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# Problems with Adherence and Social Stigma in Adolescents with Type 1 Diabetes

Lauralee Davis
*Bucknell University*, led017@bucknell.edu

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Problems with Adherence and Social Stigma in Adolescents with Type 1 Diabetes

by

Lauralee Davis

A Thesis

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## Abstract

For adolescents with Type 1 Diabetes the clinical importance of both adherence to disease management and social support from family and friends is apparent. However, the role that family support or peer support plays on adherence to diabetes management or how stigma impacts adherence is still unclear. This study aims to determine differences between the type of support provided by family compared to peers, to examine how possible differences in the type of support impact adherence, to examine how social anxiety and stigma may be related to adherence, and to examine the types of barriers adolescents with Type 1 Diabetes experience and how these barriers may impact adherence. Participants included 104 adolescents between the ages of 14 and 18 years old (61 females; mean HbA1c= 7.66%) with Type 1 Diabetes that completed a survey with nine different measures including measures of adherence, social stigma, anxiety, and family and social support. Results indicated that management support from family members was significantly higher than management support from friends in the insulin ($p < .01$), blood testing ($p < .01$), and meal plan ($p < .01$) subscales. Further, emotional support from family members was actually higher than emotional support from friends in the subscale exercise ($p < .01$). Friend companionship ($p < .05$) and friend management support ($p < .05$) is also predictive of adherence in adolescents. Stigma, stress and burnout, time pressure and planning, and social support were correlated with adherence (all $p < .01$). However, social anxiety did not mediate the relationship between stigma and adherence ($p = .97$). Future research should assess these variables among a larger sample of adolescents with Type 1 Diabetes and further examine the effect of social desirability, social anxiety, and stigma on adherence in children and adolescents with Type 1 Diabetes.

## Introduction

Patient adherence is generally defined as how well patients carry out the disease management behaviors recommended by their health care providers (Zolnierek & DiMatteo, 2009). Given the social transitions and challenges that are thought to be present during adolescence (Datye et al., 2015) adherence can be difficult, and specifically, adolescents with Type 1 Diabetes experience barriers including burnout (Gandhi et al., 2015; Helgeson et al., 2007), social stigma, cost of medical supplies or insulin, family functioning, parental role and influence, communication with doctors, and psychosocial barriers (Datye et al., 2015). For individuals with Type 1 Diabetes, the daily regimen is demanding and complex to ensure glycemic control and prevent complications. Most individuals with Type 1 Diabetes find it difficult to reach even the recommended standards prescribed to them by their doctor (Gonzalez et al., 2016).

Outcomes of non-adherence (e.g., retinopathy, neuropathy, diabetic ketoacidosis; DCCT, 1994) are severe and debilitating, however these outcomes are often not immediate and patients may overestimate the likelihood that they will change their behavior in the interim. In reality, these outcomes can develop quickly depending on the rate of non-adherence behaviors. (Chapman, 1996; Greville & Bruehner, 2010). While we do know that adherence in adolescence is low (Buston & Wood, 2000; De Moerloose et al., 2008; Gray et al., 2012; Rothmann et al., 2008; Taylor et al., 2010), little research has examined the relationship between adherence behaviors and barriers in adolescents with Type 1 Diabetes.

The quality of social support for individuals with Type 1 Diabetes can play a significant role in successful self-management (Janicke et al., 2009; Roberts & Steele, 2017). Support can vary, with peers often providing more emotional support while the family provides more support for diabetes management (Bearman & La Greca, 2002). Social conflict has deleterious effects on outcomes, whereas social support positively impacts diabetes outcomes (Palladino & Helgeson, 2012). Adolescents who do make negative attributions of friend reactions see adherence as an obstacle in social situations, and experience increased stress and poor metabolic control (Hains et al., 2006). Adolescents with Type 1 Diabetes may feel uncomfortable adhering to their diabetes self-care behaviors due to fear of social embarrassment, peer rejection, or being treated differently (Schabert et al., 2013).

Adolescents with Type 1 Diabetes are at greater risk for depression and other mood disorders (McGill et al., 2017; McGrady & Hood, 2010; Northam et al., 2005) as well as for higher levels of anxiety symptoms (Herzer & Hood, 2010; Rechenberg et al., 2018), particularly for those with poor adherence and poor glycemic control compared to those with good glycemic control (Northam et al., 2005). Though Type 1 Diabetes is a relatively invisible chronic illness, stigmatizing factors related to poor adherence include visible medical equipment, such as an insulin pump, or other methods of disease management, such as the act of checking one's blood glucose levels or injecting insulin (Link & Phelan, 2001; Schabert et al., 2013). When these factors are examined between genders, stigma is seen to be slightly higher (68.3%) in females than to males (59.3%) (Brazeau et al., 2018). However, few studies have examined how the experience of peer pressure, stigma, or anxiety in social situations acts as a barrier to adherence, and most of the research in this area has examined these factors in adolescents or adults with Type 2 Diabetes (Bajor et al., 2015; Schabert et al., 2013).

The current study investigates the experience of adolescents with Type 1 Diabetes in order to determine the impact of support from family and peers, anxiety, and barriers such as social stigma on adherence behaviors. The aims of the study are: 1) To determine if there is a difference between the type of support provided by family compared to peers; 2) To examine how possible differences in the type of support provided by family compared to peers impact adherence; 3) To examine how stigma and anxiety may impact adherence; and 4) To examine how different types of barriers impact adherence.

## Literature Review

### ***Barriers to Adherence***

Adherence is a challenging behavior to maintain, and the barriers to adherence are numerous and multifaceted, especially those related to management and adherence for individuals with Type 1 Diabetes (Borus & Laffel, 2010). There are many barriers to adherence that have been shown to play a role, such as family functioning (Hauser et al., 1990; Herge et al., 2012), peer support (Datye et al., 2015), cost (American Diabetes Association 2018; Gotham et al., 2018), communication with providers (Valenzuela et al., 2014), etc. This study examines the impact of parental role and influence, peer support, stigma, social desirability, stress and burnout, time pressure and planning, and autonomy support in particular.

### ***Stigma Framework***

Stigma is an experienced or anticipated social process of either an experience, perception, or anticipation of an adverse social response (e.g., exclusion, rejection, blame), often in the form of judgement or prejudice about a person or group of individuals that share in a specific adversity (Scambler, 2009). If this social judgement is based on a health condition, it is often related to disease management, such as a colostomy bag, limb brace, or even excessive medication usage (Scambler, 2009). The Framework Integrating Normative Influence on Stigma (FINIS) describes the relationship between perceived social stigma and adherence to a medical regimen as a product of both community and individual factors (Perscosolido et al., 2008). This starts with the combination of social characteristics and illness characteristics that shape both the evaluation of the person's behavior and also determine the likelihood that this person can be identified by a complete stranger as someone with a chronic physical illness (Pescosolido et al., 2008). The greater the social differentiation (e.g., race/ethnicity, age, gender identification, etc) between the person with the chronic physical illness and the stranger, the likelihood of negative responses increases (Loring & Powell, 1988). Additionally, the extent of the severity of the problem in ways that it might be seen as outside the social norms (e.g., injecting insulin in public) also plays a role in how much the perceived stigma increases or not (Pescosolido et al., 2008). Stigma also appears to be embedded within a larger cultural and community context, which outlines and defines the scope of the stereotype and 'othering' of groups (Pescosolido et al., 2008). However, personal contact with someone with a stigmatized issue challenges the stereotype-belief and reduces stigma due to proximity (Swan, 1999).

Though the FINIS theory is primarily based on the stigma of chronic mental illness, it can easily be transferred to chronic physical illness, because like chronic physical illnesses, a majority of chronic mental illnesses are invisible (Quinn & Chaudoir, 2009). Individuals with chronic physical illnesses are often subjected to stigmatization and ostracization from the general population (Joachim & Acorn, 2001). Health-related stigma can be experienced in many forms, for individuals with chronic physical conditions, such as shame and blame (Scambler, 2009).

### ***Adolescence and Adherence***

Adolescence is a period of transition, including: changes in hormones, body, friends, and school. For adolescents with chronic illnesses, this period is also when parents slowly transfer disease-management to the adolescent. However, adolescents have a higher risk of engaging in rebellion and risky behaviors, which may include non-adherence in individuals with chronic illnesses, leading to the decline of glycemic control during this period (Anderson et al., 1997; Hamilton & Daneman, 2002; Iannotti et al., 2006; Mortenson et al., 1998). Parent involvement in disease management decreases between the ages of 10-16 years, primarily due to increased time spent away from parents (Hanna & Guthrie, 2003; Wysocki et al., 1992).

### *Adherence in Chronic Illness*

Adherence varies between chronic illness groups due to unique barriers, and medical regimen and management plans differ in complexity (Horne & Weinman, 1999). Most share certain barriers to adherence such as forgetting, oppositional behaviors, and difficulties with time management (Modi & Quittner, 2006). Some have unique barriers such as stigma surrounding visible medical equipment (i.e. colostomy bag, insulin pump, oxygen tube), having to attend specialist appointments, or barriers that might prevent the individual from participating in regular activities or school (i.e. frequent hospitalizations, chronic pain, crutches or limb braces; Hanghøj & Boisen, 2014; Scrambler, 2009). Adherence during adolescence is particularly difficult because this is a period characterized by striving to feel normal and fit in with peers (Hanghøj & Boisen, 2014; Taddeo et al., 2008), and many chronic illness groups including epilepsy, asthma, Type 1 Diabetes, and rheumatoid arthritis report having a hard time feeling like a normal teen (Kyngäs, 2000a). Adolescents often associate their chronic illness with feeling abnormal, which becomes a barrier for medication adherence in many chronic illnesses (Dziuban et al., 2010; Kyngäs, 2000b; Modi et al., 2009; Simons et al., 2009) for reasons such as feeling like their disease or disease management regimen is taking over their lives (Buston & Wood, 2000; Rosina et al., 2003) and wanting freedom from their disease (Buston & Wood, 2000; De Moerloose et al., 2008; Gray et al., 2012; Rothmann et al., 2008; Taylor et al., 2010).

### *Burden of Diabetic Adherence*

**Type 1 Diabetes.** Type 1 Diabetes is an autoimmune disease where the immune system attacks healthy insulin-producing beta cells in the pancreas, resulting in insulin dependency. An estimated 1.25 million are living with Type 1 Diabetes in the United States, 193,000 (0.24% of the population) of whom are under 20 years of age (American Diabetes Association, 2018c).

There is a 50% higher risk of early death for individuals with Type 1 Diabetes compared to those without (CDC, 2014). This risk is associated with the complications seen with extreme hyperglycemia and hypoglycemia. Hyperglycemia occurs when blood glucose levels are elevated or “high”, typically around or above 200 mg/dL (Mouri & Badireddy, 2020). Many factors can contribute and cause hyperglycemia including non-adherence by missing or skipping insulin doses, anxiety, illness, etc (American Diabetes Association, 2015; Mouri & Badireddy, 2020). Hypoglycemia, in contrast, occurs when blood glucose levels are depleted or “low”, typically around or below 70 mg/dL (Morales & Schneider, 2014; Seaquist et al., 2013). Severe hypoglycemia can be detrimental long term, including increased risk of mortality, comas, seizures, cognitive impairment, and decreases in quality of life (Morales & Schneider, 2014). However, due to advances in treatment over the past decade, life expectancy for individuals with Type 1 Diabetes has increased by 15 years, though overall individuals lose an estimated 8-13 years off their life expectancy compared to individuals without Type 1 Diabetes (Basina & Maahs, 2018; Hunter, 2016; Miller et al., 2012).

**Daily Regimen and Medical Management.** Good diabetes management is typically defined as engaging in the tasks, behaviors, and time associated with reducing the presence of both high and low blood glucose readings (Hunter, 2016). Maintaining glycemic control to prevent complications involves a challenging daily regimen. Most individuals with Type 1 Diabetes find it difficult to reach even the recommended standards prescribed to them by their doctor (Gonzalez et al., 2016). The daily routine of a Type 1 Diabetic includes checking blood glucose levels with a glucometer an estimated 10-20+ times (both before meals and throughout the day for monitoring), 3-4 insulin injections with up to two different types of insulin (long-acting and short-acting), and monitoring carbohydrates during meal times (American Diabetes

Association, 2015; Hunter, 2016). Maintaining good diabetes management reduces the risk of complications from hypoglycemia and hyperglycemia, such as heart disease, stroke, nephropathy, kidney failure, neuropathy, limb amputations, coma, or death for hyperglycemia and seizures, syncope episodes, or death for hypoglycemia (CDC, 2014). Type 1 Diabetes requires constant adherence and monitoring, which results in a high burden for both the child and the family. Keeping blood glucose within the recommended range, which is unique and individualized for each patient, is difficult to accomplish (American Diabetes Association, 2019). Blood glucose is impacted by a variety of external variables, such as too much food or having more carbohydrates than usual, no exercise, high stress, short- or long-term pain, menstrual cycles, dehydration, alcohol, etc. (American Diabetes Association, 2015). Particularly, dietary factors like a high-fat or a high-protein diet, such as a ketogenic diet, impact postprandial blood glucose levels (Bell et al., 2015). Parents of children with Type 1 Diabetes, as well as the child themselves, often have impaired and disrupted sleep due to waking up to manage blood sugar or being woken up by multiple alarms from a continuous glucose monitor (CGM) (Streisand & Monaghan, 2014). Because so many variables can impact blood glucose, Type 1 Diabetes patients experience a high degree of uncontrollability and stress associated with the unpredictability of the disease process and daily management (Freeborn et al., 2013).

**Method of Insulin Delivery.** How insulin is administered, whether through an insulin pump or via insulin injections, can be a barrier to adherence. Insulin pumps, while convenient, appear to be problematic; 65% of insulin pump users miss a dose or two, particularly at a meal, which increases A1c by 0.5% for two missed doses a week (Burdick et al., 2004). Missing a dose at a meal is frequently due to forgetting (Burdick et al., 2004). Additionally, injections require significant diabetes knowledge in order to execute the dosages properly, which can be difficult to maintain and calculate. Type of insulin delivery, via manual daily injections versus continuous subcutaneous insulin infusion, significantly predicted high risk of deterioration in diabetes management and control among adolescents (Hilliard et al., 2010; Hilliard et al., 2013).

**Family Functioning.** Family functioning likely impacts adherence, especially in Type 1 Diabetics (Hauser et al., 1990; Herge et al., 2012). Parents of younger children diagnosed with Type 1 Diabetes typically lead the management regimen until the child can take on some of the management for themselves (Pierce et al., 2019). When children reach adolescence, they start to transition into taking a more active role in their diabetes management (Datye et al., 2015). During this period, researchers have seen a decrease in parental oversight, which has further been associated with decreased adherence rates in adolescents (Datye et al., 2015). Family functioning and adherence are strongly correlated with metabolic control, and negative family functioning processes negatively impact adherence in children and teenagers (Lewin et al., 2006). Similarly, more cohesion and agreement experienced between the adolescent and the caregiver and lower prevalence of diabetes-related conflict was correlated with lower HbA1c levels (Rybak et al, 2017). Further, Mackey et al. (2011) found that youth with positive functioning had better metabolic control. These findings suggest that family functioning may influence adherence outcomes in adolescents.

**Parental Role and Influence.** Parental monitoring or involvement in the diabetes treatment regimen is a strong predictor of adolescents' adherence (Goethals et al., 2017; Goethals et al., 2019; Landers et al., 2016). Specifically, perception of involvement by the adolescent is key, because if parental involvement is viewed as necessary, adherence will be higher whereas if parental involvement is viewed as intrusive then adherence will be lower (Datye et al., 2015). In Type 1 Diabetes, there is a significant decline in adolescents collaborating with their parents over self-management across early, middle, and late adolescence (Keough et al., 2011). Further, regimen adherence proved to be significant with level of collaboration with parents, diabetes care activities, and problem-solving methods, while gender was a significant predictor of diabetes care activities and communication with parents and doctors about goals related to Type 1 Diabetes (Keough et al., 2011). Parental influence has been identified as the main contributing factor to treatment non-compliance in adherence among adolescents with Type 1 Diabetes (Cox & Hunt, 2015). In this case, healthy parent-child relationships that consist of parental encouragement towards the child were correlated with improved treatment compliance, whereas poor parent-child relationships were correlated with treatment non-compliance (Cox & Hunt, 2015; Drew et al., 2010; Helgeson et al., 2008). Similarly, a higher quality relationship between the parents and the adolescent with Type 1 Diabetes, as well as more encouraging behaviors from the parent, correlated with less peer-oriented behaviors (e.g., seeking advice and support from peers rather than parents) and better adherence to their diabetes care regimen (Drew et al., 2010). Parenting style may also play a role; authoritative parenting was indirectly correlated with optimal HbA1c levels through both increased adherence and better glycemic control (Radcliff et al., 2018). It is therefore likely that parenting roles, influence, and even parenting style impact the adherence outcomes in adolescents with Type 1 Diabetes.

**Peer Support.** Peers have been found to provide more emotional support compared to the family, which provides more support for diabetes medical management (Datye et al., 2015). The literature surrounding peer support is mixed, while some research shows that peer influence does not actually impact adherence (Bearman & La Greca, 2002). Other research shows that adolescents report that peers have an influence on their diabetes behaviors (Palladino &

Helgeson, 2012). Social conflict was harmful and social support was helpful in diabetes outcomes such as self-care and overall glycemic control (Palladino & Helgeson, 2012). Adolescents who make negative attributions of friend reactions see adherence as an obstacle in social situations, and experience increased stress and poor metabolic control (Hains et al., 2006).

Further, aspects of both romantic and platonic relationships were correlated with health outcomes such as lower BMI, however there were more effects with romantic relationships than friend relationships (Helgeson et al., 2015). Compared to children with Type 1 Diabetes, adolescents with Type 1 Diabetes had better problem-solving abilities in response to social pressure situations, possibly reflecting their greater cognitive maturity (Thomas et al., 1997). However, adolescents were also more likely to choose behaviors that are less regimen adherent (Thomas et al., 1997). Due to limited and mixed research however, clarity regarding the impact peer relationships have on adherence in adolescence is needed.

**Stigma and Social Desirability.** Type 1 Diabetes is sometimes referred to as a concealable stigmatized identity (Quinn & Chaudoir, 2009). While most of the time the behaviors can be hidden or concealed, there are certain aspects that cannot and therefore cause stigma, whether it be from wearing a pump visibly, performing insulin injections in public, or even the simple task of checking one's blood glucose levels (Børte & Otterson, 2012). Often Type 1 Diabetes is mistaken as Type 2 Diabetes, and the associated stigma can then lead to feelings of self-blame and lower perceived self-worth (Schabert et al., 2013).

Overall,  65.5% of adolescents reported experiencing stigma related to diabetes management and features of the disease (e.g. the effects of low glucose levels, displaying pump paraphernalia, etc) and higher stigma was linked to poor glycemic control and a higher HbA1c level (Brazeau et al., 2018). Stigma can also affect the quality of life in Type 1 Diabetes, higher levels of perceived stigma was associated with higher levels of psychological distress, with more exacerbated depressive symptoms and less social support (Gredig & Bartelson-Raemy, 2017). However, little research has examined whether adolescents experience stigma when in social situations with their friends and peers. There is currently no literature on social desirability and Type 1 Diabetes. However, social desirability is important to examine due to the influence it may have on stigma and social anxiety, particularly if they are related.

**Psychological Comorbidities.** Though adolescents with Type 1 Diabetes carry an increased risk for mental health issues (Bernstein et al., 2013), there is further increased risk for depression, other mood disorders (McGill et al., 2017; McGrady & Hood, 2010; Northam et al., 2005), and anxiety symptoms (Herzer & Hood, 2010; Rechenberg et al., 2018) among Type 1 Diabetics, particularly for those with poor adherence and poor glycemic control compared to those with good glycemic control (Northam et al., 2005). In fact, higher levels of anxiety symptoms are correlated with less frequent blood glucose monitoring, as well as above average glycemic control (Herzer & Hood, 2010). Similarly, anxiety acts as an emotional barrier, such as in situations where one might feel anxious about having a hypoglycemic episode (Sato et al., 2003). Psychological barriers can have a large impact on diabetes management, and likewise diabetes management can have a large impact on psychological well-being. Social anxiety may be particularly relevant due to some of the public nature of adherence behaviors and how others respond (e.g., fear of needles and blood). However, this relationship is often complex and difficult to study.

***Outcomes of Non-Adherence***

The average rate of non-adherence in Type 1 diabetes is 24.8% (DiMatteo, 2004), with higher rates of problems with adherence to regimen and poor glycemic control among African

Americans (Patino et al., 2005). Patients often make intentional decisions to not adhere to recommendations made by their provider, such as making choices and weighing the costs of the treatment with the overall benefits from treatment and potential improvement in quality of life overall (Gonzalez et al., 2016; DiMatteo, 2004). Suboptimal diabetes management along with poor glycemic control can lead to an increased risk for hospitalization, further complications, and even early death (Nicolucci et al., 2013). One difficulty in addressing adherence is that the long-term outcomes of non-adherence (e.g., retinopathy, neuropathy, diabetic ketoacidosis; DCCT, 1994) are not in temporal spatial proximity with the non-adherent behavior when it happens (Chapman, 1996; Greville & Buehner, 2010). This is in part due to the variable temporal intervals of possible negative impacts of poor management (i.e. a series of consistent high blood glucose levels for a year results in deterioration in eyesight, possibly leading to full blindness in two years; Chapman, 1996; Greville & Buehner, 2010). These outcomes are often seen as too distant to cause worry, and patients may overestimate the likelihood that they will change their behavior in the interim, when in reality these outcomes can develop quicker depending on the rate of non-adherence behaviors (Chapman, 1996; Greville & Bruehner, 2010). While we do know that adherence in adolescence is low (Buston & Wood, 2000; De Moerloose et al., 2008; Gray et al., 2012; Rothmann et al., 2008; Taylor et al., 2010), little research has examined the relationship between adherence behaviors and barriers in adolescents with Type 1 Diabetes.

### *Aims and Hypotheses*

The clinical importance of both adherence and social support received from family and friends for adolescents with Type 1 Diabetes is apparent. Adolescence is ultimately defined by the critical transition from childhood and dependence on family, to a newfound independence and increased value and importance in peers (Robinson, 2008). However, the role that family support or peer support plays on matters such as adherence or stigma is still unclear. Anxiety and social stigma remain a relatively understudied area within Type 1 Diabetes. As noted previously, adolescence is a period of transition and making new friends, as well as being introduced to new situations. These new friends might not understand the scope of the disease and may make stigmatizing comments or fail to be accepting, resulting in anxiety and possibly non-adherence (Rechenberg et al., 2018).

The present study aims to investigate the nature and impact of support received by adolescents with Type 1 Diabetes from both family and peers as well as whether adolescents experience stigma and anxiety when in social situations with their friends and peers, and the effects this stigma has on non-adherence to their diabetes regimen.

This study aims to address the following questions:

1. Is there a difference between the type of support provided by family compared to type of social support provided by peers?
2. How do the differences in the type of support provided by family compared to peers impact adherence?
3. How does stigma and anxiety impact adherence?
4. How do other psychosocial barriers impact adherence?

**Hypothesis 1:** Support for practical diabetes management tasks (insulin management, blood glucose monitoring, diet, etc) will be provided more frequently by family members, and "companionship"-related support (emotional support) will be provided more frequently by peers.

**Hypothesis 2:** Family support will predict adherence in adolescents with Type 1 Diabetes.

**Hypothesis 3:** Stigma will impact adherence through social anxiety, which will be stronger for individuals with higher social desirability (Figure 1).

**Hypothesis 4:** Adolescents who report barriers to stigma, stress and burnout, and social support will have more problems with adherence than those who do not.

# Methods

## Participants

The present study recruited 1,105 participants with Type 1 Diabetes who accessed the survey through Qualtrics. Eight-hundred and ninety participants were excluded because they fell outside of the desired age range (14-18 years old). Another 111 participants were excluded because they did not complete at least 90% of the survey, not including the two sleep measures at the end, which a majority of the participants did not complete. The final sample included 104 adolescents with Type 1 Diabetes, who were between 14 and 18 years old. The mean age of the 104 participants was 15.83 (± 1.333) years (range: 14-18 years), with a mean HbA1c of 7.66 (± 1.435) (range: 4.9-12.3) (Table 1). There were 41 males and 61 females, and 89.4% identified as Caucasian/White. 80.8% of participants reported using an insulin pump, 29.8% of which reported using the OmniPod. When assessing for continuous glucose monitor (CGM) use, 87.5% reported using a CGM (Table 2).

## Procedure

The present study has been approved by the Bucknell University Institutional Review Board. The survey was distributed as an online Qualtrics survey through the T1D Exchange Network (emails and social media posts) and Qualtrics, as well as through social media platforms such as Facebook and Reddit . Age was assessed by asking the participant to type in their age into a box on the screen. If the adolescent typed anything between 14-18 years old, they were allowed to complete the rest of the survey. However, if they typed in an age less than 14 or greater than 18 years old, they would be directed to the end of the survey. Further, participants were excluded from the current sample if they had completed less than 90% of the survey.

For participants 14-17 years old the parent/guardian was prompted via survey to give parental consent, complete demographic questions, and then the child gave assent and completed the survey measures, while participants that were 18 years old were prompted to give consent and then went on to complete the survey measures.

**Measures**

***Demographic Questionnaire:***

The authors created a demographic questionnaire using guidelines for race and ethnicity, as well as household income. The demographic questionnaire also included medical questions regarding the participants' HbA1c, as well as what method of insulin delivery they use, and if it is accompanied by the use of a continuous glucose monitor system or not.

***Diabetes Social Support Questionnaire- Family (DSSQ-Family)***

The DSSQ-Family is a 52-item self-report measure that assesses family member support for diabetes care (La Greca & Bearman, 2002). The questionnaire measures family support in the following domains: insulin delivery and scheduling (8 items, e.g., "How often does a family member give your shots" and "How often does a family member check after you have taken your shot to make sure you have done it"); blood glucose monitoring behaviors (12 items, e.g., "How often does a family member make sure you have materials needs for blood testing"); dietary behaviors (20 items, e.g., "How often does a family member eat at the same time you do"); exercise (7 items, e.g., "How often does a family member remind you to exercise"); and social support (5 items, e.g., "How often does a family member tell you how well you've been doing with your diabetes care"). Subscale scores were computed by averaging items; items were rated on a 6-point Likert scale for management support (0 = never, 1= less than two times a month, 2 =twice a month, 3 =once a week, 4 =several times a week, 5= at least once a day) and a 5-point

Likert scale for companionship support (-1= unhelpful or not supportive, 0= neutral, 1= a little helpful or supportive, 2= helpful/supportive, 3= very supportive). The DSSQ-Family has been used in many studies with adolescents with Type 1 Diabetes (Carcone et al., 2011; Hsin et al., 2009; Ouzouni et al., 2018; Robinson, 2008). The psychometric evaluation of the DSSQ-Family revealed that the measure had acceptable levels of internal consistency (*rs* >.70). The DSSQ-Family was determined to be a reliable measure after the researchers reported good stability across adolescent's responses to the measure (α ranged from .78- to .94 for enacted support scale and from .82 to .98 for the combined scale; $p < .001$) (La Greca & Bearman, 2002). For the current study, reliability was very high, α= .95.

***Diabetes Social Support Questionnaire- Friends (DSSQ-Friends)***

The DSSQ- Friends is a 28-item self-report measure that assesses friend support for diabetes care (Bearman & La Greca, 2002). The questionnaire measures friend support in the following domains: insulin delivery and scheduling (2 items, e.g., "How often does your friend remind you to take your insulin" and "How often does your friend let you know they appreciate how difficult it is to take insulin injections."); blood glucose monitoring behaviors (6 items, e.g., "How often does your friend ask about the results of your blood test"); dietary behaviors (13 items, e.g., "How often does your friend eat at the same time you do"); exercise (4 items, e.g., "How often does your friend remind you to exercise"); and social support (3 items, e.g., "How often does your friend encourage you to do a good job of taking care of your diabetes."). Subscale scores were computed by averaging items; items were rated on a 6-point Likert scale for management support (0 = never, 1= less than two times a month, 2 =twice a month, 3 =once a week, 4 =several times a week, 5= at least once a day) and a 5-point Likert scale for companionship support (-1= unhelpful or not supportive, 0= neutral, 1= a little helpful or supportive, 2= helpful/supportive, 3= very supportive). The DSSQ-Friends has been used in many studies with adolescents with Type 1 Diabetes (Carcone, 2010; Carcone et al., 2011; Doe, 2018; Ghasemipoor et al., 2010). The construct validity of the subscales has not been confirmed because the researchers did not conduct a factor analysis, however this is suggested to be acceptable from the relationships between both frequency of enacted support and frequency by perceived support, as well as other measures of support (DSSI-Friends and Perceived Social Support– Friends) (Hanna, 2006). Predictive validity was found through blood glucose testing items being significantly predicted by greater combined support (Hanna, 2006). The test-retest reliabilities for frequency of enacted support and combined support ranged between .78 and .94, and values greater than .70 were considered satisfactory test-retest reliability (Hanna, 2006). For the current study, reliability was high, $\alpha = .94$.

***The Screen for Child Anxiety Related Disorders (SCARED)***

The SCARED is a 41-item self-report measure that assesses anxiety in children (Birmaher et al., 1997). Factor analysis reveals a 5-factor solution including panic/somatic, generalized anxiety, separation anxiety, social phobia, and school phobia (Birmaher et al., 1999). Each of these factors revealed optimal internal consistency ($\alpha$ between .78 and .87; Birmaher et al., 1999). The factors from SCARED significantly differentiate children who had no anxiety disorders from children who do ($p < .0001$). For the present study, we will use only the social anxiety subscale. Similarly, for the current study the reliability was excellent, $\alpha = .93$.

***The Diabetes Self-Management Questionnaire-Revised (DSMQ-R)***

The DSMQ is a 27-item self-report measure that assesses self-care activities related to glycemic control (Schmitt et al., 2013). Reliability and validity were assessed using cross-sectional data from a survey with 333 Germans with Type 1 Diabetes and 256 with Type 2

Diabetes. Validity was seen across all 20 mandatory items ($r$= -0.57, $p < 0.01$) and across all 27 items ($r$= -0.57, $p < 0.01$) (Schmitt, 2018). The DSMQ-R was determined to be a reliable measure after the researchers reported good stability across adolescent's responses to the measure (α ranged from 0.93 to 0.94 for the total score; all $p < .01$; Schmitt, 2018). The DSMQ-R has 27 items, while the original DSMQ has 16 items. Analyses on the DSMQ have shown that overall bivariate correlations between this measure and HbA1c had values between -0.40 and -0.43, which is above average compared to other instruments (Schmitt et al., 2016). Measurement of self-management showed a significant negative association with HbA1c (-0.53, $p < 0.001$), which explained 21% of the variation in glycemic control in participants with Type 1 Diabetes (Schmitt et al., 2016). For the current study, the reliability was questionable, α= .66.

***The Barriers to Diabetes Adherence for Adolescents (BDA)***

The BDA is a 21-item self-report measure that assesses barriers to adherence in adolescents with Type 1 Diabetes, such as stress and burnout, time pressure and planning, social support, autonomy support, and stigma (Mulvaney et al., 2011). A factor analysis was completed following data collected from 123 adolescents, which resulted in a 21-item measure with the five components mentioned above, which accounted for 63.09% of the variance (Mulvaney et al., 2011). The researchers found that the BDA total and subscales were internally consistent (α= .88 for the total and a range of .70 to .85 for the subscales) (Mulvaney et al., 2011). According to the analysis, BDA was the only predictor of HbA1c compared to the other variables used (demographic, clinical, and adherence; $F$= 6.17, $p < .05$; Mulvaney et al., 2011). For this study, the reliability was good, α= .81.

***The Attribution of Friends Reactions***

The Attribution of Friends Reactions is a 15-item self-report measure composed of vignettes and a 12-item reaction assessment to each vignette (Hains et al., 2006). This measure assesses the relationship between adherence, diabetic stress, and metabolic control. In order to determine item variance, a factor structure was performed. The factor structure found that two variables accounted for item variance: negative attributions of friend reactions (39.49%) and anticipated adherence difficulties (13.69%; Hains et al., 2006). The mean participant experience rating across vignettes (2.58 $\pm$ sd= 0.83), which implies that the vignettes reflect similar encounters and situations that the adolescent has experienced previously (Hains et al., 2006). Validity was assessed by examining the relationships between negative attributions of friend reactions and diabetes-related stress ($r$= 0.28, $p < 0.01$), anticipated adherence difficulties ($r$= 0.52, $p < 0.0001$), and no direct relationship was apparent with metabolic control ($r$= 0.01, $p$= 0.90). (Hains et al., 2006). The corrected item-total correlations between negative attributions of friend reactions and anticipated adherence difficulties (0.56 $\pm$ 0.12, 0.57$\pm$ 0.07), as well as the inter-item correlations between the same variables (0.34 $\pm$ 0.17, 0.36 $\pm$ 0.14) provided construct validity for both of the scales in the measure (Hains et al., 2006). For this study, the reliability was excellent, $\alpha$= .97.

***Children's Social Desirability Questionnaire***

The CSD is a 48-item self-report measure composed of true/false statements that assesses a child's social desirability responding motivated by either a need for peer approval or even a fear of disapproval among peers (Crandall et al., 1965; Crandall, 1966; Robinson et al., 1991). A test-retest reliability was examined to determine reliability among a small portion of the original sample (n=63) (Crandall et al., 1965). To do this, both the direct question form and the true-false form of the measure was administered for a second time after one month. Reliability between the first and the second administration of the direct question measure was .90, while reliability for the true-false form was .85 (Crandall et al., 1965). The researchers found that the CSD was therefore internally consistent (Crandall et al., 1965). For the current study, the reliability was relatively poor, α= .55.

***PROMIS Sleep-Related Impairment, Short Form 8a***

The PROMIS is an 8-item self-report measure that assesses an individual's perception of their sleep quality (including falling and staying asleep), sleep depth, sleep restoration, and sleep disturbance (Hanish et al., 2017). The adult PROMIS measure has previously demonstrated sound validity with adolescents (ages 12-18 years old) (Hanish et al., 2017; van Kooten et al., 2016). The researchers also found that the PROMIS form 8a specifically was internally consistent in sleep disturbance ($r$ = .85) and sleep-related impairment ($r$ = .70) when compared to the Pittsburgh Sleep Quality Index (Cella et al., 2010; Hanish et al., 2017; HealthMeasures, 2016). The current study's reliability was good, α= .84.

***Pittsburgh Sleep Quality Index (PSQI)***

The PSQI is a 9-item self-report measure that assesses sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, utilization of sleep medication, and daytime dysfunction (Buysse et al., 1989). Research has previously demonstrated that the PSQI is internally consistent (α= 0.73) and valid to use with adolescent populations (Ranti et al., 2018). Though the PSQI features a single-factor scoring structure that might not be complex enough to gage sleep quality in any or all populations, it is structurally valid to use with adolescents (Ranti et al., 2018). A confirmatory analysis also indicated that there was a correlation between global sleep quality (the latent factor) and duration and efficiency, as well as between global sleep quality and efficiency and latency (Ranti et al., 2018). The reliability for this measure was unable to be assessed for the current study due to lack of participant responses.

**Analysis**

All statistical analyses were performed using SPSS version 25. To estimate the conditional process analysis, the authors used the PROCESS package plugin for path estimates and moderated mediation effects using the SPSS v3.4 (Hayes, 2018).

Normality was examined individually for the variables used in each of the hypotheses before conducting each of the analyses. However, the authors chose not to address the normality based on the Shapiro-Wilks values because this analysis is better suited for sample sizes less than 50, whereas the current sample is 104 (Howell, 2010). Instead, normality was assessed using quantile-quantile plots, as Howell (2010) recommends. HbA1c, Family Companionship Support for meal time behaviors, DSSQ-Family Companionship total, DSSQ-Friend Companionship total, SCARED total, and Negative Peer Attribution, as indicated by the Q-Q plot, was slightly non-normal. The rest of the variables were normally distributed, because of this, the authors proceeded with parametric statistics. A possible reason why HbA1c was non-normal is that HbA1c in adolescents is typically higher due to hormones (Clements et al., 2016; Gaete et al., 2010). Because the normality was only slightly non-normal, it was not addressed.

Further, as a whole the data set was normal in terms of skewness and kurtosis. However, HbA1c was found to be highly skewed $z$(skew)= 1.246. With HbA1c mainly skewed right, this sample had a moderately high average HbA1c (M= 7.66) and suggested possible adherence problems. Overall the variables showed that skewness ranged between -.701 and 1.246. Kurtosis also ranged between -1.258 and 1.619.

The authors estimated that the effect size will be small (*d*= 0.353). This estimate is based on the previous literature (Hains et al., 2006) with sample sizes similar to the current study. Previous literature indicated a range of effect sizes. This may be in part because this particular sample is difficult to recruit.

Hypothesis 3 suggested a conditional process analysis, where the effect of stigma related to adherence through social anxiety is conditional on the value of the moderator (social desirability). Instead of using more traditional approaches for assessing moderated mediation, and thus avoiding any mathematical and conceptual limitations associated with such, the authors utilized the statistical methods and SPSS syntax PROCESS (Hayes, 2018).

## Results

### Hypothesis 1

A paired samples t-test conducted at an alpha level of .05 examined the differences in means between management support scores from the Insulin Injections, Blood Testing, and Meal Plan subsections of both the DSSQ-Family and the DSSQ-Friends, and the differences in means between the emotional support scores from the Exercise and General Items subsections of both the DSSQ-Family and the DSSQ-Friends. The analysis indicated that the mean management support scores for insulin behavior from family (M= 2.47, SD= 6.26) was significantly higher than the mean management support scores for insulin behavior from friends (M= 1.83, SD= 1.05); t(103)= 5.61, p < .001, two-tailed (Figure 2). The mean difference between groups was M= .64, 95% CI [.41, .87]. Further, mean management support scores for blood testing behavior from family (M= 2.44, SD= .55) was significantly higher than the mean management support scores for blood testing from friends (M= 2.17, SD= .81); t(103)= 2.95, p= .004, two-tailed (Figure 3). The mean difference between groups was M= .27, 95% CI [.089, .45]. The mean management support scores for meal plan behavior from family (M= 2.53, SD= .69) was significantly higher than the mean management support scores for meal plan behavior from friends (M=1.74, SD= .66); t(103)= .93, p < .001, two-tailed (Figure 4). The mean difference between groups was M= .79, 95% CI [.64, .93]. Finally, mean emotional support scores for exercise behavior from family (M=2.85, SD= .87) was significantly higher than the mean emotional support scores for exercise behavior from friends (M= 3.33, SD= .97); t(103)= -5.90, p < .001, two-tailed (Figure 5). The mean difference between groups was M= -.48, 95% CI [-.64, -.32].

**Hypothesis 2**

A hierarchical multiple regression analysis was conducted to evaluate the prediction of both subjective and objective measures of adherence (using the total score from the DSMQ-R and the reported HbA1c) from the total scores from the DSSQ-Family and DSSQ-Friend measures (Hypothesis 2). The first hierarchical multiple regression analysis used HbA1c as the outcome variable (Table 3). In the first step, the predictor variable Family Companionship Support was analyzed. This variable did not account for a significant amount of variance in adolescents' HbA1c, $R^2$= .000, $F$(1, 100)= .013, $p$= .909. In the second step, the predictor variable Friend Companionship Support was added into the model and accounted for a significant proportion of variance in HbA1c levels, $R^2$= .063, $F$(1, 99)= 6.637, $p$= .040, b= .288, $t$(99)= 2.576, $p$= .011. In the third step, the predictor variable Family Management Support was added into the analysis and did not account for a significant level of the variance in HbA1c levels, $R^2$= .063, $F$(1, 98)= .024, $p$= .093. Finally in the fourth step, the predictor variable Friend Management Support was added into the analysis and it did account for a significant change in variance in HbA1c levels in adolescents with Type 1 Diabetes, $R^2$= .104, $F$(1, 97)= 4.429, $p$= .029, b= -.242, $t$(97)= -2.104, $p$= .038.

To test the second part of the hypothesis, to examine whether subjective measures of adherence using the total scores from the DSMQ-R would predict adherence, the authors conducted a second hierarchical multiple regression (Table 4). The variables were the same as the previous hierarchical multiple regression and were added into the analysis in the same pattern. None of the variables accounted for significant change in subjective adherence (Family Companionship Support $R^2$= .004, $F$(1, 102)= .038, $p$= .539; Friend Companionship Support

$R^2$= .015, $F$(1, 101)= .0759, $p$= .471; Family Management Support $R^2$= .024, $F$(1, 100)= .823, $p$= .484; Friend Management Support $R^2$= .060, $F$(1, 99)= 1.582, $p$= .185).

**Hypothesis 3**

To determine how social desirability moderates the effect of stigma related to adherence through social anxiety (Hypothesis 3), a conditional process analysis was conducted. At the recommendation of Hayes (2018), a mediation analysis was not conducted prior to the conditional process analysis. With the outcome variable social anxiety, results indicated no significant effects for: Negative Peer Attributions (b= -.029, SE= .113, $p$= .797), social desirability (b= -.218, SE= .512, $p$= .671), Negative Peer Attributions and social desirability ( b= .002, SE= .004, $p$= .655). There was also no effect indicated from the following with the outcome variable set as HbA1c: Negative Peer Attribution (b= -.0008, SE= .0066, $p$= .8979), social desirability (b= -.197 SE= .51 , $p$= .699 ), social anxiety (b= -.0080, SE= .2142, $p$= .97), social anxiety and social desirability (b= .001, SE= .008, $p$= .891). The direct and indirect effect was examined using a percentile bootstrap estimation approach with 5000 samples, which was implemented with the PROCESS macro Version 3 (Hayes, 2018). These results showed that the direct coefficient was not significant (b= -.001, SE= .006, 95% CI [-.014, .012], $p$= .897).

When examining the associations between these same variables in terms of how they relate to subjective adherence, none of the variables were significant predictors of subjective adherence with social anxiety as the outcome: Negative Peer Attributions (b= -.021, SE= .112, $p$= .849), social desirability (b= -.197, SE= .509, $p$= .838), and social anxiety and social desirability (b= .001, SE= .004, $p$= .695). Further, none of the variables were found to be significant predictors of subjective adherence with the outcome variable DSMQ-R as well: Negative Peer Attributions (b= .015, SE= .008, $p$= .051), social anxiety (b= -.250, SE= .247, $p$=

.296), social desirability (b= .025, SE= .124, *p*= .838) and Negative Peer Attributions and social desirability (b= .006, SE= .009, *p*= .491).

**Hypothesis 4**

Another hierarchical multiple regression analysis examined how barriers impact adherence, using each of the 5 subscale totals for the BDA, and both subjective and objective measures of adherence using the DSMQ-R total and the reported HbA1c from each participant (Hypothesis 4) . HbA1c served as the outcome variable in the first hierarchical multiple regression analysis (Table 5). In the first step, the predictor variable Stress and Burnout was analyzed. This variable did account for significant variance in an adolescent's HbA1c, $R^2$= .157, $F(1, 100)$= 18.594, $p$= .000, b= .396, $t(100)$= 4.312, $p$ <.001. In the second step, the predictor variable Time Pressure and Planning was added into the model and accounted for a significant proportion of variance in HbA1c levels, $R^2$= .164, $F(1, 99)$= 9.727, $p$ < .001, b= .113, $t(99)$= .939, $p$= .009. In the third step, the predictor variable Social Support was added into the analysis and also accounted for a significant level of the variance in HbA1c levels, $R^2$= .164, $F(1, 98)$= 6.431, $p$ < .001, b= -.013, $t(98)$= -.171, $p$= .864. Then in the fourth step, the predictor variable Autonomy Support was added into the analysis and it did account for a significant change in variance in HbA1c levels in adolescents with Type 1 Diabetes, $R^2$= .165, $F(1, 97)$= 4.790, $p$= .001, b= -.015, $t(97)$= -.236, $p$= .814. Finally in the fifth step, the predictor variable Stigma was added into the analysis and also accounted for a significant change in variance for HbA1c level, $R^2$= .165, $F(1, 96)$= 3.793, $p$= .004, b= -.001, $t(96)$= -.035, $p$= .972.

To test the second part of the hypothesis, the outcome variable was total DSMQ-R score, which is a subjective measure of adherence (Table 6). The variables were the same as the previous hierarchical multiple regression and were added into the analysis in the same pattern.

Four of the variables tested did account for significant change in the variance for DSMQ-R scores (Time Pressure and Planning, $R^2$= .110, $F$(1, 101)= 6.244, $p$ < .001, b= .186, $t$(101)= 3.279, $p$= .001; Social Support, $R^2$= .112, $F$(1, 100)= 4.190, $p$= .008, b= -.040, $t$(100)= -.428, $p$= .670; Autonomy Support, $R^2$= .137, $F$(1, 99)= 3.939, $p$= .005, b= -.140, $t$(99)= -1.715, $p$= .089; and Stigma, $R^2$= .146, $F$(1, 99)= 3.363, $p$= .008, b= .036, $t$(98)= 1.026, $p$= .037). However Stress and Burnout was not significant, $R^2$= .015, $F$(1, 102)= 1.584, $p$= .211, b= .048, $t$(102)= 1.259, $p$= .211.

**Exploratory Analyses**

Exploratory analyses examined the difference between high and low adherence among each of the BDA subscales (Stress and Burnout, Time Pressure and Planning, Social Support, Autonomy Support, and Stigma), the SCARED total, and the CSD total. Adherence was determined as "high adherence" or "low adherence" based on reported HbA1c. According to Chiang et al. (2014) in a position statement issued by the American Diabetes Association, ideal HbA1c levels for children under 19 years old should be lower than 7.5%. Given this directive, the group membership requirement for "high adherence" was any participant with an HbA1c less than or equal to 7.5% (N= 61), and the group membership requirement for "low adherence" was any participant with an HbA1c greater or equal to 7.6% (N= 41). An independent samples t test was then performed to further compare the aforementioned measures in high adherence and low adherence conditions. The results indicated that there was a significant difference in stress and burnout for high adherence (M= 10.62, SD= 4.45) compared to low adherence (M= 13.61, SD= 4.57); t(100)= 3.287, p= .001. Difference in time pressure and planning was also significant for high adherence (M= 9.69, SD= 3.74) compared to low adherence (M= 11.56, SD= 3.96); t(100)= 2.423, p= .017. Social support was significantly different for high adherence (M= 7.41, SD=

2.04) compared to low adherence (M= 8.37, SD= 2.21); t(100)= 2.246, p= .027. Finally, the difference in autonomy support was significant for high adherence (M= 9.57, SD= 2.18) compared to low adherence (M= 8.65, SD= 2.18); t(100)= - 2.106, p= .038. Further, the results indicated that there was not a significant difference in social anxiety for high adherence (M= 11.73, SD= 4.42) compared to low adherence (M= 10.89, SD= 4.78) conditions; t(100)= -.910, p= .365. Similarly, there was no difference in social desirability for high adherence (M= 27.47, SD= 4.79) compared to low adherence (M= 28.37, SD= 4.18) conditions; t(100)= .978, p= .331 as well as stigma (high adherence, M= 11.83, SD= 5.023; low adherence, M= 13.70, SD= 6.31; t(100)= 1.662, p= .100).

**Post-Hoc Tests**

A post-hoc correlation test was performed using a paired samples t test in order to investigate possible discrepancy between the two different measures of stigma used (Negative Peer Attributions and the stigma subscale of the BDA) and the objective measure of adherence (HbA1c). The analysis indicated that both the stigma subscale of the BDA (M= 12.59, SD= 5.62) and the Negative Peer Attributions total (M= 133.55, SD= 22.51) were significantly correlated with HbA1c (M= 7.66, SD= 1.43) (Stigma subscale from BDA, t(101)= -8.943, p < .001, two-tailed; Negative Peer Attributions, t(101)= - 56.345, *p* < .001).

Another post-hoc correlation test was conducted using a Pearson's *r* correlation in order to investigate the possible correlation between the Stigma subscale of the BDA (M=12.54, SD= 5.57), Negative Peer Attributions (M= 133.73, SD= 22.33), SCARED total (M= 11.46, SD= 4.54), and CSD total (M= 27.78, SD= 4.56). The analysis indicated that the stigma subscale from the BDA was significantly correlated with the SCARED total (*r*= .261), CSD total (*r*= .209), and

Negative Peer Attributions (*r*= .226). However, Negative Peer Attributions was not correlated with SCARED total (*r*= .109) or CSD total (*r*= -.014).

# Discussion

Management support from family members was significantly higher than management support from friends in the insulin, blood testing, and meal plan subscales. Further, emotional support from family members was actually higher than emotional support from friends in the subscale exercise. There was no difference between groups for emotional support from either family or friends for the general subscale questions. One reason that management support from family was higher in insulin, blood testing, and meal planning could be because adolescents still need reminding and cues in order to adhere to their medical regimen. Lewin et al. (2016) found similar results in that family functioning and adherence were strongly correlated with HbA1c, and further that negative family functioning does in fact negatively impact adherence in adolescents with Type 1 Diabetes. However, if regimen is viewed as a more collaborative measure between the adolescent and parents, adherence will be significantly improved (Keough et al., 2011). Similarly, adolescents that indicated that their relationship with their parents was higher quality (e.g. with less peer-oriented behavior such as seeking advice and support from peers rather than parents) had better adherence with their regimen than those who reported a lower quality relationship with their parents (Drew, 2010).

The results for friend companionship support and friend management support were consistent with our predictions in that friend companionship and management support does predict objective adherence, which in this case was HbA1c. However, friend management, family management, friend companionship, and family companionship support does not predict subjective adherence. One explanation for this result could be that adolescents with Type 1 Diabetes that felt supported by their friends were more likely to adhere to their medical regimen routine when they are around friends, thus improving their adherence and HbA1c. In that case, this finding contrasts to a previous finding from Bearman & La Greca (2002) and Palladino & Helgeson (2012), in which both studies found that peers had no significant influence on adherence for adolescents with Type 1 Diabetes. However, this friend support could be related to characteristics of the friends (e.g., support could be more meaningful if the adolescent has friends that also have Type 1 Diabetes or even another chronic illness). While there were no significant results when it came to the subjective adherence, where we used total scores from the DSMQ-R, self-report measures of adherence are less reliable due to the fact that participants tend to overreport adherence (Kurtz, 1990; Mazze et al., 1984).

Stigma in social situations with friends did not impact adherence due to social anxiety. An explanation for this could be that due to the small sample size, we do not have the power to detect these effects at this time with this sample (Hayes, 2018). This may be one reason why our results differ from Schabert et al. (2013), which found that adolescents with Type 1 Diabetes might feel uncomfortable adhering for fear of being ostracized or treated differently by their peers, or fear of social embarrassment.

Finally, adolescents who report more barriers to adherence had problems with adherence than those who did not. When examining barriers against objective adherence, stress and burnout, time pressure and planning, social support, and stigma were all significant predictors of problems with adherence. However, autonomy support was not found to be a predictor of problems with objective adherence. Similarly when examining barriers against subjective adherence, time pressure and planning, social support, autonomy support, and stigma were each significant predictors of problems with adherence, but stress and burnout was not significant. These data support findings that there are a myriad of barriers to adherence when it comes to Type 1 Diabetes, and many are multifaceted (Borus & Laffel, 2010). Exploratory analyses were conducted in order to examine group differences between high and low adherence on the stress and burnout, time pressure and planning, social support, autonomy support, and stigma subscales from the BDA, social anxiety, and social desirability.

Group differences were found to be significant in stress and burnout, time pressure and planning, social support, and autonomy support. However group differences were not found to be significant in social anxiety, social desirability, or stigma. Overall, the results indicate that adolescents whose HbA1c is less than 7.5% experience fewer barriers to adherence than those whose HbA1c is greater than 7.6%. While social anxiety, social desirability, and stigma were not significantly different between groups, our results show stigma is experienced at a high level across both groups and one group does not necessarily experience more stigma than the other. However this significance across both adherence groups might be due to a lack of power effect.

The results of Hypothesis 3 and Hypothesis 4 contradicted each other. There was no direct effect of stigma (using Negative Peer Attributions) on HbA1c in Hypothesis 3, yet stigma (using the stigma subscale from the BDA) was significant correlated with HbA1c in Hypothesis 4. Seeing this, the authors decided to run a post-hoc correlation between both the BDA stigma subscale and the Negative Peer Attributions, and HbA1c. The post-hoc analysis indicated that both the Negative Peer Attributions and the stigma subscale from the BDA were significantly correlated with each other and with HbA1c. The authors chose to use the Negative Peer Attributions measure in the mediation model because it was a more in-depth assessment of stigma compared to the BDA stigma subscale. These contradictory results might be a result of type of analyses run (PROCESS versus correlations) and power issues. The literature supports the finding that there might be a relation between stigma and adherence. In previous studies, 65% of adolescents with Type 1 Diabetes have reported experiencing increased stigma, which led to poor glycemic control and similarly a higher HbA1c (Brazeau et al., 2018). Hains et al.'s 2006 study also found that adolescents that make a negative attribution of a friend's reaction see adherence as an obstacle in social situations, thus experiencing increased stress and decreased metabolic control which can be assessed through HbA1c.

Because the two stigma measures used were providing different results, the authors decided to run a correlation between the two types of stigma measures, social anxiety, and social desirability. The post-hoc analysis indicated that the stigma subscale from the BDA is significantly correlated with social anxiety, social desirability, and Negative Peer Attributions. However, Negative Peer Attributions was not correlated with social anxiety or social desirability. The results are consistent with the mediation model being insignificant.

**Limitations**

One large limitation of the study was that the sample was not fully representative of adolescents with Type 1 Diabetes in general. It is estimated that around 200,000 people under the age of 20 years old have been diagnosed and are living with Type 1 Diabetes in the United States, with 18,291 newly diagnosed cases per year (CDC, 2020). Of those, non-Hispanic whites had the highest rate of prevalence (around 27%), followed by non-Hispanic African Americans (around 19%), Hispanics (around 15%) and Asian Pacific Islander (around 10%) (CDC, 2020). The sample in this study was primarily non-Hispanic white (80.8%). The sample size that we were able to obtain was smaller than the power analysis suggested might be necessary to answer our questions. The reason for this could stem from the fact that this study chose to utilize a relatively new research registry service for Type 1 Diabetes research. Because of these factors, the effect size using Cohen's *d* for the study is altogether relatively small ($d$= .353). In order to possibly remedy the small effect size, future studies should consider recruiting a much larger sample size than the current study used.

Another limitation is that the design of a few of the measures (DSSQ-Family, DSSQ-Friends, and DSMQ-R) had dated verbiage within the measures' items (e.g., meal plan items, insulin injection items such as giving or receiving injections from family or friends). These items did not account for an older adolescent (i.e. 18 years old) who might have been diagnosed when they were younger and were relatively independent in their diabetes management. The survey used for the study also consisted of nine measures, which after completion of the study and a review of the data proved to be too many for this age group to retain their attention. A majority of the responses received for the appropriate age range completed less than 90% of the survey. Therefore, retention and survey length was a huge limitation for this study and because of that, there is substantial missing data from the last two measures: PROMIS and the Pittsburgh Sleep Quality Index. One explanation for this could be that it was due to the survey's length, however another explanation could be that the participants were not well-enough informed on their own sleep habits to properly answer and complete these two measures. Reduction of survey length could potentially bring up retention.

Finally, the last limitation would be the presence of COVID-19 and its effects on adherence to daily medical regimen for adolescents with Type 1 Diabetes. As noted previously, many different factors influence adherence, including family functioning, parental role and influence, peer support, psychological comorbidities, etc (Datye et al., 2015). These aspects and more were all altered once schools were canceled nationwide in mid-March, which potentially affected the data responses for 25% of the sample.

## Future Directions and Implications

Future research should endeavor to repeat the study with a much larger and more diverse sample size, ideally between 360-380 participants, in order to have a large effect size (*d*= 0.8) and should aim for a shorter survey if possible in order to keep retention high. More research is necessary before one can posit that social support, social anxiety, or especially stigma affect adherence in adolescents with Type 1 Diabetes. Future studies should consider using more objective measures for adherence, such as HbA1c or CGM data, as these prove to be more accurate when assessing adherence. Finally, future research should examine both family's and friend's perceived support and how much support the adolescent feels that they are receiving from their family and friends. Investigating this question would give the research community a better idea of how parents and friends can increase or decrease support based on how the adolescent is perceiving the support.

Research implications suggest that in order to improve overall HbA1c and adherence, adolescents should feel that they are supported by their family and friends for management behaviors, and from their friends in companionship behaviors. Providers should also consider discussing potential methods of coping with anxiety and stigma, as well as other various barriers for adherence in hope of giving the adolescent skills to navigate and overcome these barriers. Utilization of coping skills and methods could potentially improve how adolescents with Type 1 Diabetes perceive various barriers they face when it comes to adhering to their medical regimen.

## Conclusion

The authors found differences in type of support that impact adherence, the types of barriers that impact adherence, and group differences in patients with high and low adherence and in the barriers to adherence that they face. The discrepancy in results related to stigma's relation to adherence, social desirability, and social anxiety warrant further investigation with a larger sample. Adolescents with Type 1 Diabetes experience many barriers when it comes to adhering to their medical regimen and it is important to address these barriers in both their everyday life and in the medical community to improve long term health outcomes.

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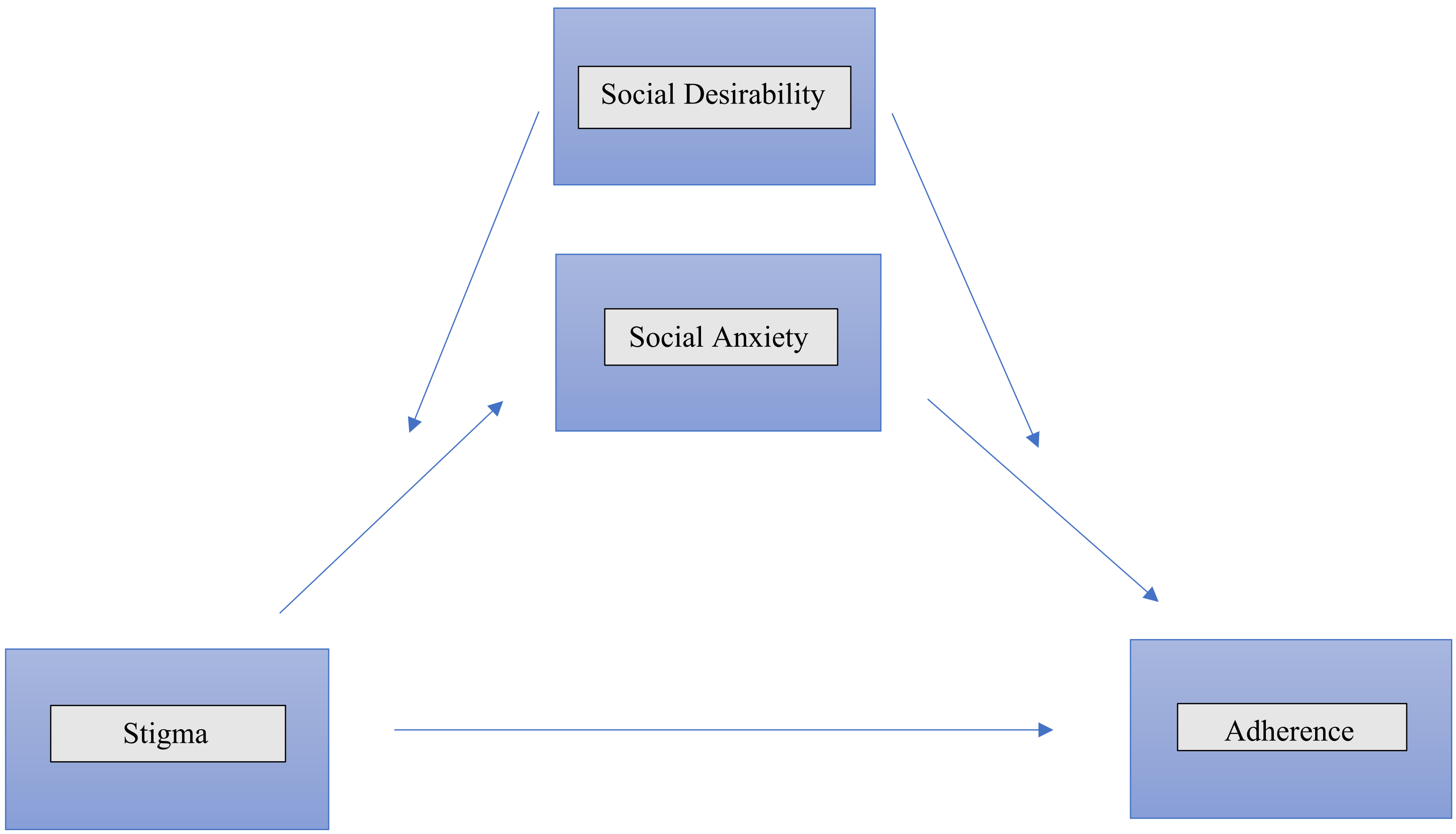
**Tables and Figures**

Figure 1




*Note*: This is a visual representation of the moderated mediation model used for the current study, which is Model 58 from Hayes (2018).

Table 1
*Demographic Information, HbA1c*

| | Age Group | | | | | | |
|---|---|---|---|---|---|---|---|
| HbA1c | 13 y (*n*= 1) | 14 y (*n*= 20) | 15 y (*n*= 23) | 16 y (*n*= 25) | 17 y (*n*= 22) | 18 y (*n*=13) | Total (*n*= 104) |
| < 5.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 5.5-6.0 | 0.00 | 2.00 | 2.00 | 2.00 | 1.00 | 0.00 | 7.00 |
| 6.1-6.5 | 0.00 | 4.00 | 1.00 | 0.00 | 3.00 | 0.00 | 8.00 |
| 6.6-7.0 | 0.00 | 4.00 | 5.00 | 7.00 | 3.00 | 2.00 | 19.00 |
| 7.1-7.5 | 0.00 | 2.00 | 2.00 | 6.00 | 6.00 | 7.00 | 23.00 |
| 7.7 -8.0 | 1.00 | 3.00 | 4.00 | 1.00 | 3.00 | 2.00 | 14.00 |
| 8.1-8.5 | 0.00 | 1.00 | 4.00 | 3.00 | 2.00 | 0.00 | 10.00 |
| 8.6-8.9 | 0.00 | 1.00 | 0.00 | 2.00 | 0.00 | 0.00 | 3.00 |
| 9.0-9.5 | 0.00 | 0.00 | 1.00 | 1.00 | 0.00 | 0.00 | 2.00 |
| 9.6-10.0 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 2.00 |
| 10.1-10.9 | 0.00 | 1.00 | 2.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 11.0-12.3 | 0.00 | 1.00 | 1.00 | 1.00 | 2.00 | 1.00 | 6.00 |

*Note*: This table represents the HbA1c levels of each age within the group.

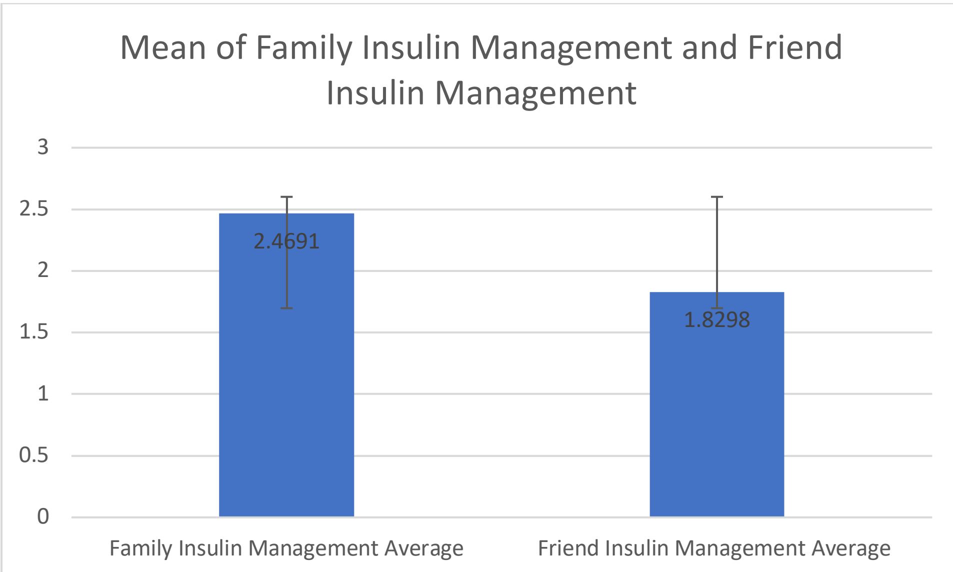
Table 2

*Demographic Information., Pump and CGM Usage*

| | Age Group | | | | | | |
|---|---|---|---|---|---|---|---|
| | 13 y | 14 y | 15 y | 16 y | 17 y | 18 y | Total |
| Variable | (*n*= 1) | (*n*= 20) | (*n*= 23) | (*n*= 25) | (*n*= 22) | (*n*=13) | (*n*= 104) |
| CGM | 1.00 | 18.00 | 21.00 | 23.00 | 17.00 | 11.00 | 91.00 |
| Insulin Pump | 0.00 | 16.00 | 21.00 | 20.00 | 16.00 | 11.00 | 84.00 |
| Insulin Injections | 1.00 | 3.00 | 2.00 | 5.00 | 6.00 | 1.00 | 18.00 |

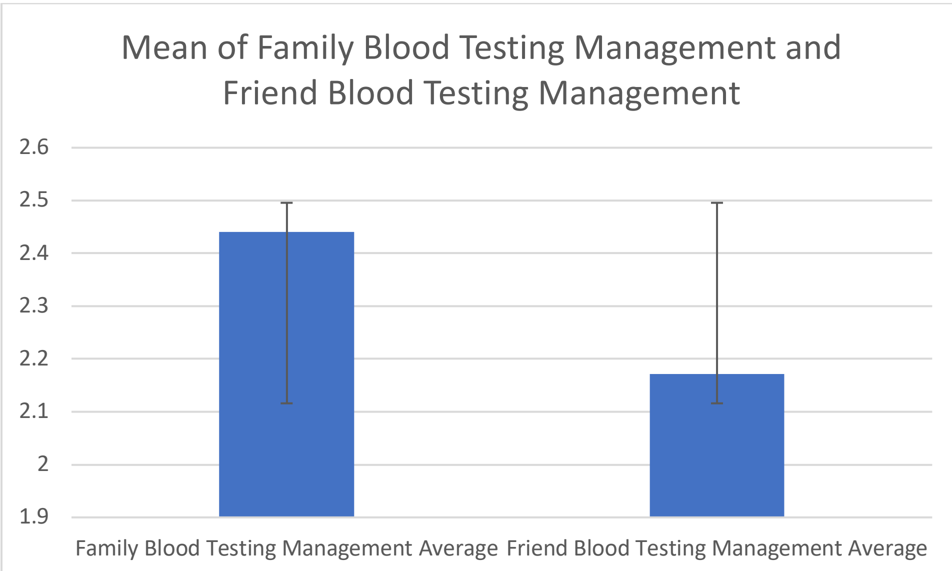
*Note:* This table represents CGM, insulin pump, and insulin injection usage among each age within the group.

Figure 2



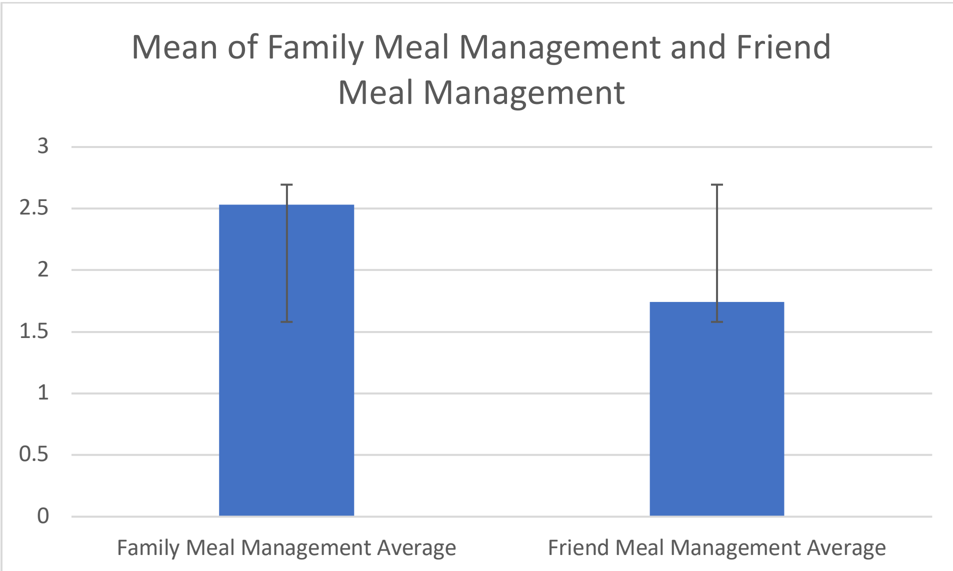

*Note:* This figure shows the differences in means between the family insulin management scores found in the DSSQ-Family and the friend insulin management scores found in the DSSQ-Friend.

Figure 3



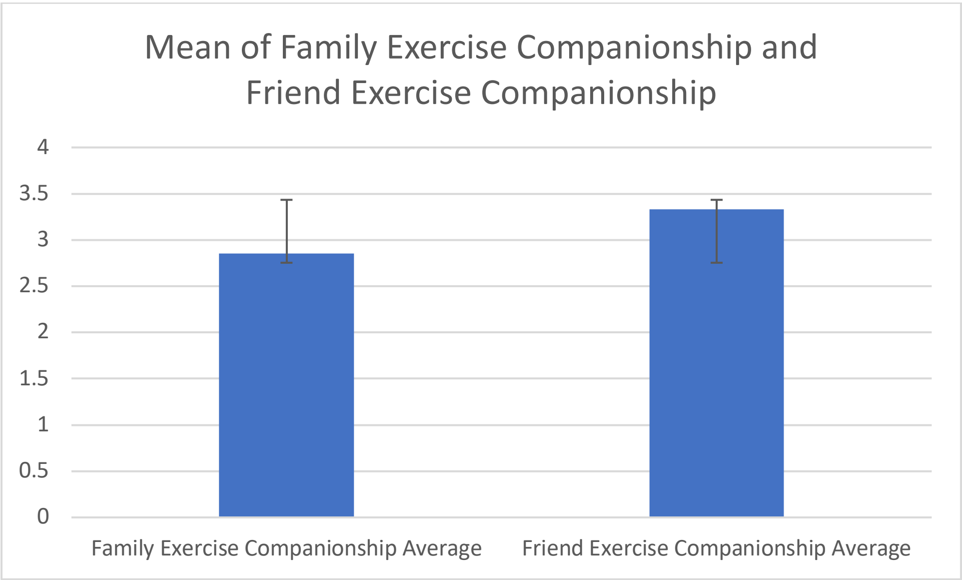

*Note:* This figure shows the differences in means between the family blood testing management scores found in the DSSQ-Family and the friend blood testing management scores found in the DSSQ-Friend.

Figure 4




*Note:* This figure shows the differences in means between the family meal management scores found in the DSSQ-Family and the friend meal management scores found in the DSSQ-Friend.

Figure 5




*Note:* This figure shows the differences in means between the family exercise companionship scores found in the DSSQ-Family and the friend exercise companionship scores found in the DSSQ-Friend.

Table 3

*Summary of Hierarchical Regression Analysis for Objective Adherence (HbA1c) and Variables Predicting Support (*N= *104)*

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *B* | *SE B* | $\beta$ | *B* | *SE B* | $\beta$ | *B* | *SE B* | $\beta$ | *B* | *SE B* | $\beta$ |
| Friend Companionship Support | .380 | .166 | .224* | .515 | .195 | .303** | .690 | .211 | .406** | .726 | .216 | .427** |
| Family Companionship Support | | | | -.299 | .229 | -.149 | -.377 | .229 | -.188 | -.457 | .253 | -.228 |
| Friend Management Support | | | | | | | -.495 | .247 | -.212* | -.578 | .270 | -.247* |
| Family Management Support | | | | | | | | | | .240 | .316 | .086 |
| $R^2$ | | .050 | | | .066 | | | .103 | | | .108 | |
| $F$ for change in $R^2$ | | 5.279* | | | 3.508* | | | 3.753* | | | 2.947* | |

*Note:* The variables shown in this table are the mean total scores for management and companionship support from the DSSQ-Family and DSSQ-Friend.

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

Table 4

*Summary of Hierarchical Regression Analysis for Subjective Adherence (DSMQ-R) and Variables Predicting Support (N= 104)*

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* |
| Friend Companionship Support | .121 | .210 | .057 | .264 | .248 | .124 | .418 | .271 | .196 | .520 | .275 | .245 |
| Family Companionship Support | | | | -.318 | .292 | -.127 | -.386 | .295 | -.154 | -.613 | .322 | -.245 |
| Friend Management Support | | | | | | | -.435 | .318 | -.148 | -.670 | .344 | -.228 |
| Family Management Support | | | | | | | | | | .679 | .402 | .194 |
| $R^2$ | | .003 | | | .015 | | | .033 | | | .060 | |
| *F* for change in $R^2$ | | .332 | | | .759 | | | 1.135 | | | 1.582 | |

*Note:* The variables shown in this table are the mean total scores for management and companionship support from the DSSQ-Family and DSSQ-Friend.

**p* < .05. ***p* < .01.

Table 5

*Summary of Hierarchical Regression Analysis Variables Predicting Barriers Impacting Objective Adherence (HbA1c) (*N= *104)*

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | | Model 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *B SE* | *β* |
| Stress and Burnout | .122 | .028 | .396** | .009 | .037 | .323** | .102 | .041 | .332* | .100 | .042 | .324* | .100 | .043 | .325* |
| Time Pressure and Planning | | | | .042 | .044 | .113 | .042 | .045 | .114 | .042 | .045 | .115 | .042 | .045 | .115 |
| Social Support | | | | | | | -.013 | .073 | -.019 | -.014 | .074 | -.021 | -.014 | .077 | -.020 |
| Autonomy Support | | | | | | | | | | -.015 | .065 | -.024 | -.015 | .065 | -.024 |
| Stigma | | | | | | | | | | | | | -.001 | .028 | -.004 |
| $R^2$ | | .157 | | | .164 | | | .164 | | | .165 | | | .165 | |
| *F* for change in $R^2$ | | 18.594** | | | 9.727** | | | 6.431** | | | 4.790** | | | 3.793* | |

*Note:* The variables shown in this table are the mean total scores for each of the subscales featured in the BDA.

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

Table 6

*Summary of Hierarchical Regression Analysis Variables Predicting Barriers Impacting Subjective Adherence (DSMQ-R) (*N*= 104)*

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | | Model 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *SE B* | *β* | *B* | *B SE* | *β* |
| Stress and Burnout | .048 | .038 | .124 | -.053 | .047 | -.138 | -.044 | .052 | .-.114 | -.066 | .053 | -.172 | -.075 | .054 | -.196 |
| Time Pressure and Planning | | | | .186 | .057 | .404** | .186 | .057 | .405** | .190 | .056 | .414** | .185 | .057 | .403** |
| Social Support | | | | | | | -.040 | .093 | -.047 | -.056 | .093 | -.067 | -.082 | .096 | -.098 |
| Autonomy Support | | | | | | | | | | -.140 | .082 | -.173 | -.140 | .082 | -.173 |
| Stigma | | | | | | | | | | | | | .036 | .035 | .110 |
| $R^2$ | | .015 | | | .110 | | | .112 | | | .137 | | | .146 | |
| $F$ for change in $R^2$ | | 1.584 | | | 6.244** | | | 4.190** | | | 3.939** | | | 3.363** | |

*Note:* The variables shown in this table are the means for each of the subscales featured in the BDA.

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