Relations of Race, Mother's Education, and Early Education on Kindergarten

Academic Readiness of Children with and without Diabetes

by

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ABSTRACT

Chronic illness can affect multiple domains of functioning, yet scientific understanding of the effects across the lifespan and under multiple contexts is still developing. For instance, research consistently indicates the early years of a child's life are pivotal for early intervening to positively affect physical, cognitive, and socio-emotional development; unfortunately, the impact of chronic illnesses, and thus appropriate interventions, during this time are not well-established. Academic achievement is one area in which children with chronic illness are negatively affected and research suggests that the effects of illness can be exacerbated by certain social determinants of health and demographic characteristics; however, no recent studies have examined these relationships for children at school entry.

The current study utilized the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) to examine variations in early academic readiness in reading and mathematics by diabetes status, race, and social determinants, specifically mother's education and access to early childhood education, among children born in 2001. Results of the current study indicated that children with diabetes scored lower on reading and mathematics relative to their non-diabetic peers. Significant interactions were evident for diabetes status by mother's education, race/ethnicity, and by early childhood education. Children in homes whose mothers had the lowest level of education did not score as high as children in homes with mothers who had higher levels of education. Among children without diabetes, those identified as Asian, Pacific Islander, or Native Hawaiian outperformed White,

Black, Hispanic, American Indian, and multi-race groups on measures of reading and mathematics, whereas among children with diabetes, those identified as multiracial scored highest. Regardless of diabetes status, children who attended preschool outperformed those who did not, yet children without diabetes who had not attended preschool outperformed diabetic children who did receive such services. Findings support the need for targeted early intervention as preschool alone did not mitigate the effects of diabetes on academic performance.

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INTRODUCTION

Chronic health problems—that is, those lasting longer than six months, such as asthma and diabetes—represent a national concern because of their considerable impact on individuals and their families. These disorders can affect young children's school readiness and academic success via the negative impacts of physiological stress and/or medication side effects on cognitive and social-emotional development, attention, and concentration, in addition to the impact of frequent illness on family and peer dynamics (Currie, 2005). Moreover, such conditions can also depress students' academic progress because these children miss considerable instructional time (Needham, Crosnoe, & Muller, 2004). Research has also shown these conditions impact educational progress throughout adolescence (Needham et al., 2004). These findings are noteworthy given that approximately 10-15% of children and youth under age 18 experience chronic health problems (Cunningham & Wodrich, 2006) and children from culturally diverse and economically disadvantaged backgrounds are at increased risk relative to their White and/or middle class peers (Larson, Russ, Crall, & Halfon, 2008).

Because chronic health problems affect multiple domains of life functioning, children with chronic health problems are served by a variety of federal agencies (e.g., U.S. Departments of Education, Health and Human Services) and are addressed in numerous state and national policies, including early intervention policy. For instance, the U.S. Department of Health and

Human Services (USDHHS) recently released Healthy People 2020, a government policy agenda with the goals of achieving health equity, eliminating disparities, and improving the health of all ages and demographic groups with a focus on early and middle childhood health experiences (U.S. Department of Health and Human Services, 2010). Thus, this policy recognizes these years as critical to children's physical, cognitive, and socio-emotional development given consensus within the scholarly community that the first five years of life are pivotal for development of foundational competencies in the cognitive, linguistic, emotional, and social domains (e.g., Pianta, Barnett, Burchinal, & Thronburg, 2009).

Policy and scholarship also emphasize the importance of quality educational experiences early in life. In particular, numerous studies have indicated that preschool can have positive effects on children's school readiness, academic achievement, and grade promotion, in addition to reducing future special education needs (Lunenberg, 2000; Magnuson, Meyers, Ruhm, & Waldfogel, 2004). However, early childhood educational experiences may be negatively influenced by the health of children when they may miss out on activities shown to bolster academic and social skills due to absenteeism or poor engagement due to their illness (Currie, 2005).

Beyond chronic conditions and early educational experiences, numerous environmental, social, and intraindividual factors influence children's overall health and consequent developmental outcomes (National Research Council and Institute of Medicine, 2004). To fully understand how these factors impact early

childhood development, they must be considered in conjunction with social determinants (e.g., socioeconomic status, geographic location, access to care). For instance, socioeconomic status (SES) can be considered a social determinant of an individual's experiences and outcomes, or "the conditions in which people are born, grow, live, work and age, including the health system" (World Health Organization, 2011).

Further, disparities in health, such as incidence and experiences with chronic illness, are relevant to study in relation to health and early development. Health disparities have been defined as "… a difference in which disadvantaged social groups…systematically experience worse health or greater health risks than more advantaged social groups" (Braveman, 2006, p. 16). Persistent and substantive health disparities—including differential prevalence and mortality—exist in multiple groups in the U.S. (U.S. Department of Health and Human Services, 2010), which may contribute to discrepant academic outcomes across groups impacted by chronic health conditions. Analyses of health disparities yielded not only different rates of incidence and prevalence, but also differences in life expectancy, health care access and quality, and disease severity across groups (e.g., Adler et al., 1994; Schnittker & McLeod, 2005). Eliminating health disparities is a major initiative by both the WHO and USDHHS, and in order to accomplish this goal multiple areas need to be examined-specifically disease, population, geography, and risk factors (Koh et al., 2010).

The present study addressed how chronic health problems, specifically Type 1 Diabetes Mellitus (T1DM), affected early academic readiness and also

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whether social determinants—specifically SES and early childhood education—

and race/ethnicity (common variables within the health disparities literature)

indicated differential effects SES. Little research has addressed health, education,

and social determinants simultaneously for younger populations, though research

suggests that academic achievement is related to health conditions for school-aged

children (e.g., Behrman, 1996; Currie, 2005) and that achievement is also related

to social determinants (e.g., Fiscella & Kitzman, 2009).

The current study sought to expand our knowledge of this vulnerable

population and to inform policy that is responsive to the multifaceted implications

of health on education. This study examined the degree to which chronic health

conditions impacted early educational outcomes for diverse children using the

Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) to obtain

population estimates of the observed relations and recognized that health and

social factors interacted to influence early childhood educational experiences and

outcomes. These are factors not often addressed in the empirical literature. The

results have implications for general education, special education, early

intervention, and health and human services policy and service delivery, as the

current policy is often poorly aligned to the evidence base (Pianta et al., 2009).

Findings highlighted readily changeable factors (e.g., access to early education)

that could have a positive effect early educational achievement. The findings also

provided further support for the necessity of early intervention efforts for certain

subgroups of the population. In addition, by weaving policy and research

addressing health disparities (e.g., *Healthy People 2020*) with academic

disparities (e.g., Elementary and Secondary Education Act), two critical policy and practice areas can be informed through the merging of research questions (Fiscella & Kitzman, 2009), as was the case in the current study.

This study was grounded in an ecological model that acknowledges the multiple interactive and dynamic proximal and distal factors and contexts that influence child development (Brofenbrenner, 1977; Brofenbrenner & Ceci, 1994). Brofenbrenner and Ceci's (1994) expanded bioecological model, which includes the biological and genetic influences on a child's development, is particularly relevant here because of the influence of both biogenetic and ecological factors in the manifestation and impact of childhood chronic illness. Specifically, Brofenbrenner and Ceci posit three propositions that guided the current study. Proposition one explains proximal processes as "forms of interaction in the immediate environment" (p 572). Proposition two states "the form, power, content, and direction of the proximal processes effecting development vary systematically as a joint function of the characteristics" of the person and of the environment (p 572). Finally, proposition three states that "proximal processes serve as a mechanism for actualizing genetic potential for effective psychological development, but their power to do so is also differentiated systematically as a joint function of the same three factors stipulated in Proposition 2" (p. 572). The propositions were explored in the current study through the exploration of achievement (i.e., proximal processes), social determinants (i.e., environmental factors), and the interaction between health (i.e., genetics) and environmental variables, given that multiple variables potentially influence the educational

trajectories of young children with chronic health problems. Therefore this model provided guidance for conceptualizing variables and outcomes that were addressed in this study and were consistent with the conceptual framework of the ECLS-B, which was also based on an ecological model (U.S. Department of Education, 1999). The goal of this research was to elucidate the relations between chronic health conditions and social determinants relative to children's early educational outcomes.

Literature Review

Chronic Health

Children's health can be conceptualized as "the extent to which an individual child or groups of children are able or enabled to: a) develop and realize their potential; b) satisfy their needs; and c) develop the capacities that allow them to interact successfully with their biological, physical, and social environments" (National Research Council and Institute of Medicine, 2004). Advances in policy and science have reduced the incidence of infant mortality and morbidity from various infectious diseases; however, in the United States, rates of diabetes, asthma, and obesity are among the highest in the world (National Research Council and Institute of Medicine, 2004) so childhood health conditions—particularly chronic health conditions—remain a salient policy and research issue. Further, this highlights the need to examine multiple factors such as environment, biology, and behavior (e.g., Brofenbrenner & Ceci, 1994) to reduce incidence as well as intervene early, as health status at any stage of development affects future health conditions (National Research Council and

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Institute of Medicine, 2004). One such common chronic condition addressed in this study is T1DM.

Diabetes

Diabetes is one of the most common chronic illnesses in children, with 25.6 million diagnosed under the age of 20 (Centers for Disease Control and Prevention, 2011). T1DM involves an inability to produce insulin, while Type 2 is characterized by an inability to properly utilize produced insulin (Kucera & Sullivan, 2011). T1DM is typically diagnosed at a younger age than Type 2; in fact the SEARCH for Diabetes in Youth Study Group found no incidences of Type 2 diabetes in youth under age four in a sample of 2,435 youth with newly diagnosed diabetes (Writing Group for the SEARCH for Diabetes in Youth Study Group, 2007). Incidence rates for T1DM vary slightly by race/ethnicity. Overall, the incidence rate for youth under age 19 years from 2002-2003 was 3.80%, while for Non-Hispanic White children the rate was 4.75%, for African American children 2.83%, and for Hispanic children 2.73% (Writing Group for the SEARCH for Diabetes in Youth Study Group, 2007).

T1DM is an autoimmune disorder characterized by the pancreas' inability to produce the insulin necessary to break down glucose in the bloodstream so that it can be converted to energy (American Diabetes Association, 2009; Holmes, Cant, Fox, Lampert, & Greer, 1999). To supplement the pancreas, exogenous insulin is injected; however, it cannot fully replicate a normally functioning pancreatic system (Hirsch, 2005). Consequently, individuals with T1DM often experience fluctuations in blood glucose throughout the day, a concern given that

normal brain functioning is dependent on continuous adequate supplies of circulating glucose (Mooradian, 1988). Abnormal blood glucose and insulin levels are associated with an array of neurocognitive deficits in memory, attention, motor skills, and executive functioning (Bade-White & Obrzut, 2009), in addition to long-term health risks such as heart disease, stroke, high blood pressure, retinopathy, kidney failure, and many more (National Diabetes Information Clearinghouse, 2011).

Children with T1DM experience a variety of academic issues during the school years: they tend to miss more school days than healthy peers, score lower on measures of academic achievement, be more likely to be retained, and have lower rates of high school graduation and post-secondary education enrollment (Kucera & Sullivan, 2011). In a review of 14 studies, cognitive and academic difficulties were evident in the areas of lower verbal IQ, visuospatial/nonverbal functioning, memory, and attention deficits (Taras & Potts-Datema, 2005). In addition, children with T1DM have been found to score lower on measures of full scale IQ and do not make cognitive developmental gains at the same rate as their peers (Holmes et al., 1999). They may also have lower scores on measures of psychomotor activity and speed, visual motor integration (Gaudieri, Chen, Greer, & Holmes, 2008), and sustained attention (Naguib, Kulinskaya, Lomax, & Garralda, 2009).

Treatment for T1DM typically involves administration of artificial insulin and diet and exercise monitoring (American Diabetes Association, 2011). The amount and frequency of insulin administration is dependent on blood glucose

levels, which must be checked multiple times during the day, typically before meals and exercise. As mentioned, poorly managed T1DM has multiple health and cognitive implications.

Social Determinants of Health

Social determinants of health—those environmental and institutional factors affecting individuals' resources and opportunities—"are shaped by the distribution of money, power and resources at global, national and local levels, which are themselves influenced by policy choices" (World Health Organization, 2011). Health inequities are generally attributable to social determinants of health as they are avoidable differences in health care status and access within countries (World Health Organization, 2011). Social determinants of particular concern in this study are SES and access to early childhood education.

SES. SES is a measure of an individual's economic standing relative to others and is usually based on income, education, occupation, or some combination of the three (Adler & Rehkopf, 2008; American Psychological Association, 2011). As previously mentioned, SES is often measured by income, occupation, and/or parental education. For the current study, mother's education was used as a proxy for SES. Research suggests that after controlling for income and other variables related to socioeconomic status, mother's education is a strong factor influencing child health (Chen & Li, 2009).

Multiple studies have indicated that those with lower SES are at risk of poor health outcomes (Koh et al., 2010). For example, even in a healthy U.S. sample, the risk of mortality among adults ages 18-77 is higher for those whose

income is below the median, which for this study was $20,190 or 3.2 times the poverty level in 1991 (Rehkopf, Berkman, Coull, & Krieger, 2008). Murray and colleagues (2006) further examined mortality differences among different races and locations across the U.S., leading to a delineation of "eight Americas" (p. 260) based on data from the National Census and National Center for Health Statistics. Each group was composed based on socioeconomic factors, geography, population, race-specific income, and homicide rate. The lowest life expectancy for was in the group consisting of Blacks living in counties with the highest homicide mortality risk, followed by Blacks in the rural South with income below $7,500, and Blacks in other counties. Among males, the difference between the life expectancy of Asians versus Blacks in high-risk urban areas was 15.4 years greater. In addition, these differences in life expectancy cannot be explained by a single cause of death such as homicide or HIV infection, and the disparities are more concentrated in the young and middle-aged rather than children and elderly (Murray et al., 2006).

Other research has also suggested patterns of increasing income and education are associated with better health indicators among children and adults; however, differences between races are still evident. Specifically, given commensurate income and education levels, Blacks do not have the same increase in health as Whites (Braveman, 2005). In regard to children, those from lower SES are more likely to be exposed to toxins such as lead and are more likely to have poor nutrition (Evans, 2004), both of which can affect cognitive development (Currie, 2005) and thus school readiness. School readiness is a

pivotal issue, as the gap between those who start behind and those who do not

widens with age (Engle & Black, 2008).

Access to early education. Early childhood education, that is education

that begins at age 3, 4, or 5, and lasts from one to three years (National Center for

Education Statistics, 2003), is considered as one of the best ways to provide

educational and developmental opportunities for all children, and is regarded as a

first step towards diminishing educational inequities (Pianta et al., 2009).

Approximately 25 percent of four-year olds attended a state-funded preschool

program in 2009, and according to a 2007 National Household Education Survey,

total enrollment at both public and private preschool at age four is 74 percent

(Barnett, Epstein, Friedman, Sansanelli, & Hustedt, 2009).

Children who have attended school-based preschool programs performed

better than those who do not on measures of reading and mathematics in

kindergarten (Magnuson et al., 2004) as well as in multiple areas of cognitive and

social development (Pianta et al., 2009). However, children from low-income

families with lower parental education attainment attended preschool at lower

rates than their peers (Magnuson et al., 2004), potentially setting up a gap

between them and their peers that widens with time (Engle & Black, 2008). In an

earlier study on the ECLS-B, a gap of more than one standard deviation was

present on mathematics and reading skills for children below the 20th percentile

on family SES compared to peers at the highest 20th percentile (Jacobson

Chernoff, Flanagan, McPhee, & Park, 2007).

Appropriate early childhood education is critical to children's academic, social, and emotional growth (Lunenberg, 2000; Magnuson et al., 2004); however, early childhood functional development and academic experiences may be negatively influenced by the health of the child (Currie, 2005). Approximately 29% of children aged 4-35 months of age have two or more risk factors that increase vulnerability to poorer health status and developmental delays (Stevens, 2006). Poor physical health has also been linked to lower achievement for first grade Latino/a immigrant children and lower achievement growth of first grade Asian immigrant children compared to whites (Crosnoe, 2006).

Present Study

Research has not adequately addressed health, education, and social determinants simultaneously. Studies suggest that academic success is related to health conditions (e.g., Behrman, 1996; Currie, 2005) and social determinants (e.g., Fiscella & Kitzman, 2009). The present study addressed not only how diabetes relates to early educational readiness, but also whether social determinants (mother's education and early childhood education) predicted differential effects for certain populations commonly impacted by health disparities, such as those in culturally diverse populations and those from lower SES. This study utilized early scores in mathematics and reading readiness from students with and without T1DM and examined the influence of mother's education, race/ethnicity, and early childhood education on the achievement scores. The primary research question here is, (1) Do early reading and mathematics achievement differ between students with and without diabetes? In

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addition, this study examined whether there were interactions between diabetes status and other child characteristics. As such, the following questions were also explored:

2. Do the differences in reading and mathematics achievement scores differ across levels of mother's educational attainment?

3. Do the differences in reading and mathematics achievement scores differ across levels of race/ethnicity?

4. Do the differences in reading and mathematics achievement scores differ across levels of participation in early childhood education?

It was expected that children without diabetes would demonstrate higher mean scores in reading and mathematics compared to children with diabetes, as previous research indicates children with T1DM tend to score lower on measures of academic achievement and those with earlier onset (before age 7) tend to perform less well than those diagnosed later (e.g., Holmes et al., 1999). In addition, it was expected that there would be an interaction between diabetes status and mother's education, such that the mean differences between students with and without diabetes would be smaller for students with higher SES and greater for students of lower SES, as those from lower SES are at risk of poorer health outcomes compared to higher SES (Koh et al., 2010) and attended preschool at lower rates than those in higher SES (Magnuson et al., 2004). In regard to diabetes and race/ethnicity, it was expected that an interaction would be present such that mean differences between students with and without diabetes would be greater for students in minority race/ethnic groups compared to whites

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as previous research suggested that young White children have better physical health and mathematics achievement upon entering elementary school compared to non-White children (Crosnoe, 2006). Further, it was expected that there would be an interaction between diabetes status and early childhood education such that there would be less of a mean score difference between students with diabetes who did and did not participate in early childhood education than among students without diabetes who did and did not attend preschool due to the negative effects of diabetes on attendance (Parent, Wodrich, & Hasan, 2009) and general risk of academic difficulties (Kucera & Sullivan, 2011).

Chapter 2

METHOD

Data Source

The proposed study utilized the Early Childhood Longitudinal Study –

Birth Cohort (ECLS-B), a nationally representative longitudinal cohort study of

approximately 10,700 U.S. children born in 2001. The ECLS-B was

commissioned under the Education Sciences Reform Act of 2002 from the Early

Childhood and Household Studies Program in order to inform research with a

prospective, longitudinal focus by providing data on multiple factors that may

have important implications in childhood development such as cognitive, social,

emotional, and physical development (U.S. Department of Education, 1999). The

current study utilized the ECLS-B to examine health disparities and educational

outcomes for a sample of young children that allowed for population estimates.

Using a large data set poses a considerable advantage over the existing literature

which has generally been with small samples or datasets with oversampling of

certain ethnicities (Belheimer & Klein, 2010).

Dataset design. The ECLS-B sampling utilized a multistage, stratified,

clustered design and was designed to allow for longitudinal analysis (Najarian,

Snow, Lennon, & Kinsey, 2010). The ECLS-B included oversampling of certain

populations in order to obtain sufficient samples (e.g., infants with low birth

weight, Native Americans), which was accounted for via sampling weights to

account for the complex sampling design. The core sample was selected within 96

primary sampling units (PSUs) to represent all infants born in 2001 within the

U.S. (Nord et al., 2004). Membership within the PSUs was determined based on where the birth occurred or on the child's mother's residence as reported on the birth certificate. The target population included all children born in 2001 except those born to mothers less than 15 years and children who died or were adopted before the 9-month assessments.

Data were collected at ages nine months (wave 1), two years (wave 2), preschool/four years of age (wave 3), and kindergarten entry in 2006 or 2007 (wave 4 and 5); their information was linked to NCES's Common Core Data (CCD) and Private School Survey (PSS) universal files. The parents of about 10,700 children participated in wave 1, with 10,200 of these children assessed between October 2001 and December 2002 according to when the child became nine months of age (Najarian et al., 2010). Wave 2 was conducted in 2003 with interviews of parents of about 9,850 children, 9,200 of which were assessed at approximately two years of age. Waves 3, 4, and 5 were more aligned with academic year start times rather than birth dates; therefore, wave 3 was conducted the year before children were expected to begin kindergarten. Wave 3 consisted of interviews of 8,950 parents and assessments conducted with about 8,750 children. Wave 4 (2006) was completed during the year the children were expected to be in their first year of kindergarten, and wave 5 (2007) was for children who did not enroll in kindergarten in 2006 or who repeated kindergarten. Wave 4 included interviews of about 7,000 parents, and 1,900 parents in wave 5. Approximately 1,550 children in wave 5 were first-time kindergarteners, about 200 were repeating, and the remaining were either enrolled in multi-grade or ungraded

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classes, enrolled in a second year of a two-year kindergarten program, homeschooled, or not enrolled in school. Wave 3, 4, and 5 data collections included in-person interviews with the primary caregiver using computer-assisted personal interviews, assessments of the child's cognitive and motor skills, and physical growth measurements. Child assessments were administered in English or Spanish and were conducted by trained field interviewers.

Due to the complex sampling design of the ECLS-B, weights were provided to obtain more accurate estimates of standard errors. Sample weights are available through ECLS-B to correct for design effects and were selected for this analysis based on the waves utilized in the statistical analysis and data source (e.g. parent report, assessments) based on the research question.

Participants

This study examined data for all children for whom kindergarten academic outcomes were reported (approximately 6,800 reading and 6,800 mathematics total unweighted cases). A list of all the variables that were drawn from the ECLS-B for this study is in Table 1.

Measures

A wide range of data collection methods were used throughout the ECLS-B process, such as birth certificates, interviews with parents, teachers, and child care providers, direct child assessments, and observations (U.S. Department of Education, 1999). Wave 3, 4, and 5 data collections included in-person interviews with the primary caregiver using computer-assisted personal interviews, direct

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assessments of cognitive and motor skills, and physical growth (Najarian et al., 2010).

   Independent variables. The variable for diabetes was composed of parent responses from wave 4 regarding whether their child has diabetes or is on medications for diabetes. These were combined into one variable that was dummy coded as yes/no for diabetes status.

   The other independent variables (mother's education, race/ethnicity, and early childhood education) were selected based on the aforementioned theoretical framework and included variables from the first kindergarten wave of data collection. Mother's education was examined because research suggests that after controlling for income and other variables related to socioeconomic status, mother's education is a strong factor influencing child health (Chen & Li, 2009). This variable was collapsed into four categories: less than high school, high school diploma or equivalent, post-secondary education up to and including Bachelor's attainment and graduate level schooling including Master's and Doctorate attainment. Whether a child has attended preschool was included as a dummy coded (yes/no) variable as receiving a preschool education is related to cognitive outcomes in kindergarten (Camilli, Vargas, Ryan, & Barnett, 2010). In addition, as there are often racial/ethnic differences across diabetes status, race/ethnicity was also examined. This variable was coded with the following groups: White, Black, Hispanic, Asian/Pacific Islander/Native Hawaiian, American Indian, and more than one race.

Outcome variables. Early reading and mathematics readiness were

assessed using a composite of measures developed specifically for the ECLS-B.

The assessment measure was designed taking into account certain considerations

such as: the need for a reliable, standardized assessment that could be

administered in a home setting; able to accommodate children with varying

needs/abilities; maximal information in short amount of time; as inclusive as

possible with children with limited English fluency.

The early reading component was assessed based on the following

constructs: English language skills/oral language, phonological awareness, letter

and letter-sound knowledge, print conventions, word recognition, and vocabulary

(Najarian et al., 2010). The areas examined with the mathematics assessment

included: number sense, properties, and operations, measurement, geometry and

spatial sense, data analysis, statistics, and probability, and patterns, algebra, and

functions (Najarian et al., 2010). To create assessment items the American

Institutes of Research developed item pools and a small pilot study was done in

fall 2002 for preschool, followed by a larger preschool pilot study after

refinement of questions in 2003 (Najarian et al., 2010). A full-scale preschool

field test was conducted in 2004 after further refinement of items. Items were

drawn from multiple sources and included the PreLAS 2000, Peabody Picture

Vocabulary Test-Third Edition, Preschool Comprehensive Test of Phonological

and Print Processing, Test of Early Mathematics Ability-3, and Family and Child

Experiences Survey. The final selections for the ECLS-B kindergarten wave

assessments were drawn from the preschool assessments as described previously,

as well as from the ECLS-Kindergarten (ECLS-K) kindergarten assessment. The preschool and kindergarten assessments had enough common items to allow them both to be calibrated on the same metric which yielded a single scaled score for each domain that also allowed for comparison between assessments over time (e.g., comparing preschool to kindergarten scores). Reliability for the reading assessment was .92 and .93 for the kindergarten 2006 and 2007 samples, respectively and .92 for mathematics for both 2006 and 2007 samples.

Because early reading and mathematics predict later achievement levels (e.g., Cunningham & Stanovich, 1997; Jordan, Kaplan, Ramineni, & Locuniak, 2009), this study utilized two outcome variables related to basic kindergarten academic competencies: early reading and early mathematics. The early reading battery used in the ECLS-B included adaptive individualized assessments of receptive language, emergent literacy, and early reading skills modified from multiple instruments, as described above; these were converted into a scaled score through item response theory. The early mathematics battery utilized in the ECLS-B was an adaptive individualized assessment of number sense, geometry, counting, operations, and patterns modified from multiple instruments, as noted previously, which was then converted into a scaled score through item response theory. The scores from wave 4 and 5 were merged into one scaled score variable, and ECLS-B support manuals provide specific syntax for this process. See Table 2 for a list of the outcome variables for wave 4 and 5.

Data Analysis

Descriptive statistics. Descriptive statistics were examined for all variables. These included within and between group frequency counts for categorical variables, and means and standard deviations for quantitative variables. Distributions of quantitative variables were also examined.

Analyses. To adjust for differential selection probabilities and nonresponse given the complex sampling design of the ECLS-B, sample weights and replicate weights were utilized, thereby reducing bias and estimating appropriate standard errors when estimating characteristics of the population (Taris, 2000). As this study collected kindergarten outcomes at two times depending on child age at enrollment (wave 4 and 5), these variables were combined into a single kindergarten outcome variable for reading and one for mathematics, per syntax available from the ECLS-B data set designers. The weight that was applied for this study is referred to as WKRO. This weight is designed for conducting analyses related to wave 4 and 5 for parent interviews and child assessments with the goal of generalizing to all children born in 2001. For this study, the GLM application within the SPSS Complex Samples Module was used to conduct the analyses; parameter estimates were computed using the Taylor linearization method. All statistical tests were therefore based on standard errors that were calculated to account for the ECLS-B complex sample design.

To address the primary research question regarding whether reading and mathematics readiness differed across students with and without chronic illness, an independent samples *t*-test was performed to examine differences in mean scores between those with diabetes and those without. The first research question

was tested with an approximate *t*-test which does not assume normal distribution and homogeneity of variance as the sample sizes differed for the two populations (with and without diabetes) (Green & Salkind, 2008). Standardized mean difference effect sizes were also estimated.

To determine whether the means on the outcome variables were the same across levels of diabetes status (yes/no), two way analyses of variance (ANOVA) were performed. The assumptions of ANOVA include: normal distribution, equal variances of the dependent variable across cells, and cases are random and independent from each other (Green & Salkind, 2008). The homogeneity of variance assumption was violated; therefore the Welch procedure was utilized to help guard against Type 1 error (Howell, 2002). The degree to which the assumptions are met was assessed through scatter plots and residual plots.

It was also hypothesized that there would be significant main effects such that the mean scores on the outcome variable would vary across levels of the factor (e.g., diabetes or early education) averaging across the levels of the other factor.

For the remaining research questions, two-way ANOVAs were conducted to examine if interactions were present which would indicate the assessment scores varied based on diabetes and either mother's education, race/ethnicity, or participation in early childhood education. It was also hypothesized   that there would be significant main effects such that the mean scores on the outcome variable would vary across levels of the factor (diabetes or education/race/preschool) averaging across the levels of the other factor.

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Chapter 3

RESULTS

Descriptives

Table 3 provides the weighted population estimates of the demographic

characteristics for children born in 2001. The population included 1,123,213 total

cases, of whom 62,934 or 1.61% were reported by parents to be diagnosed with

diabetes or receive medications for diabetes. Of children born in 2001, 200,473

(30.57%) children attended preschool. In regard to the frequencies for each

category for the variables of mother's education and race/ethnicity, please refer

for Table 3. The combined scaled scores across waves 4 and 5 (kindergarten

waves) yielded means of 44.00 ($SD = 14.25$) for reading and 44.07 ($SD = 10.15$)

for mathematics. The distributions for the reading and mathematics scale scores

appear to be reasonably normally distributed (refer to Figure 1-2).

Research Question 1: Readiness Differences across Diabetes Status

To address the first research question regarding whether reading and

mathematics readiness differed across students with and without chronic illness,

independent samples t-tests were performed to examine differences in mean

scores between those with diabetes and those without.

For reading, Levene's test for equality of variances was significant (F

$(110,134) = 36.57, p < .001$), so analyses were conducted not assuming equal

variances. The t-test was significant for reading scores, $t(68694.26) = 130.52, p <$

.001. The mean reading score for children with diabetes was lower ($M = 38.04$,

$SD = 13.41$) compared to children without diabetes ($M = 45.34, SD = 13.71$). The

effect size was computed for reading scores and yielded $\eta^2 = 0.02$, indicating that although children with diabetes scored lower on the reading assessment, the effect size was small (Green & Salkind, 2008).

In regard to mathematics scores, Levene's test for equality of variances was again significant (F (190.33)= 353.43, $p < .001$); therefore equal variances were not assumed. The *t*-test was significant for mathematics scores, t(67981.72) = 186.15, $p < .001$. The mean mathematics score for children with diabetes was lower ($M = 37.37$, $SD = 10.00$) compared to children without diabetes ($M = 45.11$, $SD = 9.75$). The effect size computed for mathematics scores was $\eta^2 = 0.03$, again indicating that although children with diabetes scored lower than children without on the mathematics assessment, the effect size was small.

Research Question 2: Diabetes x Mother's Education

A 4 x 2 analysis of variance (ANOVA) was conducted to evaluate the effects of diabetes status and parent education on kindergarten reading performance. The means and standard deviations for reading scaled scores as a function of diabetes status and mother's education are presented in Table 4. The results for the two-way ANOVA indicated a significant main effect for diabetes status, $F(1,1097103) = 448.11$, $p < .001$, partial $\eta^2 = 0.0004$, a significant main effect for mother's education, $F(3,1097103) = 4367.57$, $p < .001$, partial $\eta^2 = 0.01$, and a significant interaction between diabetes and mother's education, $F(3,1097103) = 1008.31$, $p < .001$, partial $\eta^2 = 0.003$. Figure 3 represents the estimated marginal means of reading scale scores across mother's education and diabetes status. As seen in Figure 3, it appears the most drastic change in

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estimated marginal means between children with and without diabetes was for children whose mothers' had a high school diploma only.

As the interactions were significant between diabetes status and mother's education for reading, simple main effects were examined. Levene's test of equality of error variances was significant for all ANOVAs; therefore pairwise comparisons and simple main effects were conducted not assuming equal variances. Simple main effects— effects of one independent variable within a level of the second independent variable—for diabetes status within mother's education and for mother's education within diabetes status are presented in Table 5. All simple main effects were significant, indicating there are significant mean differences on reading scores for diabetes status within each level of mother's education and for mother's education across levels of diabetes status. Pairwise comparisons between each level of mother's education were also examined and Holm's sequential Bonferonni procedure was utilized to control for Type I error. In regard to mother's educational level for children with and without diabetes, all pairwise comparisons were significant comparing mother's education within diabetes level and for diabetes status within mother's education levels. The comparisons indicate that greater mother's education yields smaller differences for children with and without diabetes than for children whose mothers have less education. Reading scores differed based on the interactions between diabetes status and level of mother's education; therefore supporting the research hypothesis (see Figure 5 and 6 for box plots of distribution of scores).

To determine whether the means for mathematics scores across levels of mother's education is the same across levels of diabetes status (yes/no), a two-way analysis of variance (ANOVA) was performed. The means and standard deviations for mathematics scaled scores as a function of diabetes status and mother's education are presented in Table 4. The results for the two-way ANOVA indicated a significant main effect for diabetes status, $F(1,1097103) = 448.11$, $p < .001$, partial $\eta^2 = 0.0004$, a significant main effect for mother's education, $F(3,1097103) = 4367.57$, $p < .001$, partial $\eta^2 = 0.01$, and a significant interaction between diabetes and mother's education, $F(3,1097103) = 1008.31$, $p < .001$, partial $\eta^2 = 0.003$. Figure 4 represents the estimated marginal means of mathematics scale scores across mother's education and diabetes status. As shown in Figure 4, it appears the most drastic change in marginal means between children with and without diabetes was for children whose mothers had less than a high school diploma.

As the interactions were significant between diabetes status and mother's education for mathematics, simple main effects were examined. Levene's test of equality of error variances was significant for all ANOVAs; therefore pairwise comparisons and simple main effects were conducted not assuming equal variances. Simple main effects for diabetes status within mother's education and for mother's education within diabetes status are presented in Table 5. All simple main effects were significant, indicating there are significant mean differences on mathematics scores for diabetes status within each level of mother's education and for mother's education across levels of diabetes status. Pairwise comparisons

between levels of mother's education were also examined and Holm's sequential Bonferonni procedure was utilized to control for Type I error. In regard to mother's educational level for children with and without diabetes, all pairwise comparisons were significant comparing mother's education within diabetes level and for diabetes status within mother's education levels. The comparisons indicate that greater mother's education yields smaller differences for children with and without diabetes than for children whose mothers have less education. Mathematics scores differed based on the interaction between diabetes status and level of mother's education; therefore supporting the research hypothesis (see Figure 5 and 6 for box plots of distribution of scores).

Research Question 3: Diabetes x Race/ethnicity

For the third research question which examined race/ethnicity, a 6 x 2 two-way ANOVA was performed to determine whether the means for reading scores across race/ethnicity are the same across levels of diabetes status (yes/no). The means and standard deviations for reading scaled scores as a function of diabetes status and race/ethnicity are presented in Table 4. The results for the two-way ANOVA indicated a significant main effect for diabetes status, $F(1,1098515)$ = 3465.63, $p < .001$, partial $\eta^2 = 0.003$, a significant main effect for race/ethnicity, $F(5,1098515) = 1664.96$, $p < .001$, partial $\eta^2 = 0.008$, and a significant interaction between diabetes and mother's education, $F(5,1098515) = 1366.55$, $p < .001$, partial $\eta^2 = 0.006$. Figure 7 represents the estimated marginal means of reading scale scores across race/ethnicity and diabetes status and indicates the most

drastic difference for reading scores between children with and without diabetes is for children who are Asian, Pacific Islander, or Native Hawaiian.

As the interactions were significant between diabetes status and race/ethnicity for reading, simple main effects were examined. Levene's test of equality of error variances was significant for all ANOVAs; therefore pairwise comparisons and simple main effects were conducted not assuming equal variances. Simple main effects for diabetes status within race/ethnicity and for race/ethnicity within diabetes status are presented in Table 5. All simple main effects were significant, indicating there are significant mean differences on reading scores for diabetes status within each level of race/ethnicity and for race/ethnicity across levels of diabetes status. Holm's sequential Bonferonni procedure was utilized to control for Type I error when examining pairwise comparisons. In regard to race/ethnicity for children with and without diabetes, all pairwise comparisons were significant with the exception of the comparison between Black and American Indian children for reading scores for children with diabetes (refer back to Table 4 for means and standard deviations). The following tests could not be computed for contrasts, therefore *t*-tests not assuming equal variances were computed using Holm's sequential Bonferonni procedure to control for Type I error: reading scores between American Indian and Hispanic children with and without diabetes, and reading scores between White and American Indian children with and without diabetes. The pairwise comparisons between Hispanic and American Indian children with and without diabetes were significant for reading scores. In regard to the pairwise comparisons between

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White and American Indian children, the comparisons for children with and without diabetes for reading scores were significant. For children without diabetes, the pairwise comparisons between White and American Indian children were significant for both reading scores. Refer to Figures 9-10 for box plots representing distribution of scores.

A 6 x 2 two-way ANOVA was performed to determine whether the means for mathematics scores across race/ethnicity are the same across levels of diabetes status (yes/no). The means and standard deviations for mathematics scaled scores as a function of diabetes status and race/ethnicity is presented in Table 4. The results for the ANOVA indicated a significant main effect for diabetes status, $F(1,1098944) = 5353.54$, $p < .001$, partial $\eta^2 = 0.005$, a significant main effect for race/ethnicity, $F(5,1098944) = 1981.73$, $p < .001$, partial $\eta^2 = 0.009$, and a significant interaction between diabetes and race/ethnicity, $F(5,1098944) = 1316.46$, $p < .001$, partial $\eta^2 = 0.006$. Figure 8 represents the estimated marginal means of mathematics scale scores across race/ethnicity and diabetes status and again indicates the most drastic difference on mathematics scores between children with and without diabetes is for children who are Asian, Pacific Islander, or Native Hawaiian.

As the interactions were significant between diabetes status and race/ethnicity for mathematics, simple main effects were examined. Again, Levene's test of equality of error variances was significant for all ANOVAs; therefore pairwise comparisons and simple main effects were conducted not assuming equal variances. Simple main effects for diabetes status within

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race/ethnicity and for race/ethnicity within diabetes status are presented in Table 5. All simple main effects were significant, indicating there are significant mean differences on mathematics scores for diabetes status within each level of race/ethnicity and for race/ethnicity across levels of diabetes status. Holm's sequential Bonferonni procedure was utilized to control for Type I error when examining pairwise comparisons. In regard to race/ethnicity for children with and without diabetes, all pairwise comparisons were significant with the exception of the comparison between Black and American Indian children for mathematics scores for children with diabetes (refer back to Table 4 for means and standard deviations). The following tests could not be computed for contrasts, therefore t-tests not assuming equal variances were computed using Holm's sequential Bonferonni procedure to control for Type I error: mathematics scores between American Indian and Hispanic children with and without diabetes, and mathematics scores between White and American Indian children with and without diabetes. The pairwise comparisons between Hispanic and American Indian children with and without diabetes were significant for mathematics scores. In regard to the pairwise comparisons between White and American Indian children, the comparisons for children with diabetes were not significant for mathematics scores. For children without diabetes, the pairwise comparisons between White and American Indian children were significant for mathematics scores. Refer to Figures 9-10 for box plots representing distribution of scores.

Research Question 4: Diabetes x Early Childhood Education

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For the fourth research question which examined early childhood education, a 2 x 2 ANOVA was performed to determine whether the means for reading scores across early childhood education (yes/no) are the same across levels of diabetes status (yes/no). The means and standard deviations for reading scaled scores as a function of diabetes status and early childhood education is presented in Table 4. The results for the two-way ANOVA indicated a significant main effect for diabetes status $F(1,163430) = 4342.58$, $p < .001$, partial $\eta^2 = 0.026$, a significant main effect for early childhood education $F(1,163430) = 1350.67$, $p < .001$, partial $\eta^2 = 0.008$, and a significant interaction between diabetes and early childhood education $F(1,163430) = 11.67$, $p < .01$, partial $\eta^2 = 0.00007$, a very small effect size. Figure 11 represents the estimated marginal means of reading scale scores across race/ethnicity and diabetes status.

As the interactions were significant for reading, preschool status within diabetes status simple main effects were examined. For children with diabetes on reading scores, the *t*-test was significant ($t(10053.51) = -34.85$, $p < .001$, $\eta^2 = 0.10$), with children who attended preschool having higher scores ($M = 33.23$, $SD = 8.28$) than those who did not ($M = 27.67$, $SD = 7.89$). For children without diabetes, the *t*-tests were again significant for reading ($t(369598.44) = -140.84$, $p < .001$, $\eta^2 = 0.03$) and again, mean scores were higher for children who attended preschool ($M = 41.68$, $SD = 13.82$) than those who did not ($M = 36.27$, $SD = 14.25$). Results indicated that children with diabetes scored lower on reading assessments than children without diabetes and those children who have diabetes

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and attended preschool have higher scores than those with diabetes who have not attended preschool, though the effect size is small.

A 2 x 2 ANOVA was performed to determine whether the means for mathematics scores across early childhood education (yes/no) are the same across levels of diabetes status (yes/no). The means and standard deviations for mathematics scaled scores as a function of diabetes status and early childhood education is presented in Table 4. The results for the two-way ANOVA indicated a significant main effect for diabetes status $F(1,163341) = 2832.70$, $p < .001$, partial $\eta^2 = 0.017$, a significant main effect for early childhood education $F(1,163341) = 1931.06$, $p < .001$, partial $\eta^2 = 0.012$, and a significant interaction between diabetes and early childhood education $F(1,163341) = 16.36$, $p < .001$, partial $\eta^2 = 0.0001$. Figure 12 represents the estimated marginal means of mathematics scale scores across race/ethnicity and diabetes status.

As the interactions were significant for mathematics, preschool status within diabetes status simple main effects were examined. For children with diabetes, the *t*-test was significant for mathematics scores ($t(10344.64) = -36.96$, $p < .001$, $\eta^2 = 0.12$) with children who attended preschool again having higher scores ($M = 37.86$, $SD = 5.39$) than those who did not ($M = 33.76$, $SD = 5.90$). For children without diabetes, the *t*-test was again significant for mathematics scores ($t(394308.14) = -145.36$, $p < .001$, $\eta^2 = 0.03$). Again, mean scores were higher for children who attended preschool ($M = 42.77$, $SD = 9.44$) than those who did not ($M = 38.88$, $SD = 10.42$). Results indicated that children with diabetes scored lower on mathematics assessments than children without diabetes and those

children who have diabetes and attended preschool have higher scores than those

with diabetes who have not attended preschool, though the effect size is small.

Chapter 4

DISCUSSION

A variety of variables have the potential to affect a young child's academic success, many of which were addressed in the current study which examined the role of social determinants, race/ethnicity, and early childhood education on early academic readiness for children with and without diabetes. The results showed that children with diabetes scored lower on reading and mathematics assessments at kindergarten compared to children without diabetes. The findings are in line with previous research which has indicated children with diabetes tended to score lower on measures of academic readiness than their peers (e.g., Holmes et al., 1999). In addition, the results highlighted the potential effects of early onset diabetes on readiness as early as kindergarten; an age group which has not been reported in the research literature. Previous research has also indicated that children with T1DM score on average 5 to 6 points lower on measures of cognitive ability (Holmes et al.), with more pronounced differences for those who were diagnosed before age seven, the population that was studied here. Therefore it is difficult to assess whether the differences in decreased academic readiness evident in the current study were influenced by diminished cognitive ability as a result of the disease. However, the effects sizes for the current study were small, therefore only a small amount of variance can be accounted for by diabetes status (Tabachnick & Fidell, 2007). Given the sample, it is not surprising that there were significant results, however the effect sizes

indicate there is a fair amount of error as well and therefore interpretation of the results must be done with extreme caution.

It was hypothesized that a significant interaction would be evident between diabetes status and mother's level of education when examining reading and mathematics scores because these children are at higher risk of poorer health (Koh et al., 2010) and attend preschool at lower rates compared to peers in higher SES (Magnuson et al., 2004). The results supported this hypothesis. Significant mean differences were evident on reading and mathematics scores for diabetes status within each level of mother's education (i.e., less than high school, high school diploma, post-secondary education, graduate education) and for mother's education across levels of diabetes status. These results indicate that reading and mathematics scores differed by mother's level of education regardless of diabetes status. The largest mean difference was seen between children whose mothers had less than a high school diploma and those whose mothers had graduate education for children without diabetes on reading scores. Overall, there was at least a 13 point advantage for children whose mothers had graduate education compared to a high school diploma for children with and without diabetes on both reading and mathematics scores.

These results highlighted the importance of mother's education on childhood readiness regardless of diabetes status, which is in line with previous research indicating children in lower SES tend to perform less well on measures of academic achievement than peers in higher SES (Sirin, 2005). For example, in a meta-analysis of studies published between 1990 and 2000 regarding the

correlations between SES and academic achievement, the mean of 207 separate correlations was .29 (Sirin). However, the results of the present study yielded a very small effect size; therefore the strength of the relationship of mother's education and diabetes status on readiness is minimal.

There are likely multiple other variables that are affecting the relationship, such as some of the variables Sirin mentioned in his meta-analysis including school level, race, school location, etc. In the current study, more pronounced differences were seen on reading and mathematics scores between typical and diabetic students for those in households with more maternal education than for those with less. For instance, the difference in mean reading scores for children whose mothers have less than a high school diploma was 1.30 (diabetic = 34.54, typical = 35.84) while for children whose mothers have a graduate education the difference was 3.07 (diabetic = 50.27, typical = 53.34). These differences may be due to those in lower SES potentially having less access to — or utilizing — early childhood education (Magnuson et al., 2004). For example, in the current sample, 24 percent of children whose mothers had less than a high school education attended preschool compared to 31 percent of children whose mothers had graduate level education who attended preschool. Another possibility is that those in lower SES may have less access to health care compared to those in higher SES (e.g., Rehkopf et al., 2008) and therefore the disease has a more prominent affect upon the child's development than if the child had adequate care and proper disease management from medical professionals. As seen in Figures 5 and 6, the greatest variability among scores was for children without diabetes across

mother's educational level. The restriction of range for graduate level education for children with diabetes was severe and warranted caution in generalizing these results (unweighted $n < 50$).

The current study indicated a significant interaction between race/ethnicity and diabetes status for reading and mathematics scores. The most drastic differences on reading and mathematics scores between children who did or did not have diabetes was evident for children who are Asian, Pacific Islander, or Native Hawaiian. Children of these races/ethnicities also scored significantly higher on reading and mathematics than all other race/ethnicities possibly indicating that racial differences in education attainment were prevalent at a young age. However, it is important to note that the unweighted sample size for this population was small; therefore individual cases are going to have a large impact and potentially skew the results.

For children with diabetes, children who were identified as more than one race scored significantly higher than all other races/ethnicities. In regard to children without diabetes, children identified as Asian, Pacific Islander, or Native Hawaiian had the highest scores for both reading and mathematics. These results are in contrast with previous research that indicated White children have higher levels of achievement upon entering elementary school than non-White peers (Crosnoe, 2006). Again, effect sizes were small for the interactions on reading and mathematics scores; therefore there are likely other variables affecting the relationship between diabetes and race/ethnicity on reading and mathematics readiness. In addition, the unweighted sample was extremely small, therefore

individual variation affected overall results more so than if there was a larger sample.

For children identified as American Indian, the reading scores for children with diabetes were higher than for those without diabetes. Again, this result may be the result of sampling issues, as the unweighted sample size was less than 50. Further studies need to be conducted to clarify whether these differences are in fact due to sampling or other factors. In regard to mathematics scores, children with diabetes also had a large range of scores which made interpretation and generalization difficult for children identified as American Indian.

For children identified as more than one race, the variability was quite large for both reading and mathematics scores for children with diabetes, which made interpretation of these results difficult. It is also unclear what was captured under "more than one race" and is likely to have included an array of different races that cannot be delineated into meaningful categories. More research is needed as to how this group performs, as well as what races are included in this group. As with the recent Census, it would likely be more meaningful for caregivers to select as many races as they want rather than only being able to select one box.

The results of the performance for children of different race/ethnicities were interesting for a variety of reasons. First, there were clear differences between many of the groups, though the reasons behind these differences could be due to a host of factors, such as access to care. Second, these differences were evident before entering kindergarten indicating that enrichment and intervention

for children may needed to begin even younger than the current practices. Rather, it may be beneficial to begin interventions before children enter formal schooling — an idea that is not new given research indicating gaps may be present as early as one to two years of age (Perez-Johnson & Maynard, 2007). Effective programs reviewed in the research literature typically begin in the first three years of life and continue for multiple years, rather than only focusing on preschool participation (Reynolds, 2004). These programs begin with family support in the home and include preschool programs, supporting the family for multiple years during the child's early development. For children with diabetes specifically, interventions are often not appropriately standardized and often younger populations are not addressed at all (Northam, Todd, & Cameron, 2006).

The results of the performance for children whose mothers had various levels of education were also revealing. As mentioned, children whose mothers had less education did not do as well as children whose mothers had higher levels of education on measures of reading and mathematics readiness. There are multiple factors that may have been at play in these relationships that were not captured in the current study. For example, health can be affected by variables related to income such as health care coverage. In a review of medical debt and insurance coverage in Arizona, one study found that both medical debt and inconsistent health care coverage were predictive of reduced access to health care (Herman, Rissi, & Walsh, 2011). As mentioned, consistent care is pivotal for chronic illnesses such as diabetes which has to be monitored regularly. Children from lower income families are also at increased risk of exposure to

environmental toxins and tend to have poorer nutrition (Evans, 2004) both of which can affect overall health.

As mentioned previously, children who attended preschool performed better than their peers who had not on measures of reading and mathematics upon kindergarten entry (Magnuson et al., 2004); however academic experiences may have been negatively influenced by the child's health (Currie, 2005). Both of these assertions were evident in the current research study, as in line with research hypothesis four, a significant interaction was evident between diabetes status and early childhood education. Children who attended preschool had significantly higher scores on reading and mathematics regardless of diabetes status, which is not surprising as research indicates that children who are exposed to early education outperform their peers who were not (Perez-Johnson & Maynard, 2007). The current study showed that children with diabetes as young as five were already showing differences in educational attainment in reading and mathematics. Research has indicated that children with early onset diabetes (before age seven) fared worse than those with later onset in multiple areas such as verbal and spatial abilities (Holmes et al., 1999). The results from the current study have highlighted the need for early intervention services and supports for these students as typical preschool is not closing the gap. Diabetes affects the academic performance of children from an early age, as seen in the current study. Further research is warranted to discern how these gaps persist throughout educational careers and to what degree. As children are beginning their formal education with discrepancies in readiness, serious consideration is warranted as to

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how these students could be best served once in school as well as early intervention. As research in other areas, such as reading, has indicated, gaps widen with age (e.g., Matthew effect; Morgan, Farkas, & Hibel, 2008) thus highlighting the importance of intervening as early as possible.

Limitations

While the ECLS-B provides a varied sample representative of the U.S. population, there are limitations in regard to the data collected and utilized in the current study. For example, the discrepancy of frequencies between children with diabetes and children on medication for diabetes implies confusion on the part of caregivers or those interviewing caregivers as to the nature of diabetes. As previously mentioned, the typical regimen for children with T1DM includes the injection of exogenous insulin. Therefore the fact that there was a higher frequency for the question relating to medication for diabetes than diagnosis of diabetes is problematic. As with any other data collection process that relies on self-report, a limitation of the ECLS-B is its reliance on caregiver report for numerous variables that were examined in the current study, such as disease status. Further, caregivers were not asked about whether their child has diabetes until wave 3 (approximately preschool age), thereby missing important data that could have been utilized to determine if earlier diagnosis led to poorer outcomes within the narrow range of birth to four years of age. In addition, while the ECLS-B provides a longitudinal examination of multiple variables, it ends at kindergarten entry, therefore long-term implications of diabetes and academic readiness cannot be assessed within the ECLS-B. In regard to the assessments,

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children entered kindergarten at different ages, and there are likely differences based on age that are not fully captured by the assessment procedures. Also, the assessments were done within a span of multiple months which may have contributed to differences in scores as some children had been exposed to more instruction than others depending on when they were given the assessments.

In order to be able to interpret statistical tests accurately, the levels of mother's education were collapsed from the original 10 groups down to four. This may have resulted in not being able to detect important differences between the original groups. The categories for race/ethnicity were also collapsed from the original nine to six, which again may be at the cost of detecting differences between the original groups.

Another limitation is that the instruments used to assess reading and mathematics scores were composites of other assessments and have not been used outside of the ECLS-B study. The degree to which standardization protocols were followed is also unknown. There is also a risk that the assessments were not a good representation of the child's academic ability if the child was not fluent in English or Spanish.

Implications

As delineated in the theoretical framework for this study (Brofenbrenner, 1977; Brofenbrenner & Ceci, 1994), there are indeed multiple influences on child's health and consequent developmental outcomes which were evident in the current study. By examining multiple levels of influence, the current study indicated that genetic (i.e., diabetes), proximal (i.e., readiness), and distal (i.e.,

environmental factors) factors affect the developing child as well as the interplay between them.

Chronic health conditions affect multiple domains of life functioning. The current study indicated that academic readiness was one area that is potentially affected for children with diabetes as early as kindergarten. Previous research had not explored the academic effects of diabetes at such an early age. While the effects sizes were small, the results suggests that intervention for children with diabetes may need to be focused on early intervention before children enter school to ensure adequate health care and establish treatment plans for successful management upon entering school. Future research should explore the development of effective early interventions for this vulnerable population.

Health inequities are avoidable and are related to social determinants and are shaped by the distribution of money (WHO, 2011). As seen in previous research, disparities in academic outcomes were present in the current study based on the social determinants of SES (mother's education) and early childhood education. As discussed earlier, children from lower SES and minority racial/ethnic groups are at increased risks of health problems and cognitive insults from toxins such as lead (Evans, 2004). Children from low-income families with lower parental education levels are also less likely to attend preschool (Magnuson et al., 2004). Eliminating health disparities is currently a major policy initiative by the WHO and USDHHS, and as the current study showed, was a salient issue given the differences in readiness for children from various SES and educational opportunities.

Research Implications

There are numerous issues that arose from this study that could guide future research in this area. First, the ECLS-B sample did not allow for differentiation based on age of diabetes diagnosis. However, this information could provide insight into differences among children with T1DM based on specific age of onset. While research has already established that earlier onset is associated with more severe consequences — such as diminished cognitive and academic skills compared to those with older age of onset (e.g., Holmes, 1999) — the earlier age onset group is typically composed of children under the age of seven without differentiation among the years. Given the glucose demands of the brain (Mooradian, 1988), perhaps there are differences within this cohort while they are undergoing rapid brain maturation.

Second, given the current results, it may be beneficial to understand whether race/ethnicity provides any explanatory power over and above SES. Given the murky definitions on self-report forms for identifying individual races/ethnicities and low unweighted samples of certain races/ethnicities in the ECLS-B, it may be that SES is a more powerful predictor of reading and mathematics readiness for students with diabetes. Future research may need to be specifically focused on the children from low SES given the results of this study; primarily that children without diabetes in lower SES underperformed compared to children with diabetes in higher SES. Research endeavors on children from low SES may be able to elucidate effective interventions to narrow the gap in readiness upon entering formal schooling.

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Third, it would be helpful to examine the level of disease management for the children with diabetes. Young children do not necessarily have the awareness to recognize signs of hypoglycemia (U.S. Department of Health and Human Services, 2003); therefore the majority of the monitoring of the child's diabetes falls upon the caregiver. The degree to which the caregiver supports the child's day-to-day glycemic control is important to examine as along with age of onset, glycemic control is strongly associated with cognitive and academic performance (Kucera & Sullivan, 2011). Areas for future interventions may also be found through investigations of caregiver's disease management. Finally, given various levels of SES and the importance of disease management, an important factor to examine in future research is access to quality health care. As mentioned, glycemic control is imperative to mitigate long-term complications from diabetes (Diabetes Control and Complications Trial Research Group, 1994) and for normal day-to-day brain functioning (e.g., Mooradian, 1988). If children are not receiving regular medical intervention regarding their disease, they may be more susceptible to the negative cognitive and academic effects than those receiving appropriate care. Those in higher SES are more likely to receive appropriate health care (Rehkopf et al., 2008), therefore it would be useful to explore levels of care for young children with diabetes within various levels of SES to potentially guide future population specific interventions.

Policy and Practice Implications

In practice, it is important to keep in mind that while the effect sizes were small, there are significant differences in the early academic readiness of children

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with and without diabetes. Educational professionals should be aware of these findings and focus on early intervention to try to diminish long-term cognitive and academic effects that have been seen in other children. For example, in a meta-analysis of neuropsychological affects of T1DM, T1DM was associated with poorer performance on visuospatial tasks, motor speed, writing, sustained attention, and reading (Naguib et al., 2009).

In addition, educational professionals should be aware of support available for children from various SES levels — such as community clinics or health insurance assistance — to help ensure children with chronic illnesses are receiving appropriate medical treatment. Specifically for children with T1DM, there are numerous ways for educational professionals to assist in disease management, which is imperative for optimal day-to-day functioning (Kucera & Sullivan, 2011). For example, behavioral interventions may be appropriate for tasks such as checking glucose at appropriate times and can be useful for a variety of ages. Collaboration with caregivers and medical professionals can also be helpful in supporting the child with T1DM, especially for younger children who are reliant on adults to assist in their disease management (U.S. Department of Health and Human Services, 2003). Glycemic control is imperative to prevent long-term medical complications (U.S. Department of Health and Human Services, 2003) and also to ensure students are performing at their best while in school.

The current study highlighted the importance of early childhood education for all children, though again the effect size was very small. Providing early

childhood education is an important step in reducing disparities in educational success (Pianta et al., 2009) and should be a policy priority for the country in order to assist children to start their educational careers on solid footing. Further, disparities in achievement among levels of SES highlighted the importance of the ongoing attempts of the government policy agenda *Healthy People 2020* (U.S. Department of Health and Human Services, 2010) with the goals of reducing health inequities and improving the health for all ages, especially early childhood. The research implications mentioned previously are also important for policy. For example, after investigating the level of disease management for children and families with diabetes, policy can address the establishment of intervention programs that could target the appropriate populations to increase disease management through education and access to information and care. Each of the research implications mentioned could drive policy with the ultimate goal of early intervention.

Summary

Chronic illness can affect multiple domains of functioning, and research has consistently indicated that the early years of a child's life are pivotal for early intervening to positively affect physical, cognitive, and socio-emotional development. The current study found that children with diabetes fared worse than their peers on measures of academic readiness as early as kindergarten. This effect is influenced by several factors, such as SES, race/ethnicity, and early educational experiences. The results highlight the importance for policy and practice to intervene as early as possible with this vulnerable population. Future

research is needed to guide efforts to mitigate the influence of diabetes on

children's academic endeavors.

Table 1

Variables to be Drawn from the ECLS-B

Description	Field Name	Field Label	Prompt	Response categories with unweighted cases
Race/ethnicity	Y1CHRACE	X1 RACE/ETHNICITY-CHILD (REVISED)		White, Non-Hispanic (4,400) Black or African-American, Non-Hispanic (1,700) Hispanic, Race Specified (1,500) Hispanic, No Race Specified (650) Asian, Non-Hispanic (1,200) Native Hawaiian or other Pacific Islander, Non-Hispanic (50) American Indian or Alaska Native, Non-Hispanic (300) More than one race, Non-Hispanic (800) Not ascertained (<50)
Diabetes status	P4DBTS	P4 CH200L CHILD HAS DIABETES	Has a doctor ever told you that (CHILD) has the following conditions? Does (he/she) have diabetes?	Yes (<50) No (8,900) Not applicable (0) Refused (<50) Don't know (<50) Not ascertained (<50)
Medications for	P4RXDIAB	P4 FH066	What is the	Yes (100)

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Concept	Variable	Label	Question	Values
diabetes	MEDS-DIABETES		medication for? Diabetes	No (2,300) Not applicable (6,450) Refused (<50) Don't know (0) Not ascertained (<50)
Early childhood education	P4ATTPRE	P4 CC518 CHILD ATTEND PRESCHOOL	Did (CHILD) ever attend preschool?	Yes (300) No (700) Not applicable (5,900) Refused (0) Don't know (<50) Not ascertained (100)
Mother's education level	X4MOMED	X4 RES MOTHER HIGHEST EDUCATION LEVEL		8th grade or below (300) 9th to 12th grade (650) High school diploma/equivalent (1,800) Voc/Tech program (250) Some College (1,850) Bachelor's Degree (1,200) Graduate professional school/No degree (150) Master's Degree (600) Doctorate or Professional Degree (200) Not ascertained (<50)

Note. Due to data reporting restrictions from Institute of Educational Sciences, all frequency counts for unweighted cases are rounded to the nearest 5

Table 2

Outcome Variables as Named in the ECLS-B

Description	Field Name	Field Label
Reading scale score, wave 1	X4RSCR2	X4 READING SCALE SCORE CLB P-K06
Mathematics scale score, wave 1	X4MSCR2	X4 MATHEMATICS SCALE SCORE CLB P-K07
Reading scale score, wave 2	X5RSCR2	X5 READING SCALE SCORE CLB P-K06
Mathematics scale score, wave 2	X5MSCR2	X5 MATHEMATICS SCALE SCORE CLB P-K07

Note: Kindergarten outcomes are listed for both waves as data collection was in two waves due to 25% of the children entering a year later.

Table 3

Characteristics of Children Born in 2001 at Age 4

	Analytic Sample		Weighted Population				Diabetic Subsample	
			Total					
	n	%	n	%			n	%
Sex								
Female	5,200	48.9	1,909,676	48.80			30,038	47.73
Male	5,450	51.1	2,003,934	51.20			32,896	52.27
Race/ethnicity								
White	4,400	41.4	2,097,220	53.73			28,146	45.69
Black	1,700	15.9	542,607	13.90			12,674	20.60
Hispanic	2,200	20.5	981,581	25.15			15,816	25.68
Asian/Pacific Islander/Native Hawaiian	1,250	11.7	107,363	2.75			1,652	2.68
American Indian	300	2.8	19,425	0.50			500	0.81
More than one race	800	7.6	155,152	3.97			2,812	4.57
Mother's Education								
Less than High School	900	8.7	583,192	15.04			21,368	33.95
High School diploma	1,800	16.82	1,090,950	28.14			10,646	16.91
Post secondary education	5,150	30.8	1,797,585	46.37			30,064	47.77
Graduate education	900	8.7	404,537	10.44			856	1.36
Preschool status								
Yes	300	3.0	200,473	30.60			4,884	42.10
No	700	6.7	455,360	69.43			6,675	57.90

Note. Due to data reporting restrictions from Institute of Educational Sciences, all frequency counts for unweighted cases are rounded to the nearest 50.

Table 4

Weighted Means and Standard Deviations for Reading and Mathematics Scaled Scores for Combined Kindergarten Waves as a

Function of Diabetes Status and Mother's Education, Race/ethnicity, or Preschool Status

	Reading		Mathematics	
	Typical	Diabetic	Typical	Diabetic
Total				
Mother's Education				
Less than High School	35.84 (13.44)	34.54 (8.72)	38.10 (9.69)	33.86 (7.97)
High School diploma	41.23 (13.33)	35.45 (12.79)	41.87 (9.81)	36.73 (8.59)
Post secondary education	46.38 (13.34)	41.02 (15.41)	45.92 (9.29)	39.64 (10.91)
Graduate education	53.34 (13.71)	50.27 (5.73)	51.21 (8.43)	49.83 (1.25)
Race/Ethnicity				
White	46.63 (13.14)	40.78 (14.43)	46.71 (9.35)	38.36 (10.67)
Black	41.29 (13.86)	37.19 (11.96)	40.27 (9.21)	37.67 (10.60)
Hispanic	42.16 (14.58)	34.83 (9.01)	41.36 (9.49)	35.41 (8.01)
Asian/Pacific Islander/Native Hawaiian	52.72 (14.84)	*	49.11 (10.38)	*
American Indian	36.29 (12.58)	38.88 (15.04)	38.03 (10.60)	36.96 (12.79)
More than one race	44.61 (13.72)	44.93 (19.83)	44.61 (9.76)	41.87 (10.01)
Preschool Enrollment				
Yes	41.88 (13.14)	33.23 (8.28)	43.74 (9.59)	37.86 (5.39)
No	37.27 (14.20)	27.67 (7.89)	38.81 (10.63)	33.76 (5.90)

Note. Overall mean score for reading was 44.00 ($SD = 14.25$), and for mathematics was 44.07 ($SD = 10.15$).

*Note: excluded due to very small n

Table 5

Simple Main Effects for Children with Diabetes for Mother's Education and Race

for Reading and Mathematics Scores

Diabetes		Independent variable	$F*$	η^2
Yes	Reading	Mother's education	1399.75	0.06
		Race	1214.57	0.09
	Mathematics	Mother's education	1959.27	0.09
		Race	510.49	0.04
No	Reading	Mother's education	164775.77	0.12
		Race	44424.63	0.06
	Mathematics	Mother's education	189965.62	0.13
		Race	77058.82	0.09

Note. $*p < .001$
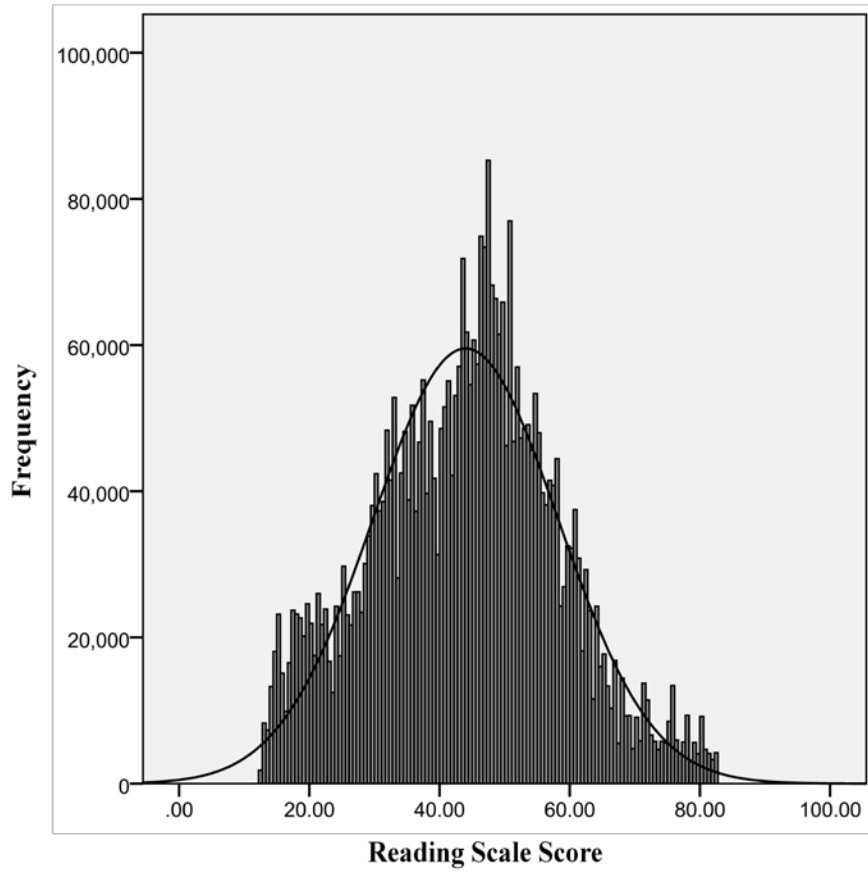
Figure 1. Approximately normal distribution of reading scale scores for sample.
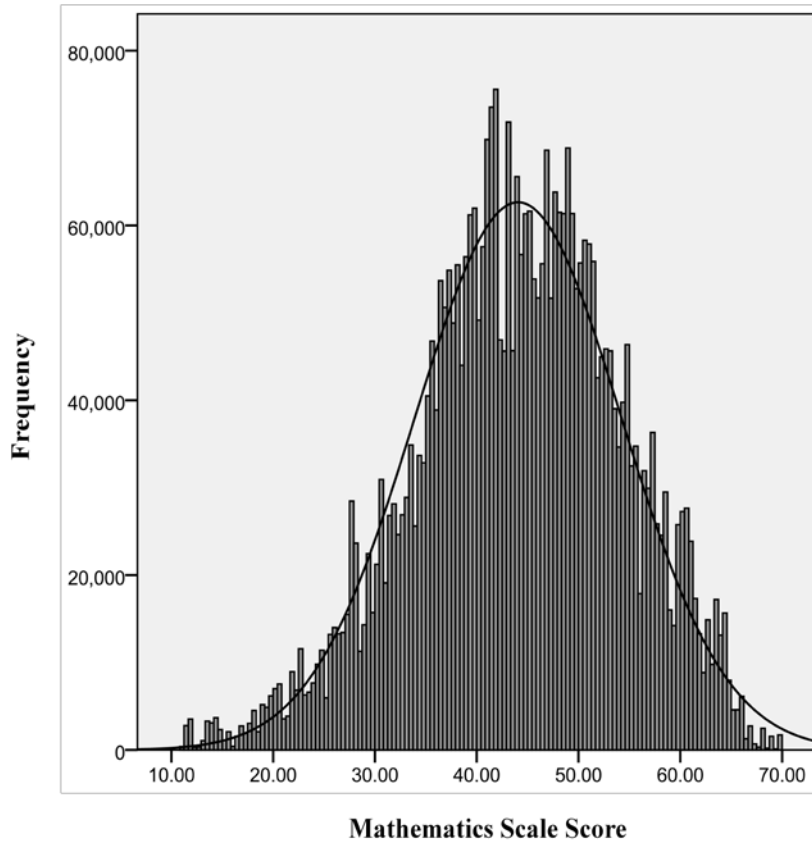
Figure 2. Approximately normal distribution of mathematics scale scores for
sample.
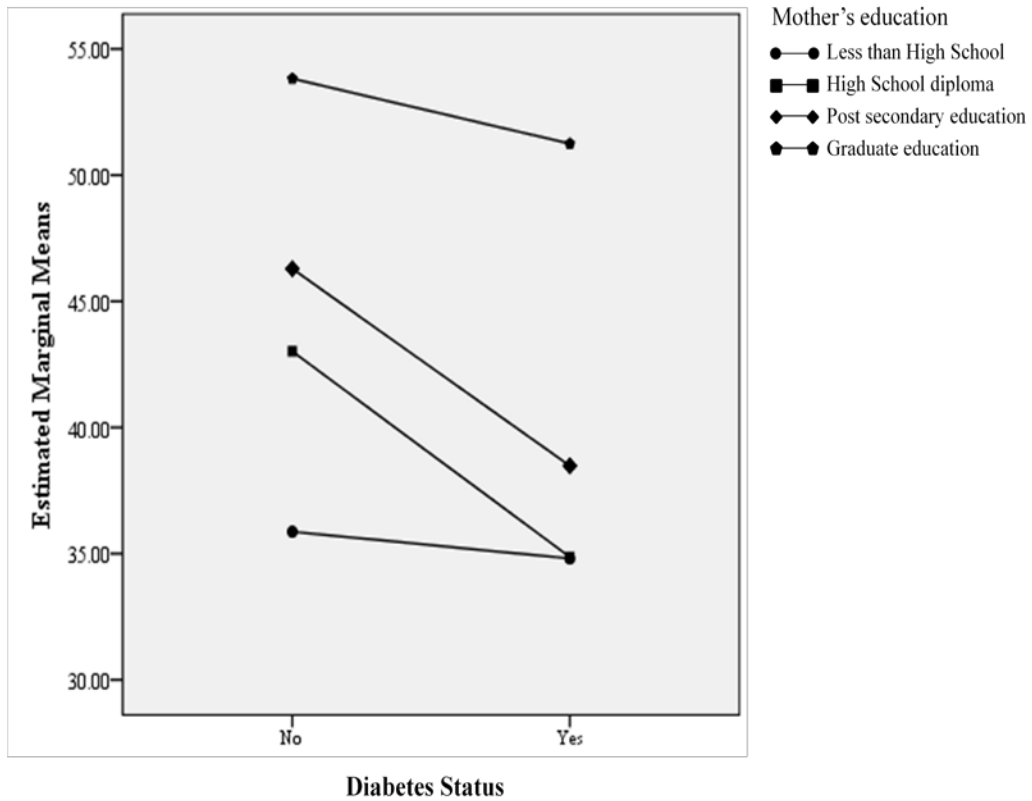
Figure 3. Weighted estimated marginal means of reading scaled score at kindergarten entry across diabetes status groups and mother's education level.
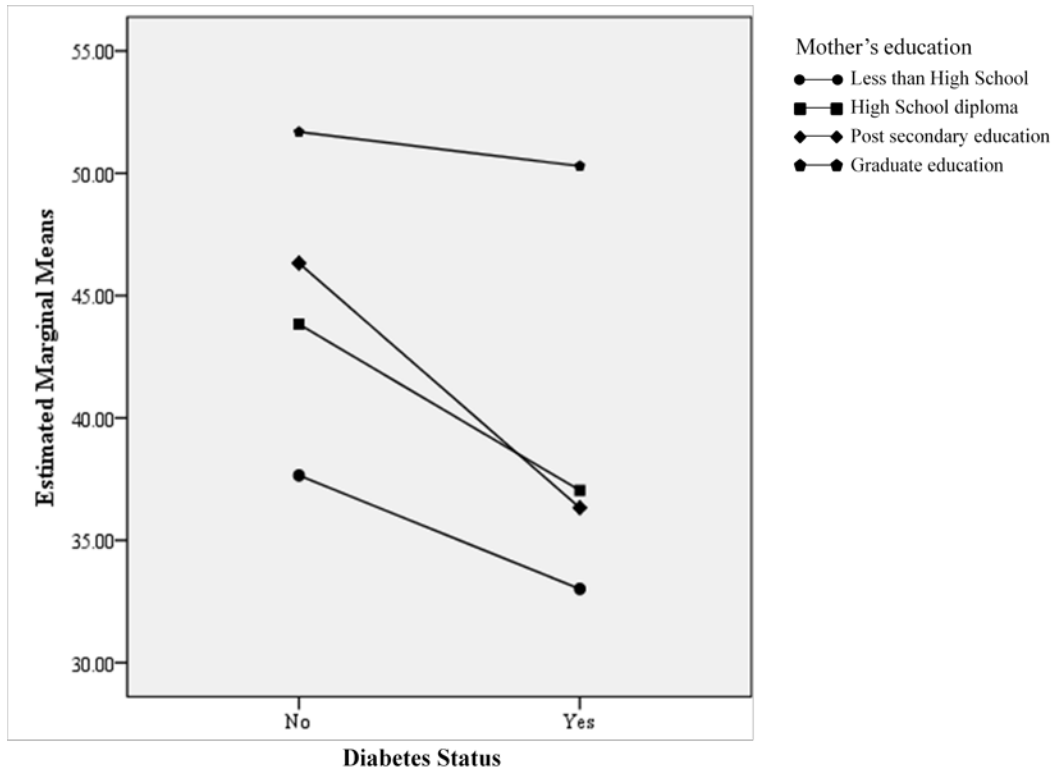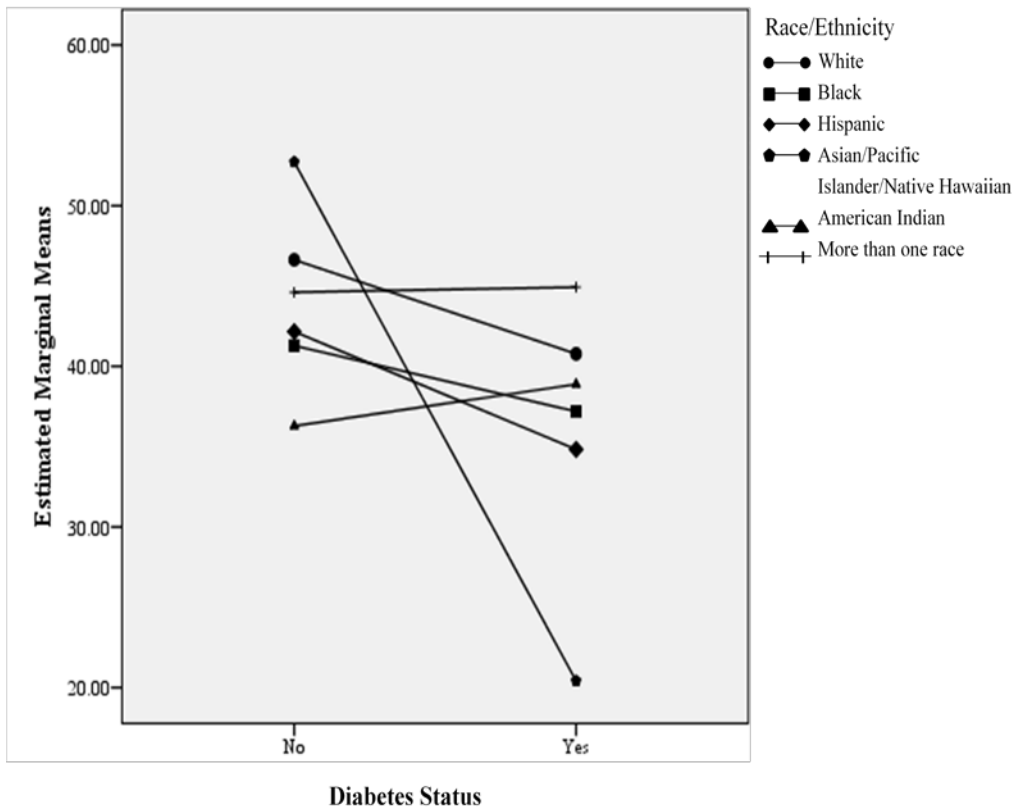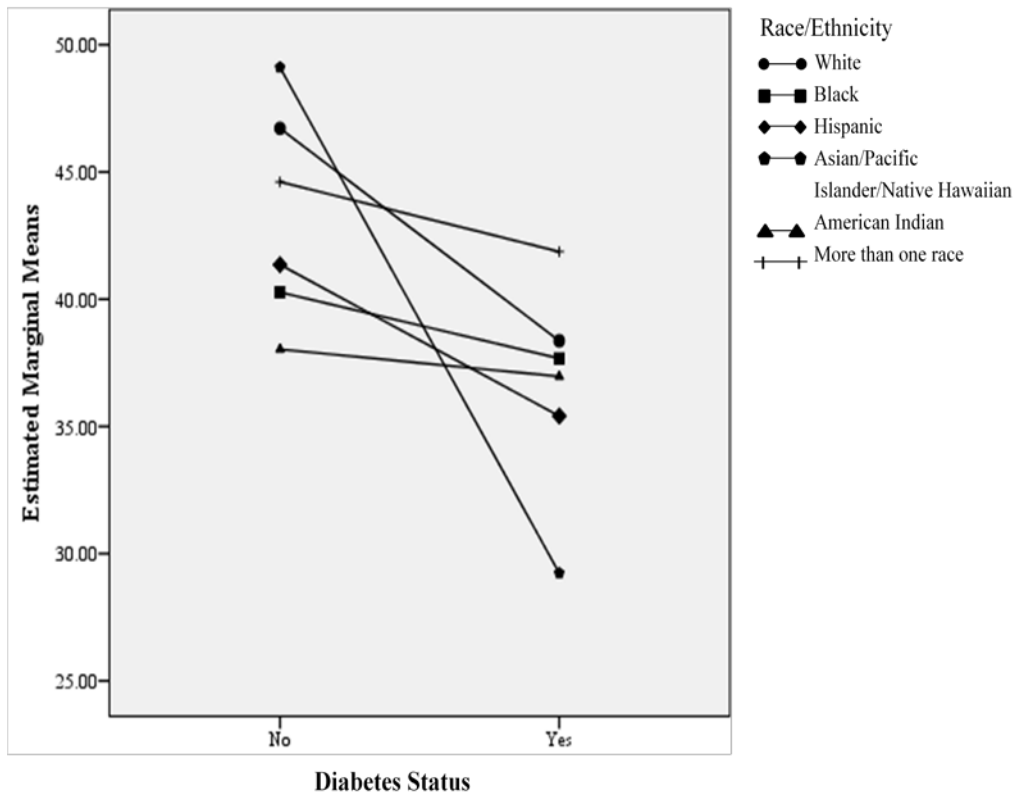
Figure 4. Weighted estimated marginal means of mathematics scaled score at kindergarten entry across diabetes status groups and mother's education level.
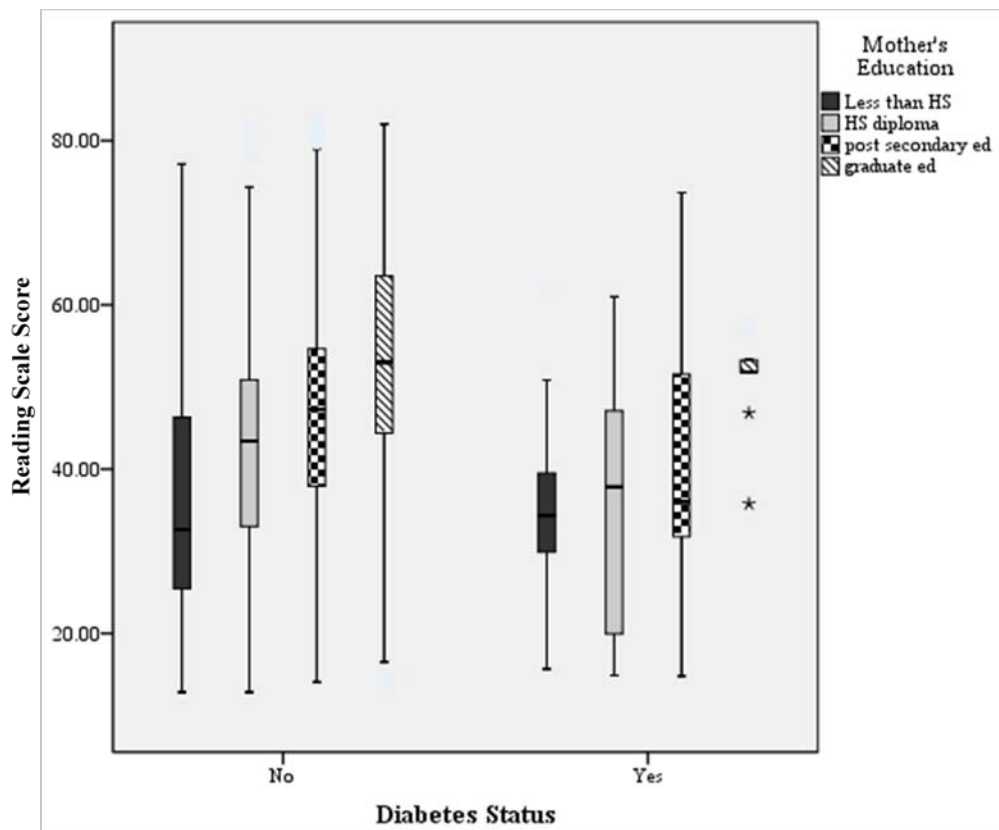
Figure 5. Box plot of reading scaled score distributions at kindergarten entry across diabetes status groups and mother's education.
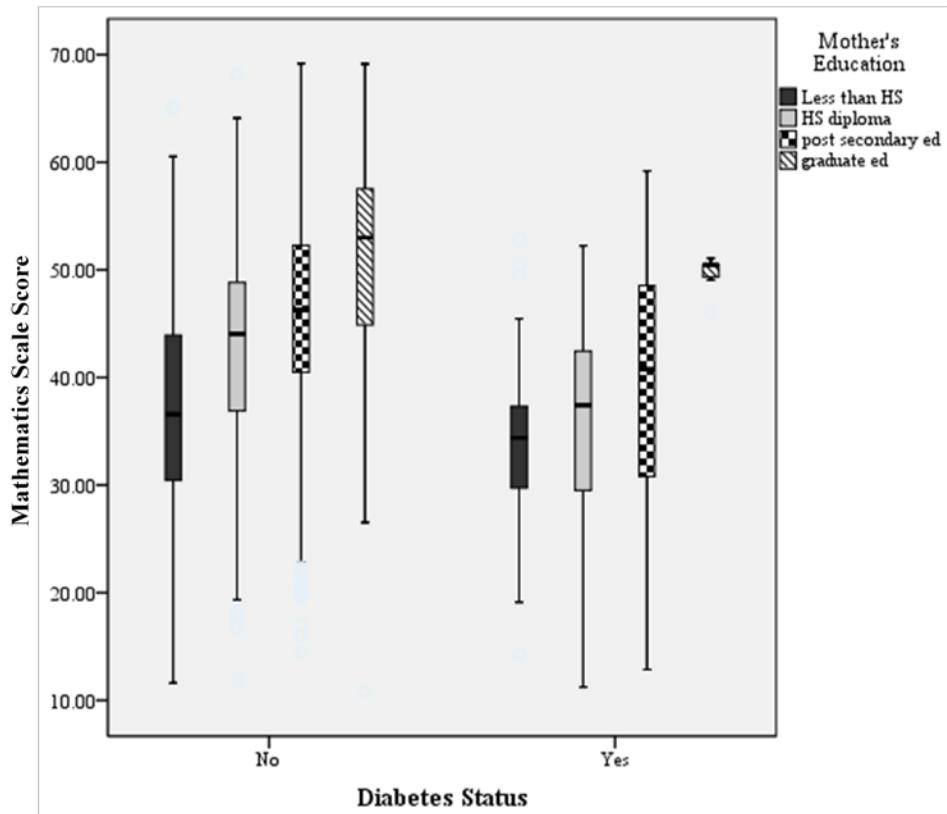
Figure 6. Box plot of mathematics scaled score distributions at kindergarten entry across diabetes status groups and mother's education.

Figure 7. Weighted estimated marginal means of reading scaled score at kindergarten entry across diabetes status groups and race/ethnicity.

Figure 8. Weighted *e*stimated marginal means of mathematics scaled score at kindergarten entry across diabetes status groups and race/ethnicity.
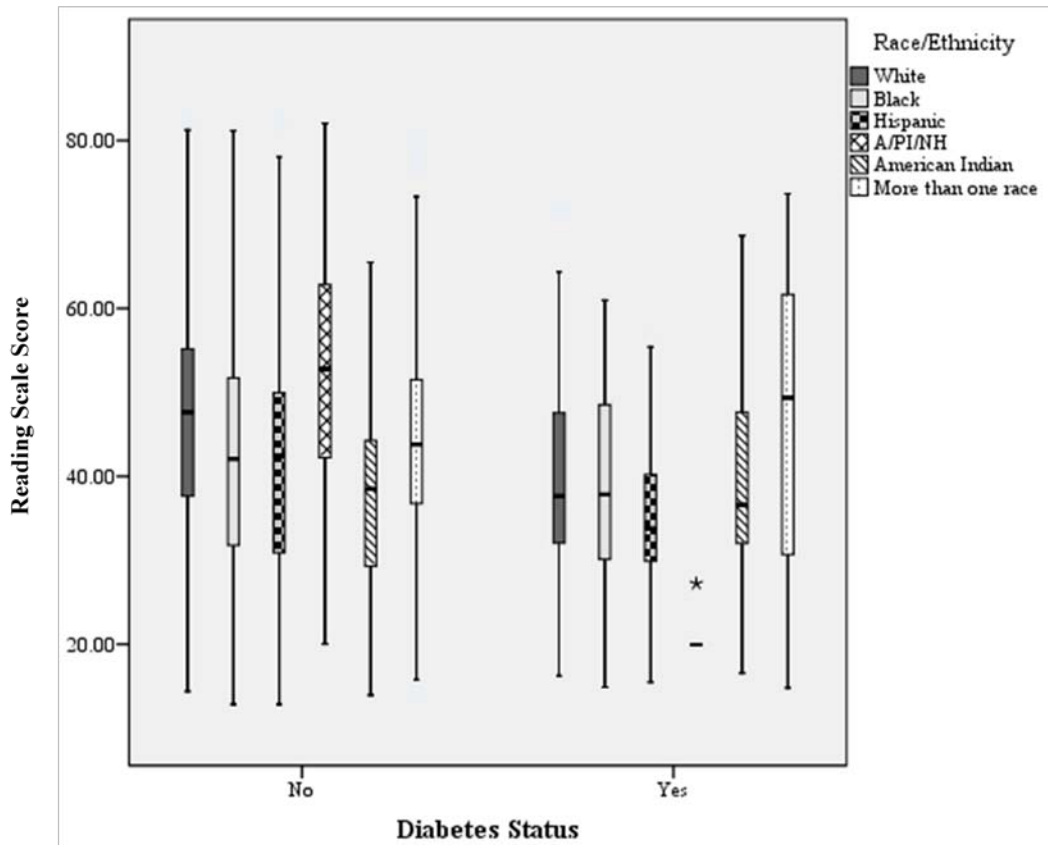
Figure 9. Box plot of reading scaled score distributions at kindergarten entry across diabetes status groups and race/ethnicity.
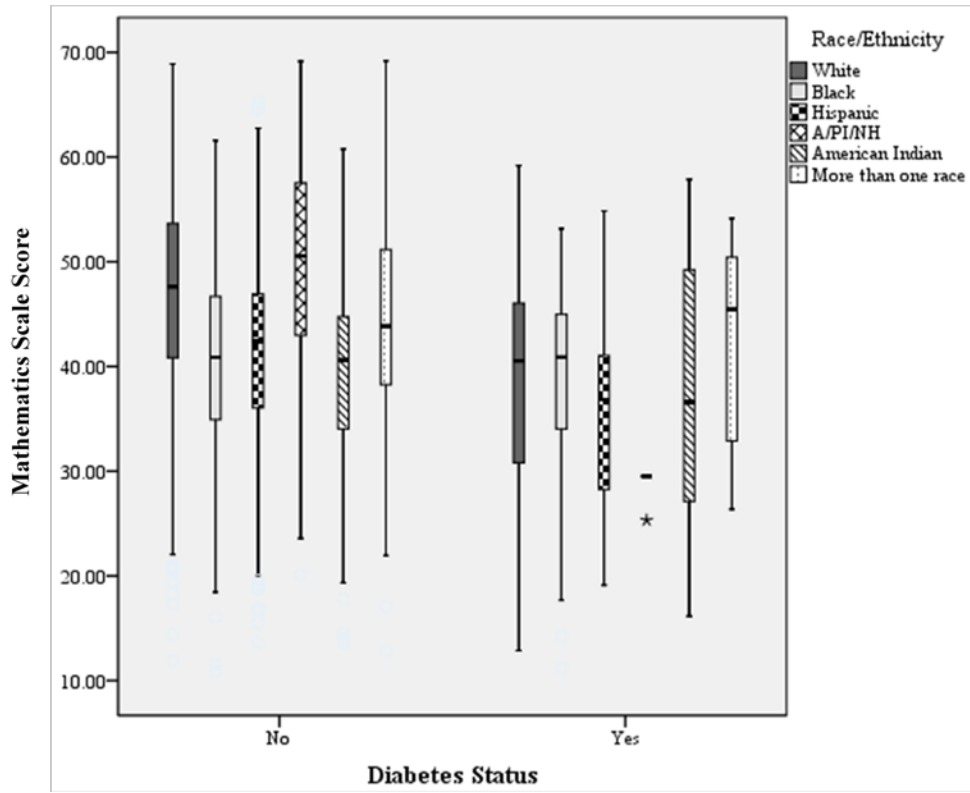
Figure 10. Box plot of mathematics scaled score distributions at kindergarten entry across diabetes status groups and race/ethnicity.
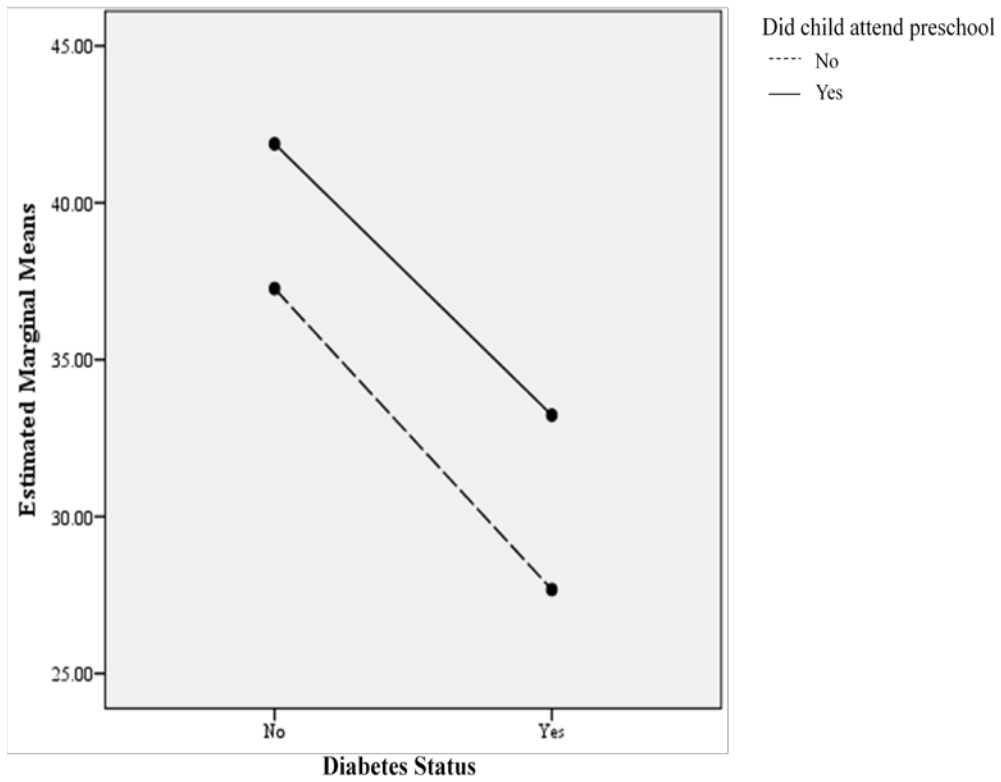
Figure 11. Weighted estimated marginal means of reading scaled score at kindergarten entry across diabetes status groups and early childhood education.
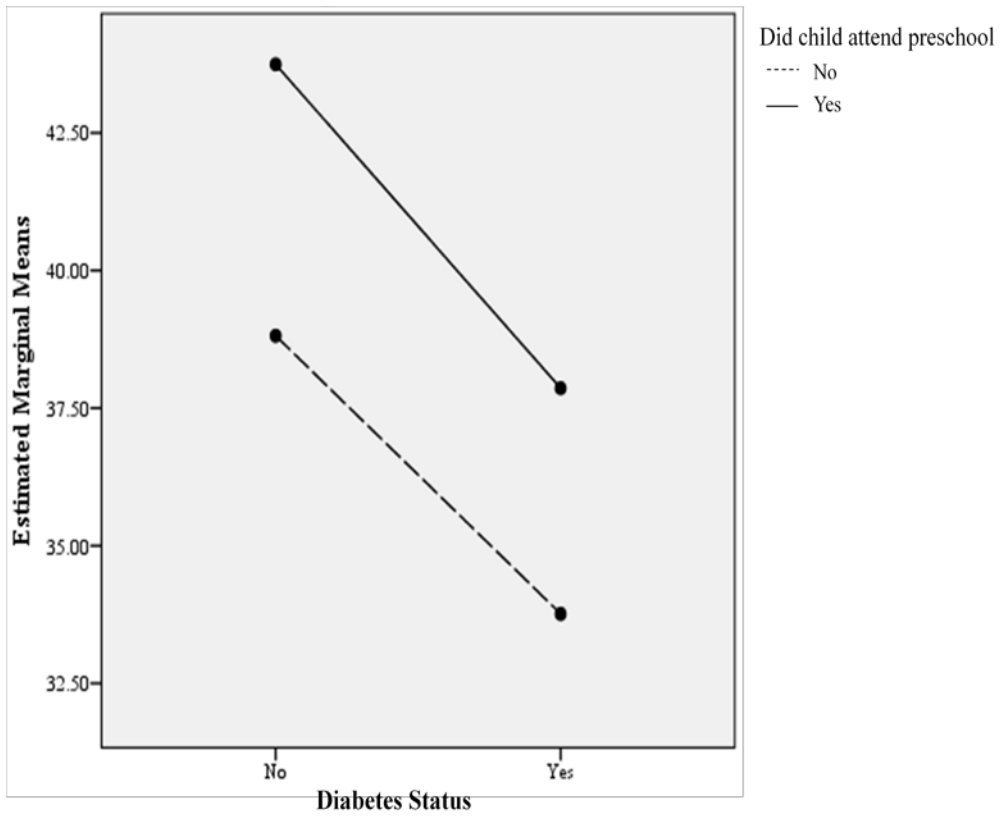
Figure 12. Weighted estimated marginal means of mathematics scaled score at kindergarten entry across diabetes status groups and early childhood education.

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