pediatric Type 1 Diabetes Care

by

Anna J. Yeo

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ABSTRACT

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune disease associated with increased risk for serious complications and premature mortality. T1DM treatment aims to maintain adequate glycemic control and involves a daily regimen of health behaviors (e.g., glucose monitoring, insulin administration, healthy diet). Among pediatric patients, both child self-regulation and quality of parental involvement have been found to influence treatment outcomes. However, it is unclear whether and how child and parental factors interact to shape glycemic control. The differential susceptibility hypothesis proposes that children with certain regulatory vulnerabilities (e.g., high negative affectivity [NA], low effortful control [EC]) may be more susceptible to the deleterious impact of inadequate parenting but also reap greater benefit from positive parenting. The present study investigated whether child temperament would moderate the impact of diabetes-specific parental assistance and support on glycemic control in pediatric T1DM patients. A sample of 101 children with T1DM ($M$ age = 12.02, $SD = 2.43$) and their parents completed self-report questionnaires; information about glycemic control was abstracted from medical records. Multiple regression analyses indicated that child NA and EC significantly interacted with parental assistance, but not support. Specifically, high parental assistance appeared detrimental for maintaining good glycemic control for children with high NA or EC. High assistance only appeared to promote glycemic control for children with low NA. Overall, findings demonstrated that the quantity of direct parental involvement should align with children’s temperamental reactivity and regulation to benefit the treatment outcomes.
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TABLE OF CONTENTS

Introduction

Overview of Pediatric Type 1 Diabetes and Treatment
  Type 1 Diabetes: Diagnosis and Epidemiology
  Medical Treatment and Technology
  Management Behavior

Overview of Parental Involvement
  Diabetes-Specific Parental Assistance
  Diabetes-Specific Parental Support

Overview of Child Temperament
  Negative Affectivity
  Effortful Control

Overview of Differential Susceptibility
  Application of Differential Susceptibility to T1DM Context

Present Study

Method
  Participants
  Location
  Procedure
  Measures
  Analytic Plan

Results
  Preliminary Analyses
Hypotheses Testing........................................................................................................p. 29
Post-hoc Analyses.........................................................................................................p. 30
Discussion......................................................................................................................p. 31
Impact of Parental Assistance......................................................................................p. 31
Role of Child Effortful Control....................................................................................p. 32
Role of Child Negative Affectivity...............................................................................p. 34
Parental Support..........................................................................................................p. 37
Post-Hoc Three-Way Interactions .............................................................................p. 38
Limitations and Future Directions.............................................................................p. 38
Conclusion..................................................................................................................p. 41
References....................................................................................................................p. 43
Tables..........................................................................................................................p. 68
Figures.........................................................................................................................p. 71
Child Temperament and Differential Susceptibility to Parenting:  
Implications for Pediatric Type 1 Diabetes Care

Introduction

Type 1 Diabetes Mellitus (T1DM) is a potentially deadly chronic autoimmune disease that is most commonly diagnosed during middle childhood to adolescence (SEARCH for Diabetes in Youth Study Group, 2006). T1DM is caused by the progressive destruction of insulin-producing pancreatic β-cells, which creates lifetime physiological dependence on exogenous insulin. When managed poorly, T1DM can lead to serious complications including neuropathy, cardiovascular dysfunctions, and kidney damage (Chiang et al., 2014; Hood et al., 2009; Kaufman, 2012; Lachin et al., 2014). Since the prognosis of T1DM depends on maintaining good glycemic control, the recommended treatment regimen involves frequent monitoring of blood glucose levels (i.e., multiple times daily), insulin injections, and healthy diet and exercise (Hood et al., 2009; Stetson et al., 2017). This treatment regimen has been shown to be effective for helping to maintain glycemic control (American Diabetes Association, 2015), yet its demanding nature requires high levels of patient self-regulation and poses adherence difficulties (Mehta et al., 2015; Stetson et al., 2017; Wiebe et al., 2018). The regimen is especially challenging for children because their self-regulatory capacities for planning, remembering, and organizing tasks are still developing (Miller et al., 2012; Smith et al., 2014). Additionally, many children with T1DM report experiencing psychosocial challenges related to the illness (e.g., feeling different from peers), which may further hinder timely and accurate execution of health behaviors (Drew et al., 2010; Hood et al., 2011). Therefore, appropriate
parental involvement is essential to effectively manage pediatric T1DM and ensure children’s short- and long-term health (Berg et al., 2011, 2019; Landers et al., 2016).

Bronfenbrenner’s bioecological model posits that children’s biopsychological characteristics and environmental contexts interact to influence their development (Bronfenbrenner, 1986; Bronfenbrenner & Morris, 2007). Dispositional intrapersonal characteristics, such as temperament, constitute one of the most influential forces affecting such interactive developmental processes because temperament shapes children’s functioning and elicits reactions from their social environments (Bronfenbrenner & Morris, 2007). On the other hand, immediate interpersonal environments, such as parenting, also comprise powerful factors that can alter the direction and intensity of the interactive processes. Notably, patterns of these interactions may change over time given shifting developmental contexts (Bronfenbrenner & Morris, 2007). Since pediatric T1DM management is similarly characterized by evolving patterns of daily collaboration between children and their caregivers (Berg et al., 2017), the bioecological model provides an excellent framework for conceptualizing parent and child contributions to treatment outcomes. For instance, children with T1DM may initially depend on their parents to administer treatment procedures and cope with their discomfort. As they age, however, they may increasingly assume greater self-care responsibility for their illness management (Berg et al., 2017). Given the changing needs and skills of growing children, parents’ affective and instrumental support for their diabetes treatment may similarly need to adapt to ensure favorable outcomes (Berg et al., 2017; Butner et al., 2018).

Consistent with the bioecological model, literature has indeed identified child self-regulation and parental involvement as two pillars of pediatric T1DM management (Berg et al.,

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1 Term ‘parent’ in this paper is inclusive of all adults serving a primary caregiver role for a child, such as grandparents.
Specifically, children with better cognitive and emotional regulation have been found to better manage their diabetes (Berg et al., 2017; Healey et al., 2018; Wiebe et al., 2018). Effective parental involvement has been found to consist of both instrumental and emotional support and been associated with better glycemic control among children with T1DM (Palmer et al., 2011; Young et al., 2014). However, less is known about how children’s self-regulation and diabetes-specific parenting may interact to influence pediatric T1DM patients’ glycemic control. For example, the optimal quality and quantity of parents’ instrumental and emotional support may differ for children with varying self-regulatory capacities (Berg et al., 2011, 2017; Hilliard, Rohan, et al., 2011; Landers et al., 2016). In support, developmental literature has shown that parenting quality may matter more for predicting adjustment outcomes among children with certain regulatory vulnerabilities (e.g., temperamental negative emotionality and effortful control) than those without (Hinshaw, 2008; Kiff et al., 2011; Rothbart et al., 2006; Slagt et al., 2016).

Nevertheless, research to date has mostly examined the interactive effects of child temperament and parenting in the context of socioemotional and cognitive development. Whether these differences in children’s temperamental susceptibility may also extend to T1DM treatment outcomes (e.g., glycemic control) remains to be tested. Since diabetes management requires high levels of children’s behavioral compliance (Healey et al., 2018; Rodbard, 2016), it may be the case that children with temperamental vulnerabilities may similarly be more susceptible to the impact of parenting quality than those without. However, to the best of our knowledge no research to date has applied the differential susceptibility model to examine patterns of parent and child contributions to pediatric T1DM treatment. An improved understanding of the optimal patterns of parent-child collaboration may help inform and guide
families’ effort to effectively manage pediatric T1DM. Therefore, the current study investigates how child temperament and parental involvement may directly and interactively shape pediatric T1DM patients’ glycemic control.

**Overview of Pediatric Type 1 Diabetes and Treatment**

**Type 1 Diabetes: Diagnosis and Epidemiology**

T1DM is a chronic autoimmune disease characterized by endogenous insulin deficiency and resultant physiological difficulties in regulating blood glucose levels (Atkinson et al., 2014; DiMeglio et al., 2018). Although T1DM can be diagnosed at any age, it continues to represent one of the most common childhood chronic diseases, with most patients being first diagnosed at school age or puberty (Atkinson et al., 2014; SEARCH for Diabetes in Youth Study Group, 2006). At diagnosis, children may present with excessive dilute urination, thirst, weight loss, hyperglycemia (i.e., pathologically high blood glucose levels), and even diabetic ketoacidosis (i.e., excess blood acids due to insufficient insulin in the body; Atkinson et al., 2014; DiMeglio et al., 2018). If not promptly detected and treated with daily insulin administration, T1DM patients may face heightened risk for morbidity and mortality (Chiang et al., 2014; Hood et al., 2009; Kaufman, 2012; Lachin et al., 2014).

Incidence rates of T1DM significantly vary across the globe (e.g., higher in the U.S. and western Europe and lower in Asia and South America), but overall global rates of T1DM incidence and prevalence have been rising in the past decade (Atkinson et al., 2014; DiMeglio et al., 2018). The exact causes underlying regional differences as well as increasing global prevalence are yet to be known; however, latest research has indicated environmental influences and their interactions with one’s innate and adaptive immune systems as possible culprits (Atkinson et al., 2014; DiMeglio et al., 2018). Specifically, early diet, vitamin D deficiency,
exposure to viruses associated with islet inflammation, and low gut-microbiome diversity have been associated with increased T1DM incidence rates (Boljat et al., 2017; Rewers & Ludvigsson, 2016). In contrast, despite some evidence for genetic susceptibility, genetic predisposition appears less impactful than environmental factors for determining the disease onset (Kondrashova et al., 2005; Pociot & Lernmark, 2016; Steck et al., 2011). For instance, population-based longitudinal research has found substantial differences in T1DM incidence rates among populations of a shared ancestry based on their differing socioeconomic circumstances (Kondrashova et al., 2005). Similar research has also observed increased rates of T1DM among genetically low risk individuals upon changes in their environments (Steck et al., 2011). Increasing rates of T1DM incidence worldwide are concerning because the disease bears immense health tolls on individuals and burdens on the healthcare systems (Kovatchev, 2018a).

**Medical Treatment and Technology**

Since insulin in bovine form was discovered in 1922, T1DM has become a treatable illness rather than a terminal condition leading to death within 1-2 years from onset (DiMeglio et al., 2018; Secrest et al., 2018). Nevertheless, despite the significant advances in treatment research over the past decades, the complete cure of T1DM has so far proved elusive (Barnett, 2018; Skyler, 2018). Instead, utilization of multiple-dose insulin to maintain optimal levels of glycosylated hemoglobin (HbA1c; i.e., glycemic control) has remained the mainstay of T1DM treatment (Atkinson et al., 2014; DiMeglio et al., 2018). HbA1c represents an index of average percentage of blood glucose over the past 8 to 12 weeks. HbA1c levels < 7.5% are considered to be optimal for children, whereas levels ≥ 8% indicate inadequate glycemic control and are associated with increased risk for short- and long-term medical complications (American Diabetes Association, 2015; Foster et al., 2019; Lind et al., 2014). In contrast, achieving and
maintaining blood glucose levels that approximate those of people without diabetes have been shown to be effective for reducing cardiovascular and other serious complications among T1DM patients (Nathan, 2014). Specifically, adequate glycemic control may help patients avoid hyper- or hypoglycemia episodes (i.e., pathologically high or low blood sugar levels among prediabetic or diabetic patients) that are known to yield both immediate and long-term life threatening consequences (Morales & Schneider, 2014; Mouri & Badireddy, 2020).

To achieve and maintain good glycemic control, insulin therapy requires frequent monitoring of blood glucose levels and delivery of appropriately dosed exogenous insulin based on the current glucose level. Insulin administration must occur several times per day to simulate physiological insulin release (e.g., long-acting, basal insulin for overnight and between meals, rapid-acting bolus insulin for carbohydrate intakes; DiMeglio et al., 2018). Traditionally, this regimen required patients to engage in multiple-times daily capillary blood draw (i.e., drawing blood from a fingertip onto a test strip to check blood glucose levels), calculation of appropriate insulin doses, and self-injection of insulin. In recent decades, however, technological advances in T1DM treatment have simplified aspects of T1DM treatment and improved glycemic control (Foster et al., 2019; Rodbard, 2016). The most popular and widely used technologies include continuous glucose monitoring (CGM) and continuous subcutaneous insulin infusion therapy (i.e., insulin pump therapy; DiMeglio et al., 2018; Peters et al., 2016). CGM refer to compact medical devices that use a sensor inserted under the skin to continuously monitor blood glucose levels (Rodbard, 2016). Although CGM devices do require periodic human input for calibration, they relieve patients from multiple times daily self-measurements of blood glucose via finger pricking (DiMeglio et al., 2018; Rodbard, 2016). Patients using CGM have demonstrated better
glycemic control and fewer episodes of hypoglycemia than the control group using the conventional self-measurement method (Battelino et al., 2011; Pickup et al., 2011).

Similarly, insulin pump therapy (i.e., a pocketsize wearable device programmed to deliver insulin into the skin) has also become increasingly available and shown good efficacy in improving glycemic control (Peters et al., 2016). For instance, T1DM patients receiving insulin pump therapy (i.e., a pocketsize wearable device programmed to deliver insulin into the skin) have demonstrated lower levels of HbA1c and lower frequency of hypoglycemia than the control group using the conventional method of insulin injections (Karges et al., 2017). Additionally, in the past decade a combined use of real-time CGM and closed-loop insulin delivery system has shown promise in further advancing T1DM treatment. This closed-loop control system uses electromechanical algorithms to monitor blood glucose fluctuations and calculate rates of insulin infusion (Hovorka, 2011; Kovatchev, 2018a). Therefore, it can alert patients of upcoming hypo- or hyperglycemia and automatically regulate basal insulin infusion (DiMeglio et al., 2018; Hovorka, 2011; Kovatchev, 2018b). Although at present this method still requires manual delivery of bolus insulin at meal times or to treat hyperglycemia, use of the closed-loop control system has been linked to improved glycemic control (Kovatchev, 2018b).

**Management Behavior**

While these technological advances have been beneficial, most pediatric T1DM patients continue to struggle with maintaining optimal glycemic control (American Diabetes Association, 2015). In 2016–2018, only 15% of U.S. children with T1DM (i.e., under age 17 years) achieved HbA1c levels under 7.5%, whereas almost 40% exceeded 9% HbA1c (Foster et al., 2019). Importantly, despite increased availability of CGM and insulin pump therapy, they can still be costly and inaccessible to many families (DiMeglio et al., 2018). Moreover, even these new
therapeutic technologies require intensive lifestyle modifications and substantial self-management resources to have desired effects (Berg et al., 2017; Healey et al., 2018; Rodbard, 2016). For instance, while CGM and insulin pump therapy may alleviate the burden of frequent blood draws and insulin self-injections, patients still need to monitor their blood glucose levels, count carbohydrate intakes, and determine the amount of insulin to administer multiple times per day (Healey et al., 2018). In other words, even with advanced medical technology, high levels of behavioral compliance with the treatment regimen are demanded to have desired efficacy and achieve adequate glycemic control (Berg et al., 2017; Healey et al., 2018; Rodbard, 2016).

Planning, remembering, and executing these treatment related tasks in accurate and timely manners require high levels of self-regulation and social support (Berg et al., 2017; Rodbard, 2016). Therefore, even with technological advances, appropriate parental involvement and child self-regulation remain critical factors influencing pediatric T1DM treatment outcomes.

**Overview of Parental Involvement**

Decades of research have documented the importance of parental involvement in pediatric T1DM treatment and investigated specific parental behaviors that may help improve children’s treatment outcomes. Broadly, effective parental involvement may include both affective (e.g., warmth and encouragement) and behavioral support (e.g., direct assistance with treatment related tasks; Berg et al., 2019; Dishion & McMahon, 1998; Palmer et al., 2011; Young et al., 2014). Specifically, parental supportive behaviors characterized by warmth, acceptance, appropriately timed independence encouragement, and open communication have been associated with improved child treatment outcomes, potentially by enhancing the quality of parent-child relationship and collaboration (Palmer et al., 2011; Young et al., 2014). While such supportive behaviors set the emotional tone of parent-child interactions, parents’ direct assistive
behaviors may ensure daily execution of T1DM treatment tasks (e.g., helping to check blood glucose levels, calculate carbohydrate intakes, administer insulin, and remember medical appointments; Palmer et al., 2011; Young et al., 2014). Of note, other types of diabetes-specific parenting behaviors (e.g., monitoring) also exist and may potentially be relevant for adolescents and young adults (Palmer et al., 2011; Young et al., 2014); nevertheless, this study focused on the impact of parental assistance and support as the essential building blocks of pediatric T1DM management across childhood. Researchers have generally considered that a high quality parent-child relationship and frequent behavioral assistance constitute positive and effective parental involvement, and that children physically and emotionally benefit from such parental behaviors (Landers et al., 2016). Growing evidence, however, suggests that determining an optimal quality and quantity of parental involvement may be more nuanced; rather than being linear and constant, optimal involvement may vary by children’s intrapersonal characteristics, including self-regulation (Berg et al., 2011, 2017; Hilliard, Rohan, et al., 2011; Landers et al., 2016; Wiebe et al., 2005).

**Diabetes-Specific Parental Assistance: Developmental and Clinical Implications**

Given children’s developing self-regulation capacity, parents often assume primary responsibility for pediatric diabetes care and directly assist with daily treatment activities (e.g., checking blood glucose, administering insulin, counting carbohydrates, treating high or low blood sugar; Palmer et al., 2011; Young et al., 2014). Consistent behavioral assistance by parents is deemed essential for effective treatment of young children with T1DM (Berg et al., 2017) and advisable throughout adolescence (Hanna & Decker, 2010; Palmer et al., 2008; Young et al., 2014). In addition to facilitating daily treatment activities, parental assistance may also have long-term implications for children’s development of self-management skills. Developmental
literature has indicated that children learn how to complete a challenging task and regulate frustration through observing and modeling parental behaviors involved in the task (Brophy-Herb et al., 2012; Morris et al., 2007; Musser et al., 2018). Specifically, processes of social cognitive learning guided by scaffolding and modeling have been found to underlie children’s development of self-regulation (Bernier et al., 2012; Fay-Stammbach et al., 2014; Morris et al., 2007). These parental behaviors share common components of teaching children appropriate ways of regulating one’s action or emotions through demonstrating, guiding, and commenting.

Scaffolding refers to deliberate efforts by caregivers using verbal or physical guidance to assist children with a challenging task (Lewis & Carpendale, 2009). Specific parental behaviors involved in scaffolding may include physical prompts and verbal elaboration of the task and assistance in maintaining and redirecting attention (Fay-Stammbach et al., 2014). While engaging with parents in this manner, children may learn and refine their regulatory skills (e.g., attention management, cognitive flexibility, problem-solving) through imitations and repeated practices (Fay-Stammbach et al., 2014; C. H. Hughes & Ensor, 2009; Matte-Gagné & Bernier, 2011). Accordingly, several parental behaviors involved in scaffolding have been longitudinally associated with improved self-regulation among children (Bernier et al., 2010; Conway & Stifter, 2012; Hammond et al., 2012; C. H. Hughes & Ensor, 2009; Matte-Gagné & Bernier, 2011). T1DM management requires acquisition of extensive knowledge and skills related to the illness and treatment (Mehta et al., 2015; Stetson et al., 2017; Wiebe et al., 2018). Hence, parental assistance with accurate and timely execution of various clinical tasks may represent opportunities for children to learn, imitate, and practice their emerging self-management skills.

Additionally, behavioral theories of modeling suggest that children learn how to recognize and manage frustrating situations and related emotions by observing caregivers’
responses to similar conditions (Brophy-Herb et al., 2012; Dubi et al., 2008). For instance, if parents frequently respond with anger toward frustrating situations, children may perceive anger as a proper response to frustration and have greater difficulty learning other adaptive responses (Brophy-Herb et al., 2012; Dubi et al., 2008). T1DM treatment presents numerous emotional and social challenges for affected children and their families on a daily basis (Drew et al., 2010; Hood et al., 2011; Miller et al., 2012; Smith et al., 2014). For example, children with T1DM report that getting high or low numbers (i.e., blood glucose levels), disclosing their illness status, or engaging in treatment activities in public can be stressful (Drew et al., 2010; Hood et al., 2011; Miller et al., 2012; Smith et al., 2014). Parents may also experience heightened stress when faced with children’s distress related to procedural pain (e.g., injections, sensor insertion) and overall illness management difficulties (Hilliard, Monaghan, et al., 2011; Patton et al., 2011). Consistent with the modeling hypothesis, parents’ manner of treatment execution and assistance, especially in challenging times, may model for children how to respond to and resolve presenting difficulties and related emotions (Berg et al., 2017). Since effective management of diabetes-related challenges has been linked to better emotional and physical health outcomes for children with T1DM (Jaser et al., 2017; Luyckx et al., 2010), a function of parental assistance as modeling appropriate health behaviors may also bear important clinical and developmental implications.

While direct parental assistance is deemed essential for effective pediatric T1DM treatment and potentially promotive for the development of children’s self-management skills, its beneficial effect may be more nuanced in middle childhood to adolescence (i.e., ages 8 to 17; Berg et al., 2017; Jaser, 2011). Middle childhood to adolescence represent an important transitional period during which children begin to assume greater responsibility for their diabetes
care (Berg et al., 2017; Jaser, 2011). Across middle childhood and adolescence, both children’s capacity and needs for self-management behaviors grow as they gain more self-regulatory skills and face changing socioemotional contexts (e.g., more time spent apart from parents and with peers; Berg et al., 2017; Butner et al., 2018). During this period, children may benefit from appropriate levels of autonomy in their diabetes management while also continuing to require some levels of parental assistance. Therefore, whether high levels of parental assistance continue to be helpful may substantially vary by children’s intrapersonal characteristics, such as temperamental reactivity and regulation.

Indeed, findings on the impact of direct parental assistance on youths’ glycemic control have been mixed. Consistent with the notion that direct parental assistance is beneficial for T1DM treatment, some studies have demonstrated cross-sectional and longitudinal links from parental assistance to improved treatment adherence and glycemic control among children in middle childhood to adolescence (Hsin et al., 2010; Ingerski et al., 2010). In contrast, other studies have found no significant associations between parental assistance and adolescents’ treatment outcomes (Palmer et al., 2008; Vesco et al., 2010). Given these inconsistent findings, continued research is needed to clarify the impact of direct parental assistance on T1DM management during middle childhood to adolescence. Particularly, it is possible that even accounting for the effect of children’s developmental maturity, individual variability in self-regulation may be a factor that modulates the link between parental assistance and treatment outcomes (Berg et al., 2011, 2017; Palmer et al., 2008).

**Diabetes-Specific Parental Support: Developmental and Clinical Implications**

In addition to direct assistance, parental support has been found to play a critical role in shaping pediatric T1DM treatment outcomes (Berg et al., 2019; Dishion & McMahon, 1998;
Palmer et al., 2011; Young et al., 2014). In the context of pediatric T1DM treatment, parental support includes emotional warmth, open communication, discussion-based decision-making, and autonomy encouragement (Berg et al., 2017; Palmer et al., 2011; Wysocki et al., 2009; Young et al., 2014). Although further research is needed to clarify the mechanism of action, researchers have proposed that high parental support may contribute to creating a positive parent-child relationship, which in turn may help children cope with diabetes treatment and related stressors (Berg et al., 2017; Rosenberg & Shields, 2009). In other words, while parental assistance may help ensure timely and accurate execution of treatment-related tasks, parental support may provide children with coping resources and facilitate effective parent-child collaboration on T1DM management (Berg et al., 2017; Goethals et al., 2017; Palmer et al., 2011; Young et al., 2014). In a collaborative parent-child partnership, parents may offer guidance and support without interfering with children’s growing sense of autonomy and self-efficacy, but instead encourage their efforts to self-manage diabetes (Berg et al., 2017; Butner et al., 2018; Chiang et al., 2014). In support of this notion, high quality parent-child relationships have not only been associated with better child glycemic control (Berg et al., 2008; Jaser & Grey, 2010; Lloyd et al., 2009; Palmer et al., 2008), but also improvements in children’s treatment adherence (Berg et al., 2008; Lloyd et al., 2009; Mlynarczyk, 2013; Palmer et al., 2011), self-efficacy (Berg et al., 2011; Ott et al., 2000), and ability to prioritize treatment over peer pressure (Drew et al., 2010).

Additionally, research has further elucidated the role of specific aspects of parental support, such as autonomy encouragement and open communication. For instance, parents’ autonomy encouragement or lack thereof (e.g., coercion) appeared more impactful on improving children’s treatment adherence than parental warmth alone (Landers et al., 2016). Open and
effective parent-child communication has been found to be integral to facilitating children’s autonomy development and treatment responsibility sharing (DeBoer et al., 2017; Goethals et al., 2019; Osborn et al., 2013). Specifically, children’s perceived positive communication experiences with their parents regarding diabetes care (e.g., emotional support, ease of disclosure, clear expectations) have been linked to better self-management of T1DM, which in turn related to better glycemic control (DeBoer et al., 2017; Goethals et al., 2019; Greene et al., 2010; Osborn et al., 2013; Shorer et al., 2011). Similarly, longitudinal data have demonstrated that establishing positive parent-child communication patterns during middle childhood may aid in adolescents’ adjustment and transition to self-care (Iskander et al., 2015).

Developmental literature provides insight into why high parental support may be critical to ensuring children’s short- and long-term health in the context of T1DM treatment. Decades of research have indicated that warm and sensitive parenting has crucial implications for children’s socioemotional and self-regulatory development (Ainsworth et al., 1974; Bernier et al., 2012). Sensitive parenting is characterized by developmentally appropriate, contingent parental responses to the child’s needs (Ainsworth et al., 1974; Bernier et al., 2012). Researchers have posited that parental warmth and sensitivity promote children’s internalization of self-regulatory strategies (Ainsworth et al., 1974; Bernier et al., 2012; Fay-Stammbach et al., 2014). In support of this idea, research has demonstrated a longitudinal link between high parental warmth and sensitivity and children’s better cognitive and emotional regulation skills (Fay-Stammbach et al., 2014; Morris et al., 2007; Rhoades et al., 2011; Speidel et al., 2020). Moreover, warm and responsive interactions with parents, especially when accompanied by appropriate scaffolding and supervision, facilitate children’s growing sense of motivation and competence for
autonomous self-regulation—an essential developmental task to ensure healthy socioemotional adjustment (Bernier et al., 2012; Deci et al., 1981).

Another notable role of warm and sensitive parenting is its contribution to building secure parent-child attachment: a long-lasting emotional bond between children and their primary caregivers (Ainsworth et al., 1974; Bernier et al., 2012; Ranson & Urichuk, 2008). Secure attachment is based on children’s perceptions that their caregivers are consistently available and sensitive to their needs and thus, may promote the internal representation of self as worthy of care, love, and responsiveness from others (Ainsworth, 1989; Ainsworth & Bowlby, 1991). Children who experience secure attachment to their primary caregivers are hypothesized to better internalize self-regulatory strategies and adapt to novel situations (Brumariu, 2015). Accordingly, a wealth of evidence has indicated that the quality of parent-child attachment is predictive of children’s socioemotional competence, cognitive development, and even health outcomes (Brumariu, 2015; Ranson & Urichuk, 2008). Based on knowledge derived from developmental research, it is reasonable to believe that warm parental support in the context of T1DM treatment would similarly foster effective parent-child collaboration as well as children’s growing ability to self-manage their illness and related challenges. Effective collaborative and autonomous management behaviors would in turn result in better glycemic control (Berg et al., 2017).

However, similar to the effect of direct assistance, it is unclear how diabetes-specific parental support may interact with children’s intrapersonal factors (e.g., temperament) to shape pediatric health outcomes. A wealth of developmental research has indicated that children with certain temperamental characteristics may be more susceptible to the effects of parenting on future adjustment (Belsky, 2016; Slagt et al., 2016). Since pediatric T1DM management requires
complex patterns of parental involvement to ensure children’s short- and long-term health, it is both clinically and scientifically crucial to investigate interactive relations between parenting and child temperament.

**Overview of Child Temperament**

Temperament refers to constitutionally based individual differences in reactivity and regulation (Rothbart et al., 2006). Such dispositional differences in reactivity and regulation have been found to be moderately heritable and can be observable as early as infancy (Lonigan & Vasey, 2009; Rothbart et al., 2006; Saudino, 2005). For instance, some infants tend to be easy to soothe while others are quick to cry and have trouble soothing. Similarly, whereas some infants can maintain their attention with relative ease, others may quickly lose focus and shift their gaze (Saudino, 2005). These temperamental characteristics have been found to remain relatively stable throughout childhood and contribute to the formation of adult personality (Lonigan & Vasey, 2009; Rothbart et al., 2006; Saudino, 2005). However, the manifestation of children’s temperament over time is influenced by children’s developmental maturity and environment (Lonigan & Vasey, 2009). Therefore, based on the existing body of literature, it would be most accurate to suggest that temperamental reactivity and regulation form a biological basis that interacts with one’s environment (e.g., parenting) to shape the course of development (Hinshaw, 2008; Kiff et al., 2011; Rothbart et al., 2006). Since T1DM treatment is known to require high levels of cognitive and emotional self-regulation, the following two dimensions of temperament may be especially salient contributors to children’s T1DM management: negative affectivity and effortful control (Berg et al., 2017; Healey et al., 2018; Wiebe et al., 2018).
Negative Affectivity

Temperamental reactivity reflects emotional, physical, and attentional responsiveness to internal and external stimuli, and is commonly indicated by levels of frustration, inhibition, and negative affect (Rothbart et al., 2006). Negative affectivity—a dimension of temperamental reactivity—refers to heightened reactivity to and avoidance of unpleasant stimuli. Children with high negative affectivity present with higher vigilance for threat signals and greater vulnerability to feeling distressed (Lonigan & Vasey, 2009; Watson & Clark, 1984). As such, a wealth of cross-sectional and longitudinal research has associated high negative affectivity with increased risk for maladaptive psychosocial outcomes (Lonigan & Vasey, 2009; Tortella-Feliu et al., 2010). Since greater psychosocial difficulties have been linked to suboptimal health outcomes among T1DM patients (Buchberger et al., 2016; Jaser et al., 2017; Luyckx et al., 2010), it is reasonable to assume that negative affectivity may similarly exert adverse influences on T1DM treatment. For instance, children with high negative affectivity may experience greater distress in response to diabetes-related stressors (e.g., procedural pains, undesirable blood glucose levels, peer pressure), which may in turn lead to more difficulties in managing the illness.

However, despite the potential relevance of child temperament, only a handful studies have investigated the effects of child temperament on T1DM management. It is also notable that pediatric research to date has produced somewhat mixed results regarding the role of negative affectivity. Consistent with the general developmental concept of negative affectivity, a recent study has indicated that children ages 3-18 years with high negative affectivity exhibit poorer glycemic control than those without (Healey et al., 2018). Similarly, in a large sample of adults with Type 1 and 2 Diabetes, negative affectivity was associated with greater difficulties in diabetes treatment adherence (Murri et al., 2017). In contrast, earlier studies have found an
unexpected association between high negative affectivity and better glycemic control among children ages 5-18 years (Rovet & Ehrlich, 1988; Weissberg-Benchell & Glasgow, 1997). In interpreting these unexpected findings, the researchers postulated that children with greater fearfulness may be more vigilant about preventing negative health outcomes and thus, achieve better glycemic control (Rovet & Ehrlich, 1988; Weissberg-Benchell & Glasgow, 1997). While these findings provide invaluable information, it is necessary to acknowledge that as reviewed in the earlier section, procedural details of T1DM treatment have substantially changed over the past decades. Therefore, the findings must be replicated to verify whether these associations similarly hold in the currently pediatric T1DM populations.

Overall, due to a limited number of investigations, inconsistent findings, and a lack of consideration of relevant interpersonal factors, it is difficult to draw any definitive conclusions about the role of temperamental reactivity in pediatric T1DM treatment. Ongoing research should not only aim to replicate prior findings, but also consider the effect of child negative affectivity on T1DM treatment in the context of salient interpersonal contributors such as parenting.

**Effortful Control**

Effortful control represents the self-regulatory aspect of temperament and refers to the ability to suppress a dominant response to perform a subdominant response (e.g., attention shifting, impulse control; Rothbart et al., 2006). Children with high effortful control exhibit greater abilities to focus and shift attention and control their behavior as needed (Bridgett et al., 2013; Rothbart et al., 2006). Effortful control has been associated with better psychosocial, behavioral, and academic functioning across childhood (Bridgett et al., 2013; Eisenberg et al., 2016; Kim et al., 2013; Valiente et al., 2011). Given the known link between better self-
regulation and T1DM treatment outcomes, high effortful control may similarly aid in achieving better glycemic control. For instance, individuals with high effortful control may be better able to plan, remember, and accurately execute treatment-related tasks. Consistent with this notion, a handful of existing studies have indicated that children with high effortful control demonstrate better glycemic control than those with low control across a wide developmental spectrum (e.g., ages 3-18; Garrison et al., 1990; Healey et al., 2018; Rovet & Ehrlich, 1988).

Other studies have indicated potential mechanisms for such better treatment outcomes, such as improved adherence and adjustment. Specifically, Garrison et al. (1990) presented a significant association between high effortful control (e.g., attention span) and better treatment adherence among young children ages 3-10 years. In another sample of T1DM patients ages 5-18 years, effortful control (e.g., better ability to stay focused on tasks) was significantly related to less behavioral and social difficulties (Weissberg-Benchell & Glasgow, 1997), which in turn have been linked to better glycemic control (Drew et al., 2010; Hood et al., 2011). In summary, research to date has offered evidence that children’s temperamental effortful control plays a protective role in promoting effective management of their diabetes. Nevertheless, little is known about how variability in children’s effortful control interacts with parental behaviors to influence T1DM treatment.

**Overview of Differential Susceptibility Hypothesis**

It has long been assumed that the effect of child temperament on future adjustment is neither linear nor unidirectional, but is rather bidirectional and interactive with relevant environmental contexts (Belsky, 2016; Kiff et al., 2011). For instance, while decades of research have established that children exposed to high-risk family environments tend to experience more dysfunctions in their health and development, they also exhibit substantial individual variability
in outcomes (Belsky, 2005; Luthar, 2006). Growing research has also indicated that individuals not only differ in their levels of vulnerability to negative environmental exposures (e.g., harsh parenting) but may also vary in the extent to which they benefit from positive environmental resources (e.g., warm sensitive parenting; Bakermans-Kranenburg & Van Ijzendoorn, 2011; Belsky, 2005). To describe and explain these phenomena, the differential susceptibility hypothesis has proposed that certain temperamental characteristics make children more sensitive to both positive (i.e., development-enhancing) and negative (i.e., risk-promoting) environmental influences (Belsky, 2016; B. J. Ellis et al., 2011; Pluess & Belsky, 2010).

Consistent with this hypothesis, research to date has identified negative affectivity as a potent intrapersonal factor shaping children’s differential susceptibility to parenting quality. Specifically, children with high negative affectivity have been found to be more vulnerable to the deleterious impact of negative parenting (e.g., rejection, hostility, intrusiveness) and experience more psychosocial maladjustments in this condition than those with low reactivity (Slagt et al., 2016). Simultaneously, children with high negative affectivity have also been found to reap greater benefit from positive parenting (e.g., support, guidance, acceptance) and achieve better adjustment outcomes in this condition than their peers with low reactivity (Slagt et al., 2016). In sum, in the context of socioemotional development, negative affectivity appears to represent greater sensitivity to parenting influences rather than mere vulnerability to stress (Belsky, 2016; Slagt et al., 2016).

Effortful control has also been found to moderate the effect of parenting on child adjustment, but in a manner somewhat distinct from that of negative affectivity. Specifically, research to date has indicated that children with low effortful control benefit more from positive parenting and display less internalizing and externalizing problems in this condition than those
with high regulation (Slagt et al., 2016). In other words, albeit somewhat limited compared to the effect of negative affectivity, low effortful control may render greater sensitivity to the impact of high parenting quality. Taken together, developmental literature provides robust evidence that children with varying levels of temperamental reactivity and regulation are differentially susceptible to parenting influences. As previously discussed, pediatric T1DM treatment similarly involves evolving patterns of parent-child interactions and collaborations, which in turn shape children’s health outcomes (Berg et al., 2017; Lansing et al., 2017). Nevertheless, no study to date has investigated whether analogous patterns of parent-child interactions contribute to determining the success and failure of pediatric T1DM treatment.

**Application of Differential Susceptibility to T1DM Context**

Pediatric literature to date has demonstrated that both the styles of parental involvement and children’s temperament influence T1DM treatment outcomes (e.g., Berg et al., 2019; Healey et al., 2018; Wiebe et al., 2018; Young et al., 2014). Importantly, per developmental research and a growing number of pediatric studies (Belsky, 2005; Healey et al., 2018; Kiff et al., 2011; Palmer et al., 2008), the effect of parenting and child temperament on T1DM treatment may not necessarily be direct; rather, these intra- and interpersonal factors may interact with each other to shape the patterns and quality of parent-child collaboration and children’s growing self-management skills. For instance, children with low effortful control, who have been found to often struggle with self-management, may be able to achieve adequate glycemic control if accompanied by high parental assistance and support. On the other hand, it is curious whether direct parental assistance would be helpful for children with high effortful control during middle childhood to adolescence when they may be beginning to assume greater self-care responsibility.
Furthermore, the differential susceptibility hypothesis may help to disentangle the mixed findings on the direct effect of negative affectivity on pediatric T1DM management behavior and outcome. Specifically, it may be the case that children with high negative affectivity are only vulnerable to poor treatment outcomes when their parents are less involved; however, when aided by ample parental assistance and support, these children may be able to achieve better outcomes than those with low reactivity. Therefore, examination of the differential susceptibility hypothesis in the context of pediatric T1DM treatment may help better elucidate the nature of parent-child collaboration characterizing effective and ineffective diabetes management.

**Present Study**

To address current gaps in the literature, the present study investigated direct and interactive contributions of parental involvement and child temperament to glycemic control among pediatric T1DM patients. Based on the existing evidence of child development and pediatric diabetes research, I hypothesized that: (a) diabetes-specific parental assistance and support would be associated with better glycemic control; (b) children’s high negative affectivity and low effortful control would be associated with worse glycemic control; (c) high parental assistance and support would be particularly beneficial for children with low effortful control compared to those with high regulation; (d) low parental assistance and support would be especially detrimental to children with low effortful control than those with high regulation; (e) high parental assistance and support would be particularly beneficial for children with high negative affectivity compared to those with low reactivity; and (f) low parental assistance and support would be especially detrimental to children with high negative affectivity than those with low regulation.
Method

Participants

Participants included 101 children with T1DM (male = 55%; $M$ age = 12.02, $SD = 2.43$) and their primary caregivers (e.g., parents, grandparents). Full sample characteristics are presented in Table 1. Participants were recruited as part of a larger longitudinal study examining child and parental factors contributing to pediatric T1DM treatment. The present study used data from Time 1 of the larger study whose inclusion criteria included children ages 8 to 16 years, a diagnosis of pediatric T1DM, and children and primary caregiver fluency in English (validated study questionnaires in other languages were unavailable). Exclusion criteria included comorbid psychotic symptoms, cognitive impairment, or developmental disabilities. Of the eligible families contacted, 61% agreed to participate in the original study ($n = 112$). For the current study, children who turned 17 years of age ($n = 1$) and had been diagnosed with T1DM for less than 6 months ($n = 10$) at Time 1 were excluded from analyses to rule out the effect of the “honeymoon” phase (i.e., temporary improvement of glycemic control when insulin therapy is first initiated; Abdul-Rasoul et al., 2006).

Location

The study was conducted in the Pediatric Endocrine Division of Albany Medical Center. Albany Medical Center is the only academic medical facility located in eastern upstate New York (within 150-mile radius) and provides 150 outpatient locations throughout the region. The Pediatric Endocrine Division offers outpatient care to children and young adults with endocrine disorders including T1DM.
Procedure

The study was approved by Albany Medical Center and University at Albany Institutional Review Boards. Participants were recruited during their outpatient visits at the Pediatric Endocrine Division of Albany Medical Center. Parents received an introductory cover letter as part of the check-in packet and could elect to provide their contact information if interested in participating in the study. A trained graduate research coordinator and undergraduate research assistants contacted interested families via phone and/or email to introduce the study and share a link to the study’s Qualtrics online survey. Parents and children provided informed consent or assent (via either paper form or online link) to initiate their survey participation and permit the research team’s access to children’s medical records. All families who completed the parental surveys received compensation for their participation ($30 gift cards).

Measures

Parental Support

The nine-item supportive behavior scale from the Diabetes Family Behavior Checklist-Parent Report (DFBC-P; Schafer et al., 1983, 1986) was used to assess levels of parental support specific to pediatric T1DM treatment. The DFBC-P is a 16-item self-report instrument assessing parental supportive and unsupportive behaviors for pediatric T1DM treatment and has demonstrated adequate to excellent psychometric properties (Lewin et al., 2005; Schafer et al., 1986). The supportive behavior scale assesses the frequency of parental support across four components of diabetes regimen: insulin administration, glucose monitoring, diet, and exercise (e.g., “Praise your child for following his/her diet,” “Encourage your child to participate in sports activities”). Parents were asked to self-rate each item on a 5-point Likert-scale (1 = never and 5 =
at least once a day), and total scale scores were calculated by summing their responses (range = 9-45; higher scores indicative of higher parental support; Schafer et al., 1986). In this sample, the DFBC-P supportive behavior scale demonstrated adequate internal consistency (α = .75).

**Parental Assistance**

Parental ratings of a modified version of the Diabetes Management Questionnaire (DMQ; Mehta et al., 2015) were used to measure the frequency of parental assistance with pediatric T1DM treatment. The DMQ is a 20-item self-report instrument assessing T1DM treatment adherence and has demonstrated good psychometric properties among both individuals with T1DM and their caregivers (Mehta et al., 2015). Particularly among pediatric patients, parent reports on the DMQ have been found to be indicative of parental involvement in daily diabetes tasks (Mehta et al., 2015). This study slightly modified the instructions for parent surveys (i.e., “how often did you adjust your child’s insulin…” instead of “how often did you or your child adjust your child’s insulin…”) to focus on parents’ administration of children’s T1DM treatment. Parents were asked self-rate each item on a 5-point Likert-scale (0 = almost never and 4 = almost always; e.g., “How often did you check your child’s blood sugar before physical activity?”). Total scores were calculated and normalized to a 0–100 scale by multiplying the mean of 20 responses (six items reverse-scored) by 25. Higher total scores reflect greater parental adherence and assistance with pediatric T1DM treatment (Mehta et al., 2015). In this sample, the DMQ displayed adequate internal consistency (α = .78).

**Child Temperament**

The 18-item Negative Affect (NA) and Effortful Control (EC) scales from the Early Adolescent Temperament Questionnaire- Revised Parent Report (EATQ-R; Ellis & Rothbart, 2001) were used to assess children’s temperamental reactivity and regulation. The EATQ-R is a
62-item parent-report measure of child temperament and has demonstrated moderate to good psychometric properties (Ellis & Rothbart, 2001; Muris & Meesters, 2009). The NA scale includes 18 items across three domains of frustration, depressed mood, and aggression, and the EC scale includes 18 items across domains of attention, inhibitory control, activation control. Parents were asked to rate each item on a 5-point Likert-scale (1 = almost always untrue and 5 = almost always true), and scale scores were calculated by averaging responses (nine items were reverse coded for Effortful Control; two items were reverse coded for Negative Affect). Both the NA and EC scales demonstrated good internal consistency in the current sample (α = .90 and .92 respectively).

**Child Glycemic Control**

HbA1c is a proxy of long-term glycemic control maintained over the previous 2-3 months, with higher values (> 8%) indicating poorer glycemic control (American Diabetes Association, 2015). HbA1c was measured using a DCA 2000 Advantage during outpatient clinic visits. HbA1c values closest to the date of the family’s survey completion (e.g., approximately within 2-3 months) were extracted from children’s medical records.

**Covariates**

Primary caregivers provided children and families’ demographic information (e.g., child age, gender, race/ethnicity, household income). Children’s health information (e.g., diabetes duration, treatment types) was obtained via medical chart review based on their documented associations with glycemic control (e.g., Abdul-Rasoul et al., 2006; Karges et al., 2017). Demographic or treatment-related variables that were significantly correlated with variables of interest (p < .05) were considered as potential covariates.
Analytic Plan

All variables of interest were assessed for univariate and multivariate normality. Descriptive and correlational analyses were used to examine sample characteristics and relations among variables of interest and potential covariates. Two multiple regression models were conducted to test direct and interactive contributions of diabetes-specific parental involvement (separately for assistance and support) and child temperament to glycemic control. Variables were entered simultaneously (i.e., one-step), and key independent variables were mean-centered by standardization (i.e., used z-scores). All analyses were performed using SPSS 26. A power analysis conducted via the G*Power 3.0 computer program (Erdfelder et al., 2009; Faul et al., 2007) indicated adequate power (85%) for a regression model including 5 main independent variables to detect a medium effect size ($f^2 = .15$) in a sample size of 101. Because rates of missingness were negligible (i.e., below 5% for all variables; Jakobsen et al., 2017), listwise deletion was employed to handle missing data.

Conditions & Rationales for Post-hoc Analyses

If both moderating effects of temperamental reactivity and regulation were statistically significant, a three-way interaction among parental involvement, child effortful control, and negativity affectivity would be considered. Consistent with developmental literature on differential susceptibility, the current study focused on examining unique modulating effects of negative affectivity and effortful control on children’s glycemic control. This was especially salient given the paucity of diabetes research investigating children’s differential susceptibility to parenting based on either temperamental reactivity or regulation. Nevertheless, if both negative affectivity and effortful control were found to play significant modulating roles in this sample, it would be clinically and scientifically relevant to further explore how the effects of these two
temperamental characteristics may also depend on each other. Albeit distinct, temperamental reactivity and regulation jointly shape children’s behavioral tendencies and may even influence each other (Bridgett et al., 2013; Farver et al., 2009). For instance, prior research has found that higher effortful control is often linked to lower negative affectivity (Bridgett et al., 2013; Moriya & Tanno, 2008; Putnam et al., 2008). In other words, better abilities to control attention appear to help children adaptively regulate their attention to and appraisal of threat cues, thereby reducing their tendency to feel negative emotions (Bridgett et al., 2013; Hofmann et al., 2011).

Furthermore, growing research has suggested that although negative affectivity and effortful control are often negatively related, individual variability may exist in levels of each temperamental dimension. For instance, some children have been found to display high negative affectivity and low effortful control, while others exhibited both high reactivity and regulation (Muris, 2006; Muris & Meesters, 2009; Oldehinkel et al., 2007; Prokasky et al., 2017; Van Den Akker et al., 2010). Accordingly, some researchers have proposed that effortful control may modulate the risk conferred by negative affectivity (Lonigan & Phillips, 2001; Lonigan & Vasey, 2009; Mathews, 2004). Specifically, while children with high negative affectivity tend to display greater vigilance, or attentional bias, toward threat signals, those who are also high in effortful control may be better able to control their attention and override this bias than children who are low in effortful control (Lonigan & Phillips, 2001; Lonigan & Vasey, 2009; Mathews, 2004). Therefore, it is possible that the effect of negative affectivity on pediatric T1DM treatment may depend on the child’s effortful control, and vice versa.

Results

Preliminary Analyses
The data screening process detected mild univariate and multivariate outliers (z > ± 3.3), which were addressed via winsorization. Skewness and kurtosis were within the acceptable range (< ± 2.0; Gravetter & Wallnau, 2014), and the assumption of linearity was upheld. Examination of the residual plots of the regression models suggested a potential mild violation of the homogeneity of regression assumption, which may produce biased standard errors. No issues of multicollinearity (Tolerance < 0.20; VIF > 5) were detected.

**Hypotheses Testing**

Correlations among key study variables and potential covariates appear in Table 2. Results indicated that older children had been diagnosed with T1DM for longer and received less parental assistance and support. Greater household income was related to a higher likelihood of having CGM and/or insulin pump and better glycemic control (i.e., lower HbA1c). Caregivers reporting higher household income also tended to report their children as having higher effortful control and lower negative affectivity. CGM/insulin pump treatment and shorter illness duration were related to better glycemic control. Shorter illness duration was correlated with higher parental assistance with child T1DM treatment. Parental assistance was positively correlated with parental support. Lastly, higher child negative affectivity was related to lower effortful control and worse glycemic control.

Linear regression models examined the direct and interactive contributions of parental assistance or support and child temperament to glycemic control, controlling for child age, illness duration, CGM/insulin pump treatment, and household income. In the model examining the role of parental assistance (see Table 3), child effortful control and negative affectivity significantly moderated the association between parental assistance and child glycemic control. Direct associations between parental assistance or child temperament and glycemic control were
not statistically significant. Among covariates, illness duration and treatment status were significantly associated with glycemic control.

Simple slope analyses were used to probe the interaction effect of parent assistance on HbA1c at high and low levels of effortful control (+/- 1 SD from the mean). Results indicated that parental assistance was only significantly associated with higher HbA1c (i.e., worse glycemic control) among children with high effortful control, \( B = 0.40, SE = 0.20, p = .047 \), but not among those with average or low effortful control. Results of simple slope analyses for the interaction effect of parent assistance at high and low levels of negative affectivity (+1/- 1 SD from the mean) indicated that parental assistance was significantly associated with higher HbA1c among children with high negative affectivity, \( B = 0.56, SE = 0.26, p = .038 \), but lower HbA1c (i.e., better glycemic control) among those with low negative affectivity, \( B = -0.41, SE = 0.20, p = .040 \). Its effect was not significant at average levels of child negative affectivity.

In the model examining the role of parental support (see Table 3), only the covariates (i.e., illness duration, treatment status) were significant at \( p < .05 \). The interaction effect between parental support and child negative affectivity on glycemic control was marginally significant \( (p < .10) \), and no other variables of interest demonstrated statistically significant associations with child glycemic control.

**Post-hoc Analyses: Three-way Interactions**

To further explore the conditional effects of child temperamental reactivity and regulation, the study tested a three-way interaction term among parental involvement, child negative affectivity, and effortful control. A three-way interaction term was added to each regression model testing the effect of parental assistance or support. In neither the parental assistance nor the support model, was the three-way interaction term significant, \( B = -0.18, SE = \)}
0.12, \( p = .136 \) and \( B = 0.06 \), \( SE = 0.10 \), \( p = .595 \), respectively. The moderating effect of child negative affectivity did not significantly depend on levels of effortful control, or vice versa.

**Discussion**

The present study applied the differential susceptibility hypothesis to better understand ideal patterns of parent-child coordination in pediatric T1DM treatment. To the best of knowledge, this study is the first to examine the conditional effects of T1DM-specific parental involvement on child glycemic control as a function of child temperamental reactivity and regulation. Results indicated that the impact of parental assistance on child glycemic control depended on levels of children’s effortful control and negative affectivity, but in directions somewhat inconsistent with the differential susceptibility hypothesis. Instead, results appeared to better align with the broad goodness-of-fit model: whether direct parental assistance would be helpful for a child depends on the child’s unique developmental and dispositional characteristics. Importantly, current findings should be interpreted in the unique context of pediatric T1DM treatment during the transitional period of middle childhood to adolescence.

**Impact of Parental Assistance**

In this sample of children ages 8-16 years with T1DM, diabetes-specific parental assistance was not directly related to child glycemic control. Parental assistance has generally been considered helpful, or even essential, for pediatric T1DM treatment (Hsin et al., 2010; Ingerski et al., 2010; Palmer et al., 2011; Young et al., 2014). However, prior evidence on its contribution to glycemic control among older children has been mixed, with several studies noting null findings (Palmer et al., 2008; Vesco et al., 2010). Current findings offer a potential explanation for such inconsistency in the literature: the effect of parental assistance during
middle childhood to adolescence may not always be promotive, but instead may substantially vary by children’s levels of temperamental reactivity and regulation.

**Role of Child Effortful Control**

Children’s levels of effortful control indicated no significant relation to glycemic control. Although this contradicts the hypothesis and previous findings (Healey et al., 2018; Rovet & Ehrlich, 1988), it is also possible that T1DM treatment during middle childhood to adolescence may still dominantly involve parent-child collaboration and thus, children’s self-regulatory capacity may not yet constitute a strong independent force contributing to treatment outcomes. Instead, child effortful control significantly modulated the impact of direct parental assistance on glycemic control. Specifically, high levels of parental assistance were related to poorer glycemic control only among children with high effortful control. This result should be understood within the developmental context of middle childhood to adolescence during which children with T1DM begin to seek autonomy and transition to greater self-care responsibility (Berg et al., 2017; Butner et al., 2018). During this period, children with high self-regulatory capacity (e.g., effortful control) may be particularly willing and able to assume greater self-care responsibility (Healey et al., 2018). For children with such temperamental characteristics, continued high levels of direct parental assistance may have been perceived as intrusive and thus, may have been detrimental to the overall quality of diabetes management.

While this study is the first to examine and identify interactions between diabetes-specific parenting behavior and child temperament, it builds upon prior research that has observed similar patterns where high levels of direct parental involvement were only helpful for adolescents with low self-efficacy (i.e., one’s belief or confidence in their own ability to successfully perform diabetes treatment-related tasks; Berg et al., 2013; Palmer et al., 2008). Self-efficacy and self-
regulation are distinct yet interrelated constructs; high effortful control during early childhood has been found to promote academic self-efficacy at school age (Liew et al., 2008), and in turn self-efficacy has been associated with improved self-regulation and task completion in young adult samples (Shea & Bidjerano, 2010; Strunk & Steele, 2011). Therefore, it may be the case that children’s temperamental regulation provides an early foundation for their developing self-efficacy in diabetes management. However, the link between child temperament and diabetes-specific self-efficacy has yet to be examined. Further research is needed to explore their associations and respective contributions to treatment outcomes.

In sum, the current finding extends the literature and highlights the notion that pediatric T1DM treatment may be more effective when parental involvement matches children’s self-regulatory capacity. For children with high temperamental regulation, allowing greater autonomy and self-management responsibility, rather than frequent direct assistance, may facilitate better glycemic control. Of note, this study did not focus on parental encouragement of child autonomy or other potentially relevant aspects of diabetes-specific parenting (e.g., monitoring; Palmer et al., 2011; Young et al., 2014). These parental behaviors are known to promote children’s growing self-care skills and scaffold the successful transition of diabetes-related responsibility from parents to children (Berg et al., 2017; Palmer et al., 2011; Young et al., 2014). Continuing research is needed to clarify appropriate processes of responsibility sharing for children with different temperamental regulatory profiles. For instance, it is possible that children’s responses to parental monitoring or other aspects of diabetes-specific parenting would vary by levels of child effortful control.
Role of Child Negative Affectivity

Somewhat consistent with the literature, child negative affectivity was significantly correlated with poorer glycemic control. This significant correlation adds mild support for the notion that heightened reactivity to negative environmental and internal affective stimuli may pose greater challenges to diabetes management (Healey et al., 2018; Murri et al., 2017). This correlational finding also suggests that temperamental reactivity and regulation may have unique relations to T1DM treatment outcomes. During middle childhood to adolescence, children’s negative affectivity may be a more salient factor influencing T1DM treatment relative to their effortful control.

In the regression models, however, negative affectivity demonstrated no significant direct association with glycemic control; instead, it served as a significant moderating factor in the association between direct parental assistance and child glycemic control. Specifically, whereas parental assistance was related to better glycemic control among children with low reactivity, greater assistance was detrimental for those with high reactivity. In developmental literature, negative affectivity has been identified as a crucial intrapersonal factor that modulates children’s susceptibility to positive and negative environmental inputs (e.g., parenting; Slagt et al., 2016). Children with high negative affectivity have been found to be especially vulnerable to the deleterious impact of negative parenting on their socioemotional development, but also reap greater benefit from positive parenting (Slagt et al., 2016). Current findings suggest that in the context of T1DM treatment, the modulating role of temperamental reactivity may be more nuanced; older children with high negative affectivity may benefit from less parental assistance, while those with low reactivity are helped by more.
In interpreting this finding, it is important to note that only a handful of studies have examined the effect of negative affectivity on glycemic control and produced mixed results. While some, including the present data, have associated high reactivity with poorer control (Healey et al., 2018; Murri et al., 2017), others have shown opposite results (Rovet & Ehrlich, 1988; Weissberg-Benchell & Glasgow, 1997). Despite the wanting state of evidence on the role of temperamental reactivity in T1DM treatment, growing research has demonstrated that children’s high negative affectivity is linked to increased parenting stress and parent-child conflicts (Acar et al., 2018; Casalin et al., 2014; S. O. Hughes & Shewchuk, 2012; Oddi et al., 2013). Therefore, it is possible that children with high negative affectivity were experiencing elevated conflicts in coordinating diabetes care with their parents. Parental assistance under the condition of low parent-child relationship quality can be perceived as unhelpful (Berg et al., 2017; Goethals et al., 2017; Young et al., 2014).

On the other hand, children with low reactivity may have enjoyed a better parent-child relationship quality and greater success in coordinating diabetes management routines with their parents. In this relational context, high parental assistance may have been more welcomed and helpful for maintaining glycemic control (Goethals et al., 2017). Although the role of parent-child relationship was beyond the scope of this study, ongoing research should replicate and investigate explanations for this finding. Given the significant correlation between high negative affectivity and poor glycemic control, continued research should clarify whether child negative affectivity influences glycemic control by impairing children’s own ability to self-manage or by compromising the parent-child relationship quality. Furthermore, potential next steps may also include evaluating differences in the quality of parental assistance (e.g., intrusive vs. helpful) and
examining how such differences may interact with child temperament to influence diabetes management behaviors and outcomes.

In sum, among children in middle childhood to adolescence, the impact of direct parental assistance or child temperament on glycemic control may not be direct or linear but may depend on the condition of each other. Importantly, results suggest that levels of parental assistance in children’s T1DM treatment should match their temperamental reactivity and regulation since too much direct parental involvement for children who may not find it helpful can disrupt their treatment. Although not entirely consistent with the differential susceptibility hypothesis, these findings fit within the broad framework of goodness-of-fit: environmental expectations and demands (e.g., parenting) that match the child’s temperament lead to optimal child adjustment (Chess & Thomas, 1991; Lerner, 1983). Research has indeed elucidated that children whose temperament characteristics are more appropriately accommodated by their home and school environments demonstrate better adjustment outcomes (Churchill, 2003; De Schipper et al., 2004; Lerner, 1983; Schoppe-Sullivan et al., 2007). However, what constitutes as a good match between child temperament and environment may substantially vary by the salient ecological and developmental contexts (e.g., home vs. school, single vs. co-parenting; Chess & Thomas, 1991; Churchill, 2003; De Schipper et al., 2004; Lerner, 1983; Schoppe-Sullivan et al., 2007). Overall, present results complement the goodness-of-fit literature and provide evidence that pediatric chronic illness management may similarly be a product of interactional processes between child temperament and parenting. Importantly, a goodness or poorness of fit found in this sample is specific to T1DM management context and the period of middle childhood to adolescence (Chess & Thomas, 1991). Therefore, further research is needed to elucidate how the fit may change over time across development and in different pediatric contexts.
Related, the deviation from differential susceptibility theory may be attributed to the fact that pediatric T1DM treatment involves unique patterns of families’ chronic illness management behaviors, whereas the theory is a conceptualization of human evolution at large (e.g., traits that make an individual vulnerable in one setting can provide increased resilience under a different condition; Belsky, 2016). Regardless, present findings have demonstrated the importance of integrating the broad framework of child development and the specific context of pediatric work to inform ongoing investigations of optimal levels of diabetes-specific parental involvement.

**Parental Support**

Unlike parental assistance, parental support (e.g., encouraging management behaviors, collaborative decision-making) demonstrated no statistically significant associations with children’s glycemic control. This lack of association is somewhat surprising since several prior studies have linked this behavior to better child treatment outcomes (Butner et al., 2018; Chiang et al., 2014; Gruhn et al., 2016; Iskander et al., 2015). Moreover, the measure, DFBC-P, exhibited adequate internal consistency in this sample similar to the levels demonstrated in prior research (Lewin et al., 2005; Schafer et al., 1986). However, growing research has also indicated that the perception and meaning of family support for diabetes management vary by environmental and interpersonal contexts (e.g., cultural norms; Ravi et al., 2018). For instance, in an urban south Indian sample in which resources for diabetes care were relatively limited, both families’ supportive and unsupportive behaviors (as measured by the DFBC’s supportive and unsupportive scales) were considered helpful since any sign of involvement was opposite of being apathetic (Ravi et al., 2018). Although the current sample predominantly consisted of non-Hispanic White families, there may have been unmeasured environmental or cultural factors that influenced associations between parental support and child outcomes. Continued research is
needed to clarify the relation between parental support and child glycemic control as well as identify other potential modulating factors. Moreover, this inconsistent finding may highlight the complexity of pediatric T1DM treatment and families’ general confusion and difficulties in maintaining glycemic control.

**Post-Hoc Three-Way Interactions**

A post-hoc analysis including a three-way interaction term of parental involvement and child temperamental reactivity and regulation indicated no significant effect, suggesting that in this sample the effect of negative affectivity did not vary by levels of effortful control and vice versa. However, this lack of finding does not eliminate the possibility that children with both high reactivity and regulation would have different experiences with their parents and diabetes management compared to those with high reactivity and low regulation or low reactivity and high regulation. In interpreting this lack of finding, it is important to note that current research focused on dimensional aspects of child temperament rather than profiles. While the dimensional approach can provide valuable information about the specific roles of temperamental reactivity and regulation, this can limit the understanding of a whole person (Planalp & Goldsmith, 2020). Although unfeasible in current data, profile-based approaches using advanced statistical methods (e.g., latent profile analysis) may offer more ecological assessments of children’s overall temperamental behavioral tendencies. Future research should consider recruiting a larger sample and adapting such approaches to investigate how children’s unique temperamental profiles may differentiate their receptivity to various forms of parental involvement.

**Limitations and Future Directions**

Current limitations may inform the aims and directions of future research. First, parental involvement and child temperament were measured exclusively via parent reports. Although all
measures have been well-validated and exhibited good reliability in this sample, employing only the parent reports may have provided limited perspectives on the intra- and interpersonal factors surrounding children’s T1DM treatment. Since prior research has noted discrepancies between parent and child reporting of parenting behaviors (Russell et al., 2016), future research should consider employing multi-informant measures. Related, parent reports of child temperament were correlated with the household income in directions consistent with prior evidence that low socioeconomic environments influence manifestation or parental perception of child temperament (e.g., high negative affectivity; Willoughby et al., 2015). Research employing multi-informant, multi-method assessments (e.g., observational) may help address these limitations and provide richer information about family and child functioning related to T1DM treatment.

Second, factors that were not emphasized in this study may have played influential roles in shaping children’s T1DM treatment. Several studies have noted that older child age (i.e., adolescence and young adulthood) may present as a potential risk factor and disrupt T1DM treatment effectiveness as patients transition to self-care responsibility (Berg et al., 2017; Butner et al., 2018; Luyckx & Seiffge-Krenke, 2009; Rausch et al., 2012; Wiebe et al., 2014). In current data, child age was significantly correlated with less parental assistance and support but did not significant contribute to glycemic control in any regression models. However, age may be an incomplete measure of any individual child’s development, especially in domains (e.g., self-regulation, socioemotional maturity) that may be relevant to T1DM management (Hilliard et al., 2012; Mackey et al., 2011). For instance, some studies have noted that pubertal status and increased self-efficacy may better predict children’s developmental maturity and preparedness for self-care responsibility (Hilliard et al., 2012; Mackey et al., 2011; Wiebe et al., 2014). Future
research should consider employing various measures of child development or a longitudinal design to further examine time-graded interactive effects of parental involvement and child temperament.

Another factor that may have been important but was unexamined in this study includes other types of diabetes-specific parental involvement, such as monitoring. Parental monitoring refers to efforts to maintain regular contact with children and supervise their general and diabetes-specific activities (Palmer et al., 2011; Young et al., 2014). As children gain more self-management skills over time, parents’ role is hypothesized to gradually shift from direct assistance to monitoring (Berg et al., 2017; Granic, Dishion, et al., 2003; Granic, Hollenstein, et al., 2003). While monitoring is an important parental behavior and may have been reflected in some items measuring parental support (e.g., congratulating children’s self-management success may only be possible if parents are aware of children’s health behavior; Berg et al., 2008), this was not a focus of this study. Since monitoring is a salient domain of parental involvement during adolescence, whether its impact also varies by child temperament may constitute an important future research question.

Lastly, the current sample consisted of predominantly English-speaking, White families (84.2%) and may have lacked socio-demographical diversity. Although the proportions of White and Latinx participants are somewhat representative of those within the Albany County population (U.S. Census Bureau, 2019), Black and Asian American families seem to have been underrepresented. Therefore, the extent to which findings from this study would be applicable to children of diverse racial/ethnic backgrounds is unclear. Abundant research has indicated that sociocultural stressors significantly contribute to the issue of pediatric health disparities (Hester et al., 2020; Mougianis et al., 2020; Valrie et al., 2020). Particularly, racial/ethnic minority
children with T1DM have been found to have poorer prognosis than White children in the U.S. (Borschuk & Everhart, 2015; Redondo et al., 2018). Equally important, growing research has suggested that associations among child temperament, parenting, and child adjustment may substantially vary by the cultural contexts (Farkas & Vallotton, 2016; Gartstein et al., 2012; Lin et al., in press; Zhou et al., 2009). Therefore, it constitutes a critical next step to replicate current findings in more racially/ethnically diverse samples and investigate potential roles of sociocultural stressors and resiliency.

**Conclusion**

Diabetes-specific parenting behaviors and child temperament interact to shape glycemic control among children with T1DM during middle childhood to adolescence. However, distinct from the differential susceptibility hypothesis, temperamental vulnerabilities (e.g., high negative affectivity, low effortful control) did not necessarily confer higher susceptibility to diabetes-specific parental assistance and support. Instead, findings broadly aligned with the goodness-of-fit paradigm and indicated that the quantity of direct parental involvement must match children’s temperamental characteristics to be beneficial during this crucial developmental period marked by increased transferring of treatment-related responsibility. Overall, results demonstrated that the ways in which the impact of parental involvement on glycemic control differs by child temperament are specific to the context of chronic illness management and should be interpreted as such.

These findings have important clinical and scientific implications. First, it may be clinically salient to consider children’s readiness and suitability for increased self-management responsibility based on their temperamental characteristics when adjusting the amount of direct parental assistance. For instance, children with high regulatory capacity (e.g., effortful control)
may benefit from gradually reduced direct assistance. For those with high negative affectivity, the impact of their reactivity on parent-child relationship and diabetes-related collaboration should be carefully monitored. Given parents’ potential wariness about granting autonomy to children whom they perceive to have difficult emotionality, therapeutic interventions to facilitate better parent-child communication may be helpful (Feldman et al., 2018). Lastly, this study highlights the need to integrate developmental and pediatric research to better understand family behaviors pertaining to child health care. Developmental research may aid in conceptualizing the interactional and transactional processes that shape the patterns of families’ efforts to manage children’s diabetes over time. It is also important that application of developmental frameworks is informed by the specific context of the pediatric condition and treatment (e.g., required amount of behavioral compliance and self-management) to enhance relevancy of the work.
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Table 1

Sample Demographic & Descriptive Statistics (n=101)

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Percentage (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>55.4% (56)</td>
</tr>
<tr>
<td>Female</td>
<td>43.6% (44)</td>
</tr>
<tr>
<td>Transgender</td>
<td>1.0% (1)</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>84.2% (85)</td>
</tr>
<tr>
<td>Hispanic/Latinx</td>
<td>5.9% (6)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>5.0% (5)</td>
</tr>
<tr>
<td>Other</td>
<td>4.0% (4)</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
</tr>
<tr>
<td>CGM</td>
<td>86.1% (87)</td>
</tr>
<tr>
<td>Insulin pump</td>
<td>88.1% (89)</td>
</tr>
<tr>
<td><strong>Patient Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Age at participation (years)</td>
<td>12.02 (2.43); 8–16</td>
</tr>
<tr>
<td>Age at diagnosis</td>
<td>7.67 (3.09); 0.92–13</td>
</tr>
<tr>
<td>Illness duration</td>
<td>4.25 (2.86); 0.5–13.08</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>8.27 (1.30); 6–14</td>
</tr>
<tr>
<td>Effortful control (EATQ-R)</td>
<td>3.14 (0.76); 1.20–4.73</td>
</tr>
<tr>
<td>Negative affectivity (EATQ-R)</td>
<td>2.66 (0.68); 1.11–4.18</td>
</tr>
<tr>
<td><strong>Caregiver Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Relationship to patient</td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>93.1% (94)</td>
</tr>
<tr>
<td>Grandmother</td>
<td>4.0% (4)</td>
</tr>
<tr>
<td>Father</td>
<td>3.0% (3)</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
</tr>
<tr>
<td>Married/living together</td>
<td>69.0% (69)</td>
</tr>
<tr>
<td>Single (e.g., divorced, widowed, separated)</td>
<td>31.0% (31)</td>
</tr>
<tr>
<td>Mean (SD); range</td>
<td></td>
</tr>
<tr>
<td>Age at participation</td>
<td>42.32 (7.44); 28–71</td>
</tr>
<tr>
<td>Annual household income</td>
<td>4.45 (1.95); 1–7</td>
</tr>
<tr>
<td>Parental direct assistance (DMQ)</td>
<td>82.38 (11.50); 41.25–100</td>
</tr>
<tr>
<td>Parental support (EATQ-R)</td>
<td>28.54 (7.03); 14–45</td>
</tr>
</tbody>
</table>

Note. CGM = continuous glucose monitoring; illness duration = months since T1DM diagnosis; household income (1= < $20k, 4= $60–80k, 7= >$120,000)
### Table 2

**Bivariate Correlations of Key Study Variables and Potential Covariates**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Child age</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Child male</td>
<td>-.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Racial/ethnic minority</td>
<td>-.04</td>
<td>-.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Household income</td>
<td>.05</td>
<td>-.01</td>
<td>-.46**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CGM/pump status</td>
<td>-.10</td>
<td>-.06</td>
<td>-.15</td>
<td>.28**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Illness duration</td>
<td>.38**</td>
<td>.05</td>
<td>-.13</td>
<td>.03</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Parental assistance</td>
<td>-.25 *</td>
<td>.09</td>
<td>-.01</td>
<td>.01</td>
<td>.02</td>
<td>-.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Parental support</td>
<td>-.27 **</td>
<td>.05</td>
<td>.14</td>
<td>.08</td>
<td>.18</td>
<td>-.09</td>
<td>.30**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Child effortful control</td>
<td>.06</td>
<td>-.03</td>
<td>-.03</td>
<td>.39 **</td>
<td>.11</td>
<td>-.07</td>
<td>.05</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Child negative affectivity</td>
<td>-.07</td>
<td>.02</td>
<td>.19</td>
<td>-.31 **</td>
<td>-.17</td>
<td>-.04</td>
<td>.05</td>
<td>-.05</td>
<td>-.68 **</td>
<td></td>
</tr>
<tr>
<td>11. Child glycemic control</td>
<td>.11</td>
<td>-.05</td>
<td>.13</td>
<td>-.23 *</td>
<td>-.41 **</td>
<td>.27 **</td>
<td>-.08</td>
<td>.01</td>
<td>-.15</td>
<td>.20 *</td>
</tr>
</tbody>
</table>

*Note. CGM/pump status = (0= no CGM or insulin pump; 1= CGM or pump; 2= CGM and pump); glycemic control = HbA1c (%); * p < .05, ** p < .01*
Table 3

Regressions of Parental Involvement & Child Temperament on Glycemic Control

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parental Assistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child age</td>
<td>0.00</td>
<td>0.05</td>
<td>0.00</td>
<td>-0.01</td>
<td>.991</td>
</tr>
<tr>
<td>Household income</td>
<td>-0.07</td>
<td>0.07</td>
<td>-0.11</td>
<td>-1.07</td>
<td>.287</td>
</tr>
<tr>
<td>Illness duration</td>
<td>0.12</td>
<td>0.04</td>
<td>0.27</td>
<td>2.70</td>
<td>.008</td>
</tr>
<tr>
<td>CGM/pump status</td>
<td>-0.86</td>
<td>0.21</td>
<td>-0.40</td>
<td>-4.15</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Parental assistance</td>
<td>0.07</td>
<td>0.12</td>
<td>0.06</td>
<td>0.59</td>
<td>.555</td>
</tr>
<tr>
<td>Child effortful control (EC)</td>
<td>0.14</td>
<td>0.17</td>
<td>0.12</td>
<td>0.84</td>
<td>.406</td>
</tr>
<tr>
<td>Child negative affectivity (NA)</td>
<td>0.18</td>
<td>0.16</td>
<td>0.14</td>
<td>1.08</td>
<td>.282</td>
</tr>
<tr>
<td>Parental assistance x EC</td>
<td>0.33</td>
<td>0.13</td>
<td>0.32</td>
<td>2.58</td>
<td>.012</td>
</tr>
<tr>
<td>Parental assistance x NA</td>
<td>0.48</td>
<td>0.20</td>
<td>0.32</td>
<td>2.45</td>
<td>.016</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Parental Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child age</td>
<td>0.00</td>
<td>0.05</td>
<td>0.00</td>
<td>0.04</td>
<td>.967</td>
</tr>
<tr>
<td>Household income</td>
<td>-0.08</td>
<td>0.07</td>
<td>-0.13</td>
<td>-1.19</td>
<td>.238</td>
</tr>
<tr>
<td>Illness duration</td>
<td>0.11</td>
<td>0.04</td>
<td>0.25</td>
<td>2.50</td>
<td>.014</td>
</tr>
<tr>
<td>CGM/pump status</td>
<td>-0.74</td>
<td>0.22</td>
<td>-0.34</td>
<td>-3.31</td>
<td>.001</td>
</tr>
<tr>
<td>Parental support</td>
<td>0.05</td>
<td>0.13</td>
<td>0.04</td>
<td>0.37</td>
<td>.716</td>
</tr>
<tr>
<td>Child effortful control (EC)</td>
<td>0.11</td>
<td>0.16</td>
<td>0.09</td>
<td>0.66</td>
<td>.509</td>
</tr>
<tr>
<td>Child negative affectivity (NA)</td>
<td>0.22</td>
<td>0.16</td>
<td>0.18</td>
<td>1.44</td>
<td>.154</td>
</tr>
<tr>
<td>Parental support x EC</td>
<td>-0.19</td>
<td>0.17</td>
<td>-0.16</td>
<td>-1.13</td>
<td>.262</td>
</tr>
<tr>
<td>Parental support x NA</td>
<td>-0.31</td>
<td>0.17</td>
<td>-0.27</td>
<td>-1.81</td>
<td>.073</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Note.* Outcome = HbA1c (%).
**Figure 1**

Moderating Effects of Child Effortful Control

![Graph showing the moderating effects of parental assistance on child glycemic control at high (1 SD above the mean), average, and low (1 SD below the mean) levels of child effortful control (EC). Significant slopes are notated as follows: *p < .05, **p < .01.](image)

**Notes.** Conditional effects of parental assistance on child glycemic control at high (1 SD above the mean), average, and low (1 SD below the mean) levels of child effortful control (EC). Significant slopes are notated as follows: *p < .05, **p < .01.
Notes. Conditional effects of parental assistance on child glycemic control at high (1 SD above the mean), average, and low (1 SD below the mean) levels of child NA. Significant slopes are notated as follows: *p < .05, **p < .01.