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Disability- and Mathematics-related Outcomes of Adolescents Born Late-preterm: An Examination of Eighth-grade ECLS-K Participants

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DISABILITY- AND MATHEMATICS-RELATED OUTCOMES OF ADOLESCENTS BORN LATE-PRETERM: AN EXAMINATION OF EIGHTH-GRADE ECLS-K PARTICIPANTS

by

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ABSTRACT

To capture a snapshot of the late-preterm academic phenotype in adolescence, and to address a research gap in empirical investigation, the researcher in the present study compared disability- and mathematics-related eighth-grade age outcomes of those born late-preterm (n = 330), to full-term (n = 5434) peers. Through an analysis of Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) the researcher in the present study examined the impact of late-preterm birth on disability-related school outcomes in adolescent-age, as measured by (1) presence of special education services; (2) presence of learning disability or other disability; (3) and presence of increased behavioral or attention needs. The researcher examined the impact of late-preterm birth on mathematics-related school outcomes in adolescent-age, as measured by (1) adolescent participant performance in mathematics; (2) adolescent participant engagement in mathematics; (3) and adverse adolescent participant outcomes in mathematics. The researcher found adolescent participants born late-preterm had greater risk of school report of provided special education services; parent report of disability; mathematics teacher report of attention-related adverse outcomes; and mathematics teacher report of decreased ability, incongruent with student's typical performance on ECLS-K standardized assessment.

Keywords: preterm birth, late-preterm birth, special education, mathematics, adolescent, school outcomes, ECLS-K, disability

In gratitude to those who have gone before,

thank you for making our world more inclusive.

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If I have seen further it is by standing on the shoulders of Giants. Isaac Newton

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LIST OF ACRONYMS (or) ABBREVIATIONS

AAP	American Academy of Pediatrics
ACOG	American College of Obstetricians and Gynecologists
ADHD	Attention-Deficit/ Hyperactivity-Disorder
aRR	Adjusted relative risk
CHQ	ECLS-K variable indicator, Child's Health and Well-being
CPT	Continuous Performance Test
ECLS-B	Early Childhood Longitudinal Study, Birth Cohort
ECLS-K	Early Childhood Longitudinal Study, Kindergarten Class of 1998-99
ECLS-K:2011	Early Childhood Longitudinal Study, Kindergarten Class of 2011
EHA	Education for All Handicapped Children Act
FMS	Field management system (ECLS-K study personnel and documentation)
FT	Full-term gestation (born 39-$40^{6/7}$ weeks' gestation)
IDEA	Individuals with Disabilities Education Act
IEP	Individualized Education Program
IQ	Intelligence Quotient
LPT	Late-preterm gestation (born 34-$36^{6/7}$ weeks' gestation)
NIH	National Institutes of Health
NCES	National Center for Education Statistics
NICHD	Eunice Kennedy Shriver National Institute of Child Health and Human Development
NICU	Neonatal Intensive Care Unit
NPASC	National Perinatal Association Steering Committee
SCQ	ECLS-K variable indicator, Schooling
SEL	Social and Emotional Learning
SES	Socioeconomic status
USDOE	United States Department of Education

CHAPTER ONE: INTRODUCTION

Late-preterm birth: a rising phenomenon

In 2005, the National Institutes of Health (NIH) sounded an alarm to a marked increase in late-preterm (born at 34-$36^{6/7}$ weeks' gestation) births. With one late-preterm birth occurring every 1.5 minutes in the United States, this previously risk-underestimated population represents 8% of all births and 300,000 children born at increased risk for long-term morbidities and perinatal mortality (Raju, 2006b). A nationwide empirical response catalyzed; fifteen years post, the call remains for continued investigations into longitudinal impacts of late-preterm birth. Researchers corroborate, extrauterine exposure in late-preterm gestation increases risk for long-term, adverse neurodevelopmental, behavioral, and medical outcomes (Baron et al., 2011; Baron et al., 2012; Raju, 2017; Saigal & Doyle, 2008) – outcomes related to increased risk for special medical and educational needs. Table 1 provides a summary of increased risks associated with late-preterm birth.

Table 1

Increased Risks Associated with Late-preterm Birth, by Category

Delays	Disorders	Adverse outcomes	Altered maturation
Cognitive	Attention	Behavioral	Brain
Neurodevelopmental	Executive Function	Neurological	Respiratory
Motor	Visuospatial	Physical morbidity	Cardiovascular
Receptive language			
Speech and language			

Late-preterm population: a new awareness by medical professionals in early 2000s

In response to the initial alarm and continued crisis, the National Institute of Child Health and Human Development of the NIH convened panel workshops in 2005 and 2015 to *Optimize*

Care and Outcome for Late-Preterm (Near-Term) Infants (Raju et al., 2006; Raju, 2017). Significant outcomes of these workshops included documenting associated minor morbidities, and highlighting the vulnerability and increased risks of this population (Chyi et al., 2008; Raju et al., 2006). Collectively, the Office of the Surgeon General, Centers for Disease Control, National Center for Health Statistics, U.S. Department of Health and Human Services, and National Institute of Child Health and Human Development emphasized associated morbidities, including problems with cognitive development and function resulting from late-preterm birth.

Call to close an empirical research gap on late-preterm population outcomes

With prematurity rates doubled to 12.5% of all births from 1998 to 2005, a 50% increase in deliveries at 37 and 38 weeks' gestation was reflected (Eunice Kennedy Shriver National Institute of Child Health and Human Development, NIH, DHHS, 2013; Raju, 2006b). Late-preterm birth is the fastest growing subset of premature births, accounting for 75% of premature births (Martin et al., 2018). Susceptibility-to-risk of adverse medical and developmental outcomes for individuals born late-preterm was conventionally thought minimal (Behrman, 2006; Raju, 2006b). Researchers today think differently. Time spent in the womb is a continuum, and exposure-response exists into the final days in-utero (Darlow & Cheong, 2019; Wiingreen et al., 2018). National departments and agencies collectively prioritized responses to the rising crisis, in effort to increase current understandings of comorbidities, risk factors, and educational outcomes.

National Institutes of Health. In July 2005, the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the NIH convened a team of medical professionals in response to this crisis. An outcome of the workshop was to create a standardized definition of neonates born between 34 and $36^{6/7}$ weeks' gestation as late-preterm, signifying the

vulnerability of this population who remain at "high risk of perinatal morbidity and mortality" (Raju, 2006b, p. 775). The panel noted an underestimation in risk for this population, which lacked evaluation and adequate follow-up (Raju, 2006b). A final panel outcome was a charge to educate personnel: "Even seemingly healthy, late-preterm infants are physiologically immature, and therefore they should be diligently evaluated, monitored, and followed" (Raju, 2006b, p. 776).

American Academy of Pediatrics. As a direct outcome of the initial workshop, the National Institute of Child Health and Human Development of the NIH and American Academy of Pediatrics (AAP) Committee on Fetus and Newborn called for multidisciplinary analyses of late-preterm survivors' long- and short-term outcomes (Raju, 2006a, 2006b). Both organizations documented associated major and minor morbidities for late-preterm individuals, while emphasizing vulnerability, including adverse neurodevelopmental and behavioral outcomes (Cheong et al., 2016; Chyi et al., 2008). To promote research toward this end, *Seminars in Perinatology* featured two issues on *Optimizing Care and Outcomes for Late Preterm Infants* in February 2006, exploring short- and long-term outcomes.

Committee on Understanding Premature Birth and Assuring Healthy Outcomes. The Committee on Understanding Premature Birth and Assuring Healthy Outcomes, through the Institute of Medicine of the National Academies, built upon this initial work in July 2006, creating a brief on preterm birth, in an effort to establish a "framework for action" and research agenda on the issue. The Committee called for studies to increase understanding of the "impact of preterm birth on various public programs" (Behrman, 2006, p. 3). NIH experts reaffirmed commitment to prematurity research by calling for an increased examination of this topic. Elias Zerhouni (2008), then NIH Director, affirmed: late-preterm infants have heightened

"neurological and developmental morbidities rates during childhood" (p. 5) – and suggested this population attributed to the overall increase in neurodevelopmental disorders (Zerhouni, 2008).

Other national organizations. In parallel, the Office of the Surgeon General, in June 2008, convened a conference to review key findings on preterm birth and to establish a research agenda to address the public health crisis (Surgeon General Conference on Preterm Birth, 2008). The U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, and National Center for Health Statistics also affirmed, infants born late-preterm are more likely than term peers to "suffer brain injury that can result in long-term neurodevelopmental problems. Accordingly, increased high levels of late-preterm births are an important public health issue" (Martin et al., 2009, p. 1).

The Eunice Kennedy Shriver National Institute of Child Health and Human Development of the NIH promoted a continuing education program to convey the risks faced by individuals born late-preterm (National Institute of Child Health and Human Development, 2011, para. 6). Institute leadership of these organizations committed to funded research on late-preterm birth and interventions aligned with outcomes (Gyamfi-Bannerman, 2018; Hadfield et al., 2017; Putnick et al., 2017; Raju, 2017; Wapner, 2018). Investigators responded in kind, with explorations of medical and educational outcomes for individuals born late-preterm (Engle, 2006; Raju, 2006b; Surgeon General Conference on Preterm Birth, 2008). Medical researchers responded with over 2,400 empirical articles, including thirteen investigations (with large n/N) of school outcomes (Abel et al., 2017; Chan & Quigley, 2014; Chyi et al., 2008; ElHassan et al., 2018; Lipkind et al., 2012; Morse et al., 2009; Peacock et al., 2012; Quigley et al., 2012; Searle et al., 2017; Shah et al., 2016; Wiingreen et al., 2018; Williams et al., 2013; Woythaler et al., 2019). While investigations of early-school outcomes occurred, a research gap remains in

empirical investigations of academic, cognitive, and behavioral outcomes of adolescents born late-preterm. Notably, experts in the education field remain largely unaware of the crisis or the need for an empirical response.

Emergent findings of late-preterm birth and impact on longitudinal outcomes

Over the past decade, researchers identified significant developmental advantage in birth at term (39-40$^{6/7}$ weeks' gestation), compared with early-term (37-38 weeks' gestation) or preterm, including late-preterm (Baron et al., 2014; Poulsen et al., 2013). For the late-preterm survivor, missing the last few weeks in-utero can have lasting impacts on developmental, cognitive, social, and behavioral outcomes.

Impact of late-preterm birth on developmental outcomes

The final weeks of pregnancy are critical to ensure typical development of vulnerable and immature fetal organ systems, including the nervous system, which needs complete gestation to mature (Cheong et al., 2016; Kennaway et al., 2012; van Soelen et al., 2010; Zafeiriou, 2016). Typical brain development has significant implications for special education professionals, as early brain development is linked to later academic performance. Across the preterm and early-term spectrum, gestational age at birth is a predictor of conceptual ability, including verbal, motor, spatial, and adaptability scores (Baron et al., 2012).

Impact of late-preterm birth on nervous system development. Tremendous brain development occurs in the late-preterm period, including rapid cortical sulcation, arborization, neural networking, and density growth (Baron et al., 2012; Hill, 2017; Phillips et al., 2013). Late-preterm birth and subsequent exposure to the extrauterine environment alters neural development across various areas of the brain, leading to decreased brain volume, altered brain matter, and a delay in neuro and social development (Brumbaugh et al., 2016, 2014; Cheong et al., 2016;

Jiang, 2015; Kelly et al., 2016; Munakata et al., 2013; Rogers et al., 2014). More, prefrontal cortex development is especially vulnerable to this extrauterine environmental disturbance (Brumbaugh et al., 2014; Hodel et al., 2016); each week of reduced gestation is associated with decreased corticomotor excitability and plasticity. Evidence exists showing white matter disturbances in the front-cortical areas, occurring in the late gestational period, persist into early adolescence (Baron et al., 2014; Kennaway et al., 2012). Kennaway and colleagues (2012) determined decreased corticomotor excitability and plasticity provide a mechanistic link between poor neurodevelopment, reduced efficiency, and associated behavioral disorders in individuals born late-preterm.

Impact of late-preterm birth on academic outcomes

Late-preterm birth carries with it an (often) undetected, un-surveilled summative effect of challenges (Amor et al., 2012; Church et al., 2012). As individuals born late-preterm develop, concerns shift from medical management of major morbidities and adverse medical outcomes to educational support of low severity outcomes including behavior disorders and cognitive delay, which impact academic performance and social assimilation. While longitudinal surveillance of late-preterm cognitive development indicates full-scale IQ scores within normative range for 90% of children by preschool age (Romeo et al., 2012), this population in several national studies struggles to perform academically.

Potential impact of late-preterm birth on learning. Across the preterm spectrum, gestational age at birth is a predictor of conceptual ability, including verbal, motor, spatial and adaptability scores (Woythaler et al., 2019). Those born late-preterm are at risk for specific mathematical and reading deficiencies compounded by aforementioned developmental morbidities, as described in the subsequent systematic literature review (Ahmed et al., 2013;

Geary, 2011; Odd et al., 2012). These morbidities may manifest later in development, and are complexed by compromised social, behavioral, emotional, creative, and physical development (Woythaler et al., 2019; Woythaler et al., 2015; Romeo et al., 2012).

For the late-preterm student with reduced cortico-excitability and plasticity, implications for learning are great – efficiency in cognitive function is directly related to on-task behavior; achievement of goals and standards; efficiency of learning, social-skills and positive peer interactions; dynamic and targeted interventions; self-determination; and preparedness for school settings (Mason & Reid, 2018; Reid et al., 2012; Schunk & Bursuck, 2013; Wehmeyer, 2013). Students born late-preterm may demonstrate difficulty with executive functioning, as seen through deficits in reading comprehension, written language, mathematics task performance, and independence of learning (Callan & Cleary, 2019; Mason & Reid, 2018). Church et al. (2012) maintain, for the student born late-preterm:

> challenges to [identify morbidities] and lack of awareness in the school setting can converge to result in an academic hurricane, resulting in significant and potentially preventable morbidity and disability... [as] the weakness of the preterm child tends to be diffuse, crossing multiple domains of development, rather than an isolated weakness. (p. 148)

If children born late-preterm struggle early in academics, those achievement standards may follow them in later grades. The importance of early academic achievement was studied using the Early Childhood Longitudinal Study – Kindergarten cohort (ECLS-K), a nationally representative sample of students enrolled in kindergarten, during the 1998 to 1999 school year. As a longitudinal study, Walston and McCarroll (2010) followed participants through eighth grade. Of note to the current study, data were collected in multiple school-related areas,

including mathematics and disability. What researchers found was "higher scores on the ECLS-K mathematics assessment in the fifth grade were associated with higher levels of algebra enrollment by the eighth grade" (p. 10). In other words, student performance in elementary school did predict academic performance in the secondary grade levels, including in the area of mathematics. Higher achievement in early childhood impacts enrollment in advanced mathematics courses, beginning in middle school and into high school (Walston & McCarroll, 2010). These impacts are significant to students born late-preterm – who often face delays or deficits in early childhood, with potential carryover into elementary and secondary school (Church et al. 2012).

Potential impact of late-preterm birth on special education and 504 eligibility. Neurodevelopmental disparities occur across the preterm spectrum; late and moderately preterm children have twice the risk for neurodevelopmental impairments at two years of age, with cognitive disability as the most common adverse outcome (Amor et al., 2012; Manktelow et al., 2015). Again, longitudinal surveillance of late-preterm cognitive development indicates the vast majority of children born late-preterm register full-scale IQ scores within normative range by preschool age (Romeo et al., 2016, 2012); yet, late-preterm children have 50% higher odds of receiving special education services (Aylward, 2002; Odd et al., 2012; Voigt et al., 2012).

Late-preterm survivors have higher odds of severe impairment, developmental delay, and presence of an Individualized Education Program (IEP) (Woythaler et al., 2015). "Given the high prevalence of late-preterm births, even small differences in abilities, special education, and length of education may have broader consequences" (Woythaler et al., 2019, p. 58). As such, the NPASC team emphasizes increased screening for special education in this population, stressing 74% of disability is concomitant with preterm birth – compounded by aforementioned

risk of associated morbidities (Phillips et al., 2013). Children born prematurely may manifest coexisting conditions; comorbidity across the preterm spectrum is common – and directly relates to special educational needs; as evidenced through increased odds of receiving special education services (Church et al., 2012; Woythaler et al., 2019; Woythaler et al., 2015). Teachers may struggle to differentiate instruction for students with one disability (Brownell et al., 2010, p. 372); yet, children born late-preterm often have multiple comorbidities which impact school success (Church et al., 2012). Impacts of late-preterm birth on the education system extend to special educators because they must meet the needs of struggling or at-risk students within the inclusive classroom (Brownell et al., 2010). Unpacking the complexity of development is essential for teachers working with the late-preterm population. Accordingly, teachers may need further professional development to understand the nuances of development affecting this population (Johnson et al., 2015).

Researchers have begun to explore impacts of late-preterm birth on cognitive and behavioral outcomes in early childhood, but impacts into adolescence are largely ignored (Lipkind et al., 2012). This lack of scientific exploration into long-term impacts is concerning, as increased behavioral and cognitive gaps may emerge with development – gaps not measured in early-school outcomes; morbidities including attention and behavioral disorders may not surface until later-elementary or adolescence (Harris et al., 2013; Rabie et al., 2015). Additional services, including special education, may be required in childhood, adolescence, or even into adulthood; yet this population may be under-identified and underserved. To counter this under-identification, Adams and colleagues (2013) emphasize a collaborative approach and partnership between the medical, special education, and therapeutic fields – to ensure "individualized, accessible early intervention services" (p. e1073). Successful developmental follow-up includes

a collaborative approach which supports high-risk populations through "monitoring of services provided and outcomes achieved" (p. e1073).

Potential impact of late-preterm birth on academic delays. Preterm and low-birthweight children also have a higher risk of executive function disorder and Attention-Deficit/ Hyperactivity-Disorder (ADHD), than term peers (Amor et al., 2012; Rabie et al., 2015; Sucksdorff et al., 2015), often resulting in less formalized services through a 504 plan. Baron and colleagues reinforced their previous findings supporting "an inverse relationship of neuropsychological deficit with later delivery along the gestational continuum" (Baron et al., 2014, p. 545). In comparing characteristics associated with ADHD manifested in children born late-preterm to their full-term counterparts also diagnosed with ADHD, Amor and colleagues (2012) found clinical outcomes were similar; yet those born late-preterm scored lower in sustained attention on the Continuous Performance Test (CPT) and showed significantly greater symptoms of anxiety. The researchers also found lower comparative concentrations of glutamate in the prefrontal cortex region, which may impact typical brain development.

Further, the National Perinatal Association Steering Committee (NPASC) highlighted, in 2013, increased risk for sensory or speech impairments and increased risk of developmental delay, including psychomotor, cognitive, and school readiness delays. Developmental risk factors include fine and gross motor development delays, and tendencies toward risky behavior. The NPASC (2013) notes increased risk for behavioral disorders in this population, with recommended screening for attention disorders, hyperactivity, internalizing behavior, autism, and schizophrenia.

Impact of late-preterm birth on long-term development

Nearly four million children born late-preterm are currently in U.S. schools – estimates are two students per classroom (Martin et al., 2018). With continuing upward trends in late-preterm births (March of Dimes, 2017), the increasing numbers may have immense impacts on the system, heightening the need for special education follow-up.

Increased risk of disability or comorbidities. Compared with typical peers, persons born late-preterm face increased risk of disability and medical morbidity, including: cognitive, neurodevelopmental, motor developmental delay; altered brain, respiratory, and cardiovascular maturation; attention and executive function disorders; adverse emotional and behavioral outcomes; broad neurological impact and physical morbidity; receptive language, speech, and language delays; and visuospatial disorders (Chan et al., 2014; Chorna et al., 2017). Persons born late-preterm also are at significant risk for long-term comorbidities. As comorbidity is directly related to special educational needs, emerging evidence indicates children born late-preterm have higher odds of receiving special education services, which in-sum impacts academic and lifetime outcomes (Moreira, 2014; Wang et al., 2014)

Proposed longitudinal surveillance by medical professionals

The National Perinatal Association published guidelines for developmental follow-up protocols – spanning across professional disciplines, including education (Phillips et al., 2013). These guidelines emphasize all late-preterm infants are at increased risk for multiple morbidities which impact school outcomes, including neurodevelopmental, behavioral, and adverse health outcomes. Individuals born late-preterm "need a multidisciplinary, personalized and effective follow-up care that begins at birth and continues, with varying degrees of surveillance and reflecting individual needs, throughout the lifespan" (Gallini et al., 2014, p. A26). "There is no

recognized endpoint to long-term follow-up care" (Phillips et al., 2013, p. S17) for the late-preterm population – morbidity can continue through the lifespan. Recommendations for long-term follow-up include: growth; respiratory health; sensory, developmental, behavioral, and maternal screening; family and developmental risk factors; as well as individualized infant and family support. The guidelines emphasize the importance of collaboration between the healthcare team and the family in the education process throughout long-term follow-up care (Phillips et al., 2013).

Inadequate response by academic community to outcomes of students born late-preterm

Raju and colleagues (2006) emphasize the vulnerability of the individual born late-preterm, as "there is no such thing as a normal preterm infant" (p. 1208). Despite clear evidence of the impact of an inverse relationship with later delivery, the PK-12 education community is largely unaware of the late-preterm phenotype, especially as it relates to developmental and school outcomes. Without an understanding of the impact of late-preterm birth, education professionals may struggle to support the summative effect of high incidence outcomes and complex needs of this population (Baron et al., 2012). As a result, "there is limited capacity to identify or prepare the school for these children" (Church et al., 2012, p. 148); if educators are underprepared to support the developmental and academic needs of this growing population (Amor et al., 2012; Church et al., 2012; Johnson et al., 2015), academic underachievement and failure may occur (Baron et al., 2011, 2012; Church et al., 2012).

Purpose of study

While exploration of academic outcomes of individuals born late-preterm in early-childhood has begun, little empirical data exists on outcomes after fifth grade; yet researchers note compounded, disruptive effects of late-preterm birth may not manifest until adolescence

(Amor et al., 2012; Ask et al., 2018; Barros et al., 2011). To capture a snapshot of the late-preterm academic phenotype in adolescence, and to address a research gap in empirical investigation, the researcher in the present study compared disability and mathematics-related eighth-grade age outcomes of those born late-preterm, to those born full-term. Through an analysis of indicator variable measures of disability- and mathematics-related outcomes a comparison occurred within the public-use datafile – Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K).

Research aims

1. Characterize academic-related outcomes in adolescence of children born late-preterm as compared with full-term peers, and as measured by disability-related outcomes.
2. Characterize academic-related outcomes in adolescence of children born late-preterm as compared with full-term peers, and as measured by mathematics-related outcomes.

Definition of terms

Preterm (birth): "American Academy of Pediatrics and the American College of Obstetricians and Gynecologists define a "preterm" infant as one who is born before the end of the 37th week (259th day) of pregnancy, counting from the first day of the last menstrual period" (Raju et al., 2006, p. 1208)

Late-preterm (birth): Formerly 'near-term' in medical lexicon, "infants born between the gestational ages of 34 weeks and 0/7 days through 36 weeks and 6/7 days (239th–259th day)," as defined by National Institute of Child Health and Human Development of the National Institutes of Health a multidisciplinary team, in 2005 (Raju et al., 2006, p. 1208)

Full-term (birth): The March of Dimes (2020) clarifies, "American College of Obstetricians and Gynecologists (also called ACOG) and the Society for Maternal-Fetal

Medicine (also called SMFM) define a full-term pregnancy as a pregnancy that lasts between 39 weeks, 0 days and 40 weeks 6 days." (What is Full-term?, 2020)

ECLS-K database: The Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) "focuses on children's early school experiences beginning with kindergarten and following children through middle school…and provide descriptive information on children's status at entry to school, their transition into school, and their progression through 8th grade." (ECLS-K, 2019, para. 1)

Individualized Education Program: Provided for each public school student who receives special education services: "The IEP creates an opportunity for teachers, parents, school administrators, related services personnel, and students (when appropriate) to work together to improve educational results for children with disabilities" (A Guide to the Individualized Education Program, 2000). Contents of the IEP include current performance; annual goals; special education and related services; participation with nondisabled children; participation in state and district-wide tests; dates and places; transition service needs; needed transition services; age of majority statement; and means of measuring progress.

Disability: "Child with a disability means a child evaluated in accordance with §§300.304 through 300.311 as having an intellectual disability, a hearing impairment (including deafness), a speech or language impairment, a visual impairment (including blindness), a serious emotional disturbance (referred to in this part as "emotional disturbance"), an orthopedic impairment, autism, traumatic brain injury, an other health impairment, a specific learning disability, deaf-blindness, or multiple disabilities, and who, by reason thereof, needs special education and related services." (IDEA, Sec. 300.8, Child with a Disability)

CHAPTER TWO: LITERATURE REVIEW

Late-preterm entered the lexicon in 2005; since then 2,400 empirically-based articles emerged on the care and outcomes of this population. These articles range in topic from immediate post-birth care, risk factors for preterm birth, impact of antenatal steroid use, morbidities corresponding with late-preterm birth, mortality, associated delay, breastfeeding, respiratory impacts, and practitioner protocols; with hundreds dedicated to developmental outcomes.

Overview of empirical response to date

To date, professionals within the medical and public health communities responded with empirical research, primarily at the elementary level (Amor et al., 2012; Baron et al., 2011; Baron et al., 2012; Brumbaugh et al., 2014; Chan & Quigley, 2014; Chyi et al., 2008). Currently, no empirical literature exists on individuals born late-preterm by education professionals, and the literature is scarce to nonexistent in the long-term outcomes and impact for this population beyond early education years (birth to first grade).

Although researchers have cited school-related morbidities and delays as a potential concern, "there are still many questions that remain unanswered" (Woythaler, 2019, p. 58). These questions are specifically void in the literature about long-term impacts of birth between 34-$36^{6/7}$ weeks' gestation, noted in the literature as late-preterm. A recognition in the past decade on the disruptive effects of late-preterm birth exists, yet a significant knowledge gap remains regarding the overall academic impacts of this disruption in full-term development (Boyle, 2018; Gallini et al., 2014; Marlow et al., 2014; Nelson et al., 2018; Raju, 2017; Vohr, 2015; Woythaler, 2019). Within the scope of this literature review, the researcher identifies empirical studies on the academic achievements of individuals born late-preterm. This comprehensive literature

review is an attempt to both identify patterns of potential concerns for education professionals, including special education professionals, for this population beyond the early grades and to help fill the substantial knowledge gap in long-term outcomes for this population, as urged by NIH and APA (Engle, 2006; Raju, 2006). The specific discussion about the impact of late-preterm birth focuses on 1) overall academic outcomes and school readiness, 2) reading achievement and proficiency, 3) mathematics achievement and proficiency, and 4) disability eligibility. A specific focus in this review is the impact of this phenomenon in predicting, for this population in adolescence, difficulties that emerge in mathematics and the potential for eligibility for various types of disabilities.

Literature Review Methodology

Eligibility criteria

For the scope of this literature review, empirical studies are to have a known gestational range which included late-preterm (34-$36^{6/7}$ weeks' gestation) participants, compared with term (> 37 weeks' gestation) peers. School performance assessment occurred at or beyond kindergarten (age five), with no restrictions on study design. Studies including comparison of other gestational ages at birth were permitted, but school performance analysis of late-preterm compared to term peers were included.

Primary outcome for each included study is school or academic achievement or performance, as assessed by a validated instrument (e.g. standardized assessments or scales). Secondary outcomes include measured performance in specific areas of cognition, such as IQ, reading, English Language Arts, mathematics, spatial ability, expressive language, use of special education services, or secondary disability diagnoses.

Information sources

A literature search was conducted of studies published in English from 2008 to 2019. Retrospective studies included students born as early as 1973. Databases used were Medline, CINAHL Plus, PsycINFO, ERIC, Web of Science, and Academic Search Premier. A search of the catalog and multiple databases also was performed. The primary studies and references were reviewed to identify any applicable articles.

Search strategy

The researcher used the following search terms: "Late-preterm" with no field selected, AND "school or kindergarten or grade" in the title, NOT "review" in the title, AND "achievement OR outcome OR attainment OR academic" with no field selected. Again, database results were supplemented by analysis of references from included studies.

Study selection and data extraction

Studies were de-duplicated and assessed by title and abstract; eligibility for inclusion were analyzed to contain search terms stated. Studies were excluded if data collection focus was early-childhood, disability, medical morbidities, SES confounders, brain growth, cognitive outcomes, health outcomes, early intervention, motor ability, hospital care, developmental outcomes, body mass index, or diagnosis-specific clinical manifestations of prematurity.

Designs of included study designs and populations

Regional scope of included studies

Studies included in the search were retrospective population-based cohort designs conducted in the United States, Denmark, and the United Kingdom – also included were Swedish national databases examined by researchers in the United States – representing national (Abel et al., 2017; Chan & Quigley, 2014; Chyi et al., 2008; Quigley et al., 2012; Searle et al., 2017; Shah

et al., 2016; Wiingreen et al., 2018; Woythaler et al., 2015), city-wide (Lipkind et al., 2012), county-wide (Peacock et al., 2012), state-wide (Morse et al., 2009; Williams et al., 2013), and hospital-wide (ElHassan et al., 2018) cohorts. Table 2 provides a summary of the studies included along with the type of study, population, sample size, age of participants, and databases used. The color coding in Table 2 shows the studies clustered by national, county/state, and international. The results are presented as a discussion about each of the 4 color-coded clusters.

Table 2

Comparison of Included Studies, by Country, Scope, Type, Population, N, Age of Participants, Database Examined

Study	Country	Scope	Type	Population	N	Age	Database/s
Chyi et al. 2008	USA	National	Retrospective population-based	1998-1999 K class	970	K, 1st, 3rd, 5th grades	ECLS-K
Woythaler et al. 2015	USA	National	Retrospective population-based	Born 2001	5,850	9mo, 24mo, K (6 years)	ECLS-B
Shah et al. 2016	USA	National	Retrospective population-based	Born 2001	5,250	K	ECLS-B
Morse et al 2009	USA	State-wide Florida	Retrospective population-based	Born 1/1/1996 to 8/31/1997	159,813	pre-K and K	Florida Office of Vital Statistics, Medicaid, NICU data, EIP, FL DOE
Lipkind et al. 2012	USA	City-wide NYC	Retrospective population-based	Born 1994 to 1998	215,138	3rd grade	Longitudinal Study of Early Development data warehouse
Williams et al. 2013	USA	State-wide Georgia	Retrospective population-based	1st grade 2004-2009	314,328	1st grade	Georgia DOE, Georgia birth records
ElHassan et al. 2018	USA	Hospital Arkansas	Retrospective Hospital cohort	Born 1998	1,424	3rd-8th grade	University of Arkansas for Medical Sciences; Arkansas DOE
Quigley et al. 2012	U.K.	National	Retrospective population-based	Born 2000-2001	7,650	Foundational Level (5 years old)	U.K. Millennium Cohort Study
Chan et al. 2014	U.K.	National	Retrospective population-based	Born 2000-2001	6,031	KS1 (7 years old)	U.K. Millennium Cohort Study

Study	Country	Scope	Type	Population	N	Age	Database/s
Peacock et al. 2012	U.K.	County Avon	Retrospective population-based	Born 1991 to 1992	12,823	KS1 (7 years old)	Avon Longitudinal Study of Parents and Children
Searle et al. 2017	Australia	S. Australia	Retrospective population-based	Period 2008-2010	28,155	Grade 3 (~age 8)	Individual National Assessment Program – Literacy and Numeracy
Abel et al. 2017	Sweden	National	Retrospective population-based	Born 1973-1994	2,277,940	16	Swedish Medical Birth Register (MBR); National School Register
Wiingreen et al. 2018	Denmark	National	Retrospective population-based	All students 2015-2016 SY	615,789 409,902	School-age	Danish national registers, linked (reporting data mandatory by law)

Relative age and number of included participants

A summary of all 13 studies included retrospective cohorts of children born between 1973 and 2001; studied at pre-K, kindergarten, 7 years of age, 1st, 3rd, 5th, 8th grades, and secondary school completion (16 years of age). Data were obtained through prescribed longitudinal collections – matching vital statistics, Medicaid, medical records (maternal, neonatal, perinatal), early intervention, Department of Education and standardized testing data. Of the included studies for this literature review, over 700,000 participants were in the United States [green and blue categories in Table 2] (Chyi et al., 2008; ElHassan et al., 2018; Lipkind et al., 2012; Morse et al., 2009; Williams et al., 2013; Woythaler et al., 2015), over 26,000 participants were sampled in the United Kingdom [yellow categories in Table 2] (Chan & Quigley, 2014; Peacock et al., 2012; Quigley et al., 2012), 28,000 in South Australia (Searle et al., 2017), 2 million in Sweden (Abel et al., 2017), and 1 million were sampled in Denmark [white categories in Table 2] (Wiingreen et al., 2018). A portion of each sample were late-preterm, as described in subsequent comparisons. Table 3 provides a comparison of maternal versus child confounding variables, which were considered to impact school outcomes, within included studies of this systematic literature review.

Table 3

Confounding Variables: Maternal vs. Child

Maternal	Child	
Education level	Gender	SES
Age at child's birth	Mode of delivery	Apgar score
Race/ethnicity	Birthweight	NICU admission
Marital status	Gestational age at birth	Absence from school
Drug or alcohol use	Race/ethnicity	Medical morbidities
Intelligence Quotient (IQ)		
Socio-economic status (SES)		

Confounding variables of late-preterm birth

Confounders were considered, within each study, when modeling data to consider relationships and correlations between gestational age and school performance. Maternal confounding variables of preterm birth include education level and age at child's birth, race/ethnicity, marital status, drug or alcohol use, IQ, and SES. Child confounding variables of preterm birth include sex, mode of delivery, birthweight, gestational age at birth, race/ethnicity, SES, Apgar score, NICU admission, absence from school, and medical morbidities.

Inclusions and exclusions of included studies

Select authors chose to limit sample populations to healthy individuals, considering birthweight, length of hospital stays, and absence of multiple births or congenital anomalies (Chyi et al., 2008; ElHassan et al., 2018; Morse et al., 2009; Peacock et al., 2012; Shah et al., 2016; Williams et al., 2013). For example, Williams et al. (2013) included participants born as singletons; birthweight between 400-5000g; gestational age at birth between 24-43 weeks; race was categorized within three categories; and included only those whose records could be linked to the U.S. Department of Education. Woythaler and colleagues (2015) examined participants with gestation at birth >34 weeks, included multiple births, but excluded participants with inadequate assessments or without assessments due to "major congenital anomaly, blindness, or deafness" (p. 425).

In accordance with The American College of Obstetricians and Gynecologists Committee on Obstetric Practice Society for Maternal-Fetal Medicine's Committee Opinion of gestation assignment, to facilitate data reporting in research, the researcher in this study will designate the following categories within term pregnancy: Early term ($37^{0/7}$ weeks' gestation through $38^{6/7}$ weeks' gestation), full-term ($39^{0/7}$ weeks' gestation through $40^{6/7}$ weeks' gestation), late term

($41^{0/7}$ weeks' gestation through $41^{6/7}$ weeks' gestation), and postterm ($42^{0/7}$ weeks' gestation and beyond) ("Definition of term pregnancy," 2013) – although authors included within this literature review may not have followed this recommendation (as described, below in Table 4).

Table 4

Classification of Gestation at Birth, From 34 Weeks' Gestation

Designation	Weeks' Gestation
Late-preterm[1]	$34^{0/7}$ to $36^{6/7}$
Early term[2]	$37^{0/7}$ to $38^{6/7}$
Full-term	$39^{0/7}$ to $40^{6/7}$
Late term	$41^{0/7}$ to $41^{6/7}$
Postterm	$42^{0/7}$ and beyond

[1] Weeks 34-36, in accordance with NIH/PAS recommendation (Raju, 2006a)
[2] Weeks 37 and beyond in accordance with ACOG recommendation ("Definition of term pregnancy," 2013)

Within included studies, populations surveyed were categorized by gestational age at birth, although this categorization was inconsistent; in general, researchers classified late-preterm as $34^{0/7}$-$36^{6/7}$ weeks' gestation and full-term as > 37 weeks' gestation. Others were more specific, designating full-term as 39-41 weeks, early term as 37-38 weeks, late-preterm as 34-36 weeks, moderately preterm as 32-33 weeks, and very/early preterm as <32 weeks (Chan & Quigley, 2014; Quigley et al., 2012). Peacock and colleagues (2012), as well as Searle and colleagues (2017), categorized gestations 32-33 weeks as late-preterm, though the NICHD of the NIH, together with the Pediatric Academic Societies (PAS), proposed uniformity in lexicon: "The workshop panel proposed that infants born between weeks 34 and 36 (d 239 through 259) of gestation ought to be called late-preterm instead near term" (Engle, 2006; Raju, 2006a, 2006b, p.775). Shah et al. (2016) combined moderate and late-preterm into one category while analyzing and reporting data, while Williams et al. (2013) designated 28-33 weeks' gestation as moderate-preterm, with 24-27 weeks' gestation categorized as early-preterm. Abel et al. (2017) and

Wiingreen (2018) and colleagues reported data by weeks' gestation, rather than categorical grouping of multiple gestation clusters.

Systematic literature review based on school outcomes: Summary of study findings

Clusters of four areas of reporting provide a summary of the researchers' findings on the outcomes for children born late-preterm, as noted in the color categories in Table 2. The researcher provides a summary of each of the clusters of studies are presented followed by a summary of the two primary targets of this dissertation research: impact of late-preterm birth on mathematics proficiency and disability or 504 eligibility in adolescence. While the two primary targets include impacts of late-preterm birth on mathematics achievement and disability eligibility, in an effort to gain a greater understanding of the late-preterm phenotype, the researcher reports the outcomes across each cluster of studies. This systematic literature review concludes with a synthesis of the findings across all of these studies related to late-preterm birth across the core categories.

Studies sampling national databases within the United States

Using large nationally representative, population-based probability samples within the United States, researchers in three studies compared school outcomes and readiness in children born late-preterm versus term peers (Chyi et al., 2008; Shah et al., 2016; Woythaler et al., 2015). Two studies examined school readiness at kindergarten age using Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) – comprising nearly six thousand records (Shah et al., 2016; Woythaler, 2015), while a third examined one thousand school records, within Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K), to analyze direct child assessment test scores, teacher academic rating scales, and presence of an IEP or special education in kindergarten, 1st, 3rd, and 5th grades for comparison (Chyi et al., 2008).

National databases, United States Cluster findings on overall school readiness

Woythaler et al. (2015) reported 1.5 times greater adjusted odds of direct cognitive scores in the bottom 5% overall Total School Readiness for children born late-preterm versus term peers. Similarly, Shah (2016) and colleagues found 44% greater adjusted odds of poor school readiness in both mathematics and reading for those born late-preterm. Though Shah et al. (2016) noted pairwise comparisons, demonstrated differences were not significant.

National databases, United States: Cluster findings on mathematics proficiency

When comparing children born late-preterm in kindergarten, 1st, 3rd, and 5th grades, Chyi et al. (2008) reported greatest risk of poor mathematics outcomes in kindergarten (15% greater risk) and first (22% greater risk) grades. Teachers rated those born late-preterm most at risk in kindergarten (25% greater risk), though direct mathematics t-scores demonstrated less risk than teachers anticipated. Woythaler et al. (2015) agreed, students born late-preterm had statistically significantly lower mean scores in all subscales of Total School Readiness, including mathematics – though adjusted odds showed only slightly greater risk of scoring in the bottom 5%.

National databases, United States: Cluster findings on reading proficiency

Those born late-preterm showed statistically significantly lower mean Total School Readiness scores in the areas of reading and expressive language – with 1.7 times greater adjusted odds of direct cognitive scores in the bottom 5% for reading (Woythaler, 2015). Chyi et al. (2008) found teachers rated students born late-preterm as being at risk of poor reading outcomes consistently at 30% greater risk than full-term peers. Student achievement on direct reading T-scores did not reflect these judgments, students born late-preterm demonstrated

greatest risk in 1st grade of poor reading outcomes (24% greater risk), but performed almost on par with term peers in 3rd and 5th grades for reading.

National databases, United States: Cluster findings on disability

Within the ECLS-K database, students in kindergarten and first grades demonstrated greater odds, 38% and 44% respectively, of having an IEP, compared with full-term peers. Kindergarten students born late-preterm were two times more likely to be enrolled in special education. Results reported in first (44% greater odds), third (22% greater odds), and fifth (28% greater odds) grades also reflected greater odds of special education enrollment, with greater odds plateauing in the 20th percentile in third grade.

Studies sampling within individual states, city, and hospital within the United States

Included in the next cluster of studies are investigations spanning state-wide (Morse et al., 2009; ElHassan et al, 2018), city-wide (Lipkind et al., 2012), and hospital-wide (ElHassan et al., 2018) samples in the United States. Correlations were examined between late-preterm birth and outcomes of: developmental delay or disability, pre-K program for children with disabilities at age three, pre-K program for children with disabilities at age five, designation “not ready to start school” at start of kindergarten, exceptional education, suspension, and retention (Morse et al., 2009); first-grade state-wide standardized test failure in Math, Reading, and ELA (Williams et al., 2013); Grades 3 through 8 scores and levels of proficiency from annual state-mandated examinations in literacy and mathematics (ElHassan et al., 2018) and; standardized test scores from mandatory third-grade assessments in ELA and mathematics, as well as the presence of an IEP (Lipkind et al., 2012).

Regional databases, United States: Cluster findings on school readiness

Morse and colleagues (2009) found only 4% greater adjusted relative risk of poor school readiness in four-year-old children born late-preterm than term peers; yet, by age five, students born late-preterm faced 19% greater adjusted risk of suspension, and 11% greater risk of retention.

Regional databases, United States: Cluster findings on mathematics achievement

ElHassan and colleagues (2018) found Arkansas students born late-preterm, in Grades 3 through 8, had overall lower mean achievement test scores at every grade level, as compared with full-term peers. Williams et al. (2013) similarly found students in first grade, born late-preterm, had 17% greater odds of mathematics failure on Georgia's Criterion-Referenced Competency Test (CRCT). The findings of Lipkind et al. (2012) also found mathematics achievement on standardized assessment for those born late-preterm below full-term peers, with 6.7% of SD lower adjusted mathematics scores.

Regional databases, United States: Cluster findings on reading achievement

In Grade 1, students born late-preterm were found to have greater odds (13%) of failure on the reading and writing (15% greater odds) components of Georgia's statewide standardized test (Williams et al., 2013). Students in Arkansas, born late-preterm in Grades 3 through 8, were found to have lower mean achievement test scores and lower percent literacy proficiency at every grade-level, than full-term peers (ElHassan et al., 2018). While third graders, in New York City, born late-preterm, had 4.0% of SD lower adjusted ELA scores than full-term peers (Lipkind et al., 2012).

Regional databases, United States: Cluster findings on disability

Children born late-preterm were found to have 36% greater risk of developmental delay or disability, in Florida – from birth to three (Morse et al., 2009). Similarly, students born late-preterm, in New York City, were found to have 34% higher adjusted odds of special education enrollment, compared with full-term peers (Lipkind et al., 2012). While preK students born late-preterm at age five in Florida, faced only 10% greater adjusted risk of having a disability or enrollment in exceptional student education (Morse et al., 2009).

Studies sampling databases within the United Kingdom

The third cluster of studies includes sampling within the United Kingdom, measuring statutory assessment outcomes of students at ages 5 and 7. Included investigations are two studies (Quigley et al., 2012; Chan et al., 2014) examining data extracted from the U.K. Millennium Cohort Study – a nationally representative sample – and a third county-wide sample (Peacock et al., 2012) spanning a longitudinal analysis of parents and children. Correlations were surveyed between late-preterm birth and outcomes of five- and seven-year-old children on statutory end-of-school year assessments. Researchers within these studies sought to measure outcomes of achievement in reading, writing, mathematics (Chan et al., 2014; Peacock et al., 2012), in addition to communication, physical, creative, social, and emotional development (Quigley et al., 2012).

National/regional databases, United Kingdom: Cluster findings on school readiness

At age five, 25% of students born late-preterm were "not working securely in the 'knowledge and understanding of the world" – with a 30% adjusted relative risk of scoring within this scale (Quigley et al., 2012, p. F171). Further, 13.6% of students born late-preterm were "not working securely in the 'physical development' scale, compared with 9.7% of their

term peers – representing a 27% adjusted relative risk (Quigley et al., 2012). Overall, students born late-preterm, at age five, faced 12% greater relative risk of 'not good level of overall achievement' (Quigley et al., 2012, p. F171), and by age seven, faced 36% greater relative risk of not achieving expected levels in reading, writing, and mathematics – combined (Chan et al., 2014).

National/regional databases, United Kingdom: Cluster findings on mathematics achievement

Students born late-preterm, in the United Kingdom, when measured at age five, demonstrated 16% greater adjusted relative risk of not being proficient in three scales of mathematical development (Quigley et al., 2012); while by age seven, students born late-preterm were measured as having only 3% greater relative risk of poor mathematics outcomes than full-term peers (Chan et al., 2014). Although, the proportion successful on the mathematics section of standardized assessment was seven points below term peers (Peacock et al., 2012).

National/regional databases, United Kingdom: Cluster findings on reading achievement

Students born late-preterm, at age five, were found to have 11% greater relative risk of not working securely in all four scales of communication, language, and literacy (Quigley et al., 2012). By age seven, students born late-preterm were at 55% and 35% greater relative risk of not achieving expected levels in reading or writing, respectively, than term peers (Chan et al., 2014; Peacock et al., 2012)).

National/regional databases, United Kingdom: Cluster findings on disability

At age five, nearly 30% of students born late-preterm were not working securely in all three scales of personal, social, and emotional development, compared with 25% of term peers – a 14% adjusted greater relative risk for students born late-preterm (Quigley et al., 2012). While, Chan and colleagues (2014) found 36% greater relative risk of not achieving at grade level for

speaking and listening outcomes for seven-year-old children born late-preterm, compared with term peers.

Studies sampling databases outside the United States or United Kingdom

The fourth cluster of studies includes sampling outside the United States or United Kingdom – examining data extracted and analyzed from national assessments in Australia (Searle et al., 2017), together with National School Registers in Sweden (Abel et al., 2017) and Denmark (Wiingreen et al., 2018). Correlations were examined between late-preterm birth and outcomes of: risk of being at or below national minimum standard, compared with term (Searle et al., 2017); final grade achieved upon secondary education completion at age 16 (Abel et al., 2017); failing to complete compulsory school after 10 years of education; and finally, special education support registration (Wiingreen et al., 2018). Note: Wiingreen et al. utilized an unconventional categorization of late-preterm gestation – extending late-preterm to 32 weeks', rather than a minimum of 34 weeks' gestation. The authors attempted to justify their position, arguing many infants born at 32 weeks' gestation do not require major medical intervention (Wiingreen et al., 2018) – although many in the medical field may disagree (Raju et al., 2006).

Databases outside the United States or United Kingdom: Cluster findings on school readiness

Wiingreen et al. (2018) measured school difficulties for Danish students using two measures, one of which was the risk of failing to complete compulsory school, after 10 years of education. Multivariate analysis odds ratios indicated students born at 32 to 34 weeks' gestation had 31% greater odds of failing to complete compulsory school after 10 years of education, while the odds were 26% greater for students born at 35 to 36 weeks' gestation – compared with term peers. Abel et al. (2017) found final grade average achieved on completing secondary

education at 16, for Swedish children born late-preterm, expected approximately -0.10 SD change versus term peers.

Databases outside the United States or United Kingdom: Cluster findings on mathematics achievement

Within this cluster, only Searle et al. (2017) reported on mathematics achievement, reporting South Australian students born late-preterm, in Grade 3, faced 12% greater adjusted relative risk of being at or below national minimum standard in numeracy domains on national assessments.

Databases outside the United States or United Kingdom: Cluster findings on reading achievement

Again, only Searle et al. (2017), within this cluster, reported on reading outcomes. The authors found reading achievement among South Australian Grade 3 students, born late-preterm, at greater adjusted risk for scoring at or below national minimum standard, as compared with term peers. Risks included increased: aRR 18% in Reading; aRR 11% in Writing; aRR 16% in Spelling, and; aRR 16% in Grammar /punctuation.

Databases outside the United States or United Kingdom: Cluster findings on disability

Multivariate analysis odds ratios for provision of special educational support for school-age children in Denmark, showed 73% greater odds ratio for students born 32-34 weeks' gestation, compared with term peers; while, students born at 35-36 weeks' gestation showed 40% greater odds ratios (Wiingreen et al., 2018).

Summary and response to impact of late-preterm birth on outcomes

Summary of impact of late-preterm birth on mathematics outcomes

Of the thirteen included studies in this systematic literature review, comprising all studies which investigated school outcomes of individuals born late-preterm, ten included examination of outcomes in mathematics. Although one research team found a decreasing significant difference from term peers as students progressed in grade levels (Chyi et al., 2008), others found sustained risk of lower mathematics achievement for students born late-preterm through elementary school (ElHassan et al., 2018; Searle et al., 2017). All included authors found increased risk, for those born late-preterm, of lower mathematics proficiency across the early grades (Chan & Quigley, 2014; Lipkind et al., 2012; Peacock et al., 2012; Quigley et al., 2012; Williams et al., 2013). To date, no authors looked directly at mathematics outcomes beyond eighth grade, which is often tied to graduation rates – this remains a significant knowledge gap in the literature.

Summary of impact of late-preterm birth on disability

A dearth of empirical research on the impact of late-preterm birth on disability exists. From 2014 to 2019, two studies directly examined incidence of intellectual disability, without genetic cause, in individuals born preterm. Authors found increased risk of ID with preterm birth, with greater or lesser risk dependent on mode of delivery and size and/or gestation at birth (Heuvelman et al., 2018; Hirvonen et al., 2017; Hirvonen et al., 2014, 2018). One report provided by Darcy-Mahoney et al. (2016) delineates estimates of risk of late-preterm birth with autism diagnoses – citing increased risk with early-preterm birth. The authors cite increased probability of an autism diagnosis, but no statistically significant relative risk, for those born late-preterm (Darcy-Mahoney et al., 2016).

Evidence of an emerging need

In a U.K. national survey by Johnson and colleagues (2015), educational professionals, including teachers and educational psychologists, were assessed on knowledge of preterm birth and its outcomes. Results indicated education professionals are ill-prepared to respond to the academic needs of the late-preterm child. Only 16% of teachers were knowledgeable about preterm outcomes, and over 90% requested further preparation. "As teachers have primary responsibility for providing long-term support for children born preterm, this is of significant public health and educational concern" (Johnson et al., 2015, p. 1). Developmental follow-up protocols may need to evolve, as studies increasingly reveal association of developmental delay, poor school performance, and lower achievement levels with late-preterm birth (Chyi et al., 2008).

Call for an appropriate response

The emerging phenotype of late-preterm survivors is complex. Gestational age appears to have dose-response across the preterm spectrum; for the preterm survivor, missing the last few weeks in-utero can have life-long impacts. Chyi et al. (2008) suggest "if brain maturation plays a role in school outcomes, then expect a gradient of outcome on the basis of degree of prematurity" (p. 30). Across all thirteen studies and five nations, authors reported increased risk for lower school achievement, decreased mathematics and reading outcomes, increased special education and disability need, and lower school readiness and/or success, for students born late-preterm in elementary school. While school readiness and literacy are reported areas of need, the current emphasis to prepare students for success in STEM-related fields necessitates an urgent response and further investigation into the long-term effects of late-preterm birth on mathematics outcomes. The National Center for Education Statistics – Institute of Education Sciences

maintains: Success in eighth-grade mathematics sets up a sequence which leads to a "greater likelihood of entering a 4-year college or university;" and "may be integral to preparing students for success in college and the labor force, including careers in competitive mathematics- and science-related disciplines" (Walston & McCarroll, 2010, p. 1). On the reverse, struggle to succeed and a lack of intervention for the struggling, perhaps unidentified student with a disability, increases risk of secondary education failure, as was reported by Abel et al. (2017) and Wiingreen et al. (2018) in students born late-preterm. Further investigation into middle and high school outcomes for students born late-preterm is warranted, and the near lack of literature on this population hastens an empirical reply.

Researchers have reported increasing rates of late-preterm birth (Raju, 2006). Further, the included studies indicate an increased risk of needing special education services in children born late-preterm, so the education community should anticipate an increased projected rate of corresponding students who are eligible for disability services. By anticipating future need, educators can ready future supports, in line with IDEA recommendations (Lipkin, Okamoto, & Council Children Disabilities, 2015). Finally, the findings from this literature review indicate the late-preterm population is at higher risk for adverse school outcomes in Grades K through five. While causal relationships are not firmly established, specialists consider development of the fetus as a vulnerable continuum; preterm birth is a disruption which carries critical consequences (Darlow & Cheong, 2019). As fetal growth follows a continuum, analysis of each successive gestational age-group should be reported separately, to ensure accuracy and proper response to needs (Baron et al., 2012). As such, and in sum, the researcher in this investigation seeks to respond by investigating and reporting on an age-group largely ignored within the late-preterm school-outcomes literature: the adolescent.

CHAPTER THREE: METHODOLOGY

Methodology: A rationale based on childhood development continuum

Research gap

As fetal development is a vulnerable continuum, outcome analysis of the late-preterm population within each developmental stage needs further documentation and investigation (Baron et al., 2012). Multiple researchers have investigated early-school outcomes of children born late-preterm (Chan & Quigley, 2014; Chyi et al., 2008; ElHassan et al., 2018; Lipkind et al., 2012; Morse et al., 2009; Peacock et al., 2012; Quigley et al., 2012; Searle et al., 2017; Shah et al., 2016; Williams et al., 2013; Woythaler, 2019). Despite research at the early-childhood and elementary stages of life, a dearth of empirical data exists on the relationship between late-preterm birth and outcomes for adolescent-aged individuals. The researcher for the present study found only two studies investigating outcomes past Grade 5 (Abel et al., 2017; Wiingreen et al., 2018). In response to this gap, the present research study presents an investigation of school-related outcomes for a large sample population in adolescent-age; the researcher examined students born late-preterm with a focus on mathematics and special education services.

General causation: A conceptual framework

The conceptual framework central to this study is general causation, as described by Rizzi and Pedersen (1992). The authors argue, when exploring impacts of medical events, causal factors emerge from a general model – rather than from singular causation. Rizzi and Pedersen maintain: “When seeking to establish a general cause-effect relation in the scientific situation, the possibility tree has innumerable variables. Any odd factor can be chosen and proposed in a causal link hypothesis, which subsequently can be validated experimentally” (Rizzi & Pedersen, 1992, p. 240). This need for a general model is certainly true in the experience of individuals

born late-preterm; the researcher should consider this when attempting to assign causation or even correlation. A single event (such as birth, itself) cannot define the impacts on development from late-preterm birth. Rather, the impacts of late-preterm birth comprise a chain of events, often disparate in nature, which impact the growth of the individual. Compounding these complexities are innumerable confounding variables affecting school outcomes, including many impacts on childhood development (Church et al., 2012).

A cause for comparison: Potential delays in disability manifestation

Children exposed prematurely to the extrauterine environment often fall outside typical development echelons, and developmental deficits, resulting from late-preterm birth, collectively impact academic performance (Church et al., 2012; Johnson et al., 2015), with each developmental stage presenting unique morbidities; early childhood may evince speech delay, while adolescence may reveal broader attention-related impacts (Harris et al., 2013; Rabie et al., 2015). Those born late-preterm are at risk for specific mathematical and reading deficiencies, compounded by aforementioned developmental morbidities (Brumbaugh et al., 2016; Kelly et al., 2016; Rogers et al., 2014). Morbidities may manifest later in development; presence of an IEP may not show in early-school records, but may be necessary in later school years. As such, measures of school-related outcomes provide the framework for analyses, to identify potential impact of late-preterm birth in adolescence.

Further, as "central to childhood development is the concept that it is a fluid process" each developmental stage may present unique morbidities (Church et al., 2012, p. 143). Thus, the researcher also descriptively compared disability-related, adolescent-aged outcomes with those measured for the collective sample in kindergarten, first, third, and fifth grades, in an effort to distinguish potential differences in morbidity manifestation, based on stages of development.

Church and colleagues (2012) describe the complexity of investigating children born preterm, in the school setting,

> while the preterm survivor may have average overall abilities on composite developmental assessments…deficits may not be pervasive enough to warrant a disorder or delay designation but may be either environmentally provoked problems or occur within a cluster of challenges that synergistically create impairment. (p. 145)

By comparing early-school disability-related outcomes with those in adolescence, the researcher's intent is to contribute to the field a greater understanding of the late-preterm phenotype through stages of development in special education and eighth-grade mathematics.

Two aims within the present study

1. Characterize school-related outcomes in adolescence of children born late-preterm as compared with full-term peers, and as measured by disability-related outcomes.
2. Characterize school-related outcomes in adolescence of children born late-preterm as compared with full-term peers, and as measured by mathematics-related outcomes.

Study design and sample description

Using a large cohort sample, the researcher performed an exploratory, retrospective quantitative analysis of school outcomes, to examine potential impacts of late-preterm birth on academic achievement in adolescence. The researcher extracted data from the United States Department of Education (USDOE) public-use datafile, Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), to analyze available measures of disability- and mathematics-related school outcomes and provide a snapshot of academic characteristics of adolescents born late-preterm, within the present sample.

Exposition of database

ECLS-K background

ECLS-K is the earliest of three cohort-prospective ECLS longitudinal datasets; ECLS-B follows a cohort from birth, while ECLS-K:2011 follows Kindergarten Class of 2011 cohort through fifth grade. ECLS-K, managed by the National Center for Education Statistics (NCES), was fashioned in response to a dearth in empirical research into early childhood educational outcomes (West, 2017). It was the "first study to follow a nationally representative sample of children attending kindergarten in the United States through early school years (kindergarten through Grade 5)" (West, 2017, p.1). Participants were followed in Grades K, 1, 3, 5, and 8 (or age equivalent).

Field management system (FMS) personnel selected participants in accordance with a nationally representative sample: from both public and private school settings; entering K at age five; entering K for the first time; and from diverse, representative demographics. A sample of N = 22,782 participants, in 1,277 kindergarten programs, provided a nationally representative kindergarten cohort. With subsequent survey years, due to cost restrictions, a random 50% of transitioned (movers) participants continued: 18,080 children surveyed in first-grade; 16,670 children surveyed in third-grade; 12,030 children surveyed in fifth-grade; and 11,930 (n = 9,480, public; n = 2450, private) children surveyed in eighth-grade. The samples are representative at the school, teacher, and child level in base year; in successive years, data are representative only at child level. In eighth grade year, analyses are representative only to the sample, due to participant attrition, mortality, and non-selection due to mobility.

ECLS-K data collection item type

Included in the database are outcomes on birth status; transition to nonparental care; early childhood care and programming; family and community experiences; child development; school performance; parent and teacher surveys; and direct child assessments, including participant-response surveys. Data were obtained by ECLS-K field management system personnel through a variety of means, including general education teacher, teacher-level questionnaires; general education teacher, child-level questionnaires; reading/English, mathematics, and science teacher, child-level questionnaires; special education teacher, teacher-level questionnaire; special education teacher, child-level questionnaire; direct child assessment; data field management system reporting throughout all grades; Head Start data from parent interview and directly from Head Start; school facility checklists; school-provided student record abstracts; and parent interviews. Table 5 provides a summary of ECLS-K data collection items; bold typeface indicates collection items used within present study.

Table 5

ECLS-K Data Collection Item by Type

Collection item by type	Collection Round, Grade
General education teacher questionnaire A, teacher-level	Fall, K; Spring, K, 1, 3
General education teacher questionnaire B, teacher-level	Fall, K; Spring, K, 1, 3
General education teacher questionnaire C, child-level	Fall, K; Spring, K, 1, 3
Special education teacher questionnaire A, teacher-level[b]	Spring, K, 1, 3, 5, 8
Special education teacher questionnaire B, child-level[b]	Spring, K, 1, 3, 5, 8
Reading/English teacher questionnaire, child-level	Spring 5, 8
Science teacher questionnaire, child-level	Spring 5, 8
Mathematics teacher questionnaire, child-level[a]	**Spring** 5, **8**
School administrator questionnaire, administrator-level	Spring, K, 1, 3, 5, 8
School facility checklist	Spring, K, 1, 3, 5
Student record abstract[a]	**Spring, K, 1, 3, 5**
Head-Start	Fall, K
Parent Interview[a]	**Fall, K, 1; Spring, K, 1, 3, 5, 8**
Direct child assessment[a]	Fall, K, 1; Spring, K, 1, 3, 5, **8**

[a] Data from denoted collection type analyzed within present study, bolded

[b] All data from special education teacher questionnaires suppressed for public-use data-file

Modifications to data collection in Round 7

The eighth-grade age sample of ECLS-K included participants sampled in (at least) the base or first-grade year (ECLS-K personnel refreshed participants in first grade). Noted modifications to data collection in eighth-grade age (Round 7) collection include: surveying parents on transition-related topics, family activities, and report of school suspension; parent satisfaction with child's education; parent and participant report of child internalization and externalization of behaviors and feelings; assessment of participants in proctored settings, rather than one-on-one, as in earlier collection rounds; two-level (high versus low) assessment forms, deviating from three-level forms used in previous rounds; changes to child self-description questionnaires, including age-appropriate rating items; completion of direct child assessments in group assessment sessions; and replacement of general education teacher questionnaires with

domain-specific academic rating scales for teachers of math, science, and reading/English domains. In eighth-grade collection year, of note to the present study, "half of the children were selected to have a child-level questionnaire filled out by their mathematics teachers and the other half were selected to have a child-level questionnaire filled out by their science teachers" (NCES Handbook of Survey Methods, ECLS-K Survey Design, p. 2).

Impact of ECLS-K data suppression on current study

The NCES, in preparing public-use datafiles, de-identified participant, family, school, teacher, and administrator data, including disability-related, school-specific, and demographic data. NCES suppressed all data obtained from special education teachers, for publication within public-use datafile. Therefore, significant portions of special education-related data, although available in restricted datafiles, are suppressed or masked in the public-use file. Round 7, eighth-grade age, saw discontinued collection of school record abstracts, which included report of IEP.

For the present study, the researcher used public-use data to present an initial snapshot of academic outcomes for the included sample; special-education-related data extraction was limited to portions of parent report of evaluation and diagnosis of disability-related outcomes for Grades K, 1, 3, 5, and 8; school report of IEP in Grades K, 1, 3, and 5 (suppressed in Grade 8); and field management system personnel report of provided special education services for Grades K, 1, 3, 5, and 8. In addition, NCES personnel suppressed parent report of specific disabilities, to protect participant identities, in public-use datafile. While parents identified specific disabilities within the interview, data suppression in public-use datafile prevented the researcher in the present study from analyzing specific categories of disability.

Descriptive demographic statistics of sample

Study cohort

The included study sample consists of children born full-term (FT) and late-preterm (LPT), who entered kindergarten at age five, school-year (SY)1998-1999. Participants (N = 5764; n = 5434 FT, n = 330 LPT) included in the present study were active in kindergarten or first-grade, as well as Grade 8 of ECLS-K data collection. School outcomes of examined participants include disability-related outcome data from Grades K, 1, 3, 5, and 8, and mathematics-related outcome data collected in Grade 8, SY2006-2007. Table 6 provides a summary of participant demographic characteristics.

Exposure

The study analysis compared late-preterm individuals with full-term peers: n = 330 participants born late-preterm (34-$36^{6/7}$ weeks' gestation), within range weight (neither small nor large for gestational age); and n = 5434 participants born full-term (39-$40^{6/7}$ weeks' gestation), within range weight (neither small nor large for gestational age). The researcher used a categorical measure of gestational age at birth for participants, in line with NIH recommendations for assignment. The researcher defined gestational age in days for statistical analyses. In addition, the researcher screened the original dataset for participants born within range weight, neither large nor small for gestational age, according to revised weight recommendations by American College of Obstetricians and Gynecologists (Duryea et al., 2014).

Exclusion criteria of study sample

Excluded from the present study's sample were participants with partial or missing data on gestational age or weight at birth. Specifically, the researcher excluded ECLS-K participants whose data were not active in eighth-grade age collection; with missing, conflicting, or partial

data for parent report of weight at birth; and/or with missing, conflicting, or partial data for parent report of gestational age at birth. Also excluded from study sample are participants born large for gestational age (>90th percentile) or small for gestational age (<10th percentile), as children not born within range weight for gestation are increasingly at risk for adverse medical (and potentially, school) outcomes (Duryea et al., 2014; Nicolaides et al., 2018).

Gender and race

Binary gender characteristics are evenly distributed throughout the entire sample; however, for the present sample, gender presents a statistically significant association with late-preterm birth, with trend toward male gender in participants born late-preterm, $\chi 2(1) = 12.13$, $p = .000$; $\varphi = 0.046$. ECLS-K questionnaires offered only a binary option for parents, when choosing child gender. Race did not present associations with birth at late-preterm compared with full-term ($\chi 2(1) = 5.43$, $p = .608$), with distributions similar between those participants born late-preterm with full-term. Although, those born late-preterm did present in slightly greater percentages in both White (FT, 64%; LPT, 68%) and Black race categories (FT, 9%; LPT, 10%).

Multiple birth status

Multiple birth status is well-documented in literature for its association with preterm birth. Participants within the present study follow this trend; Likelihood Ratio (4 cells have expected count less than 5) of ($\chi 2(3) = 99.38$, $p = .000$), with 11% of those born late-preterm presenting with multiple birth status, compared with 1% of those born full-term. Grade level distribution at eighth-grade age was not statistically significantly associated with late-preterm birth, as compared with full-term; Likelihood Ratio (8 cells had expected count less than 5) of $\chi 2(6) = 3.74$, $p = .712$.

Grade level in Round 7

Finally, ECLS-K personnel completed Round 7 of data collection in SY2006-2007, primarily in spring. Participants entered kindergarten in SY1998-1999 at age five, and following typical school progression, would have presented in eighth-grade for the final round (7) of data collection. However, 1% of students in both late-preterm and full-term categories reported grade level as sixth; 9% of full-term and 11% of late-preterm reported grade level as seventh; 90% of full-term and 88% of late-preterm reported Grade 8. There were very small, similar percentile, reports of students in both full-term and late-preterm categories who reported ninth grade as current in SY2006-2007.

Table 6

Demographic Characteristics of ECLS-K Sample, Round 7 Collection[1]

	Full-term		Late-preterm	
Indicator variable	*%*	*N*	*%*	*N*
Gender*				
Male	49	2658	59	194
Female	51	2776	41	136
Race				
White, non-Hispanic	64	3470	68	223
Black, African American, non-Hispanic	9	485	10	32
Hispanic, race specified	8	460	7	22
Hispanic, race not specified	8	452	8	25
Asian	5	250	4	12
Native Hawaiian, other Pacific Islander	1	63	0	1
American Indian or Alaska Native	2	111	2	8
More than one race, non-Hispanic	3	139	2	7
Multiple Births*				
Fraternal Twin	1	35	6	17
Identical Twin	0	11	3	9
Higher Multiple	0	0	2	5
Single Birth	99	5382	89	258
Grade Level				
Fourth grade	0	1	0	0
Fifth grade	0	3	0	0
Sixth grade	1	39	1	4
Seventh grade	9	462	11	36
Eighth grade	90	4910	88	289
Ninth grade	0	17	0	1
Ungraded classroom	0	2	0	0

*statistically significantly associated with late-preterm birth, $p = <.05$

[1] Eighth-grade age participants born late-preterm or full-term, within range weight, $N = 5764$

Socioeconomic indicators of study sample

Table 7 a provides summary of current study participants' socioeconomic status (SES) indicators. ECLS-K data management system personnel collected indicators of family structure and status by parent report, and included: parent involvement; family structure; home environment, activities, and cognitive stimulation; parent level of schooling; critical family processes; discipline, warmth and emotional supportiveness; non-resident parent questions; primary language; child health and well-being; parent psychological well-being and health; parent education; parent employment; welfare and other public transfers; food security; parent income and assets; and child mobility. For this study, four indicators were included: food security status, categorical and continuous SES measures (configured and imputed by NCES), poverty level, and mother's education level.

Food security and SES status. Similar distributions for food security status presented between late-preterm and full-term groups, each with 93% of participants identifying as food secure. For categorical SES measure, full-term participants (First Quintile, 14%; Second Quintile, 19%) presented slightly greater than those born late-preterm (First Quintile, 11%; Second Quintile, 15%), although there was no statistically significant association existed between categorical ($\chi2(4) = 6.49$, $p = .165$) or continuous ($r_{pb} = .019$, $p = .197$) SES measures and late-preterm versus full-term birth.

Poverty level and mother's education level. Distributions of at-or-above poverty threshold were not even between late-preterm (90%) and full-term (86%) groups. While those born late-preterm presented at-or-above poverty level in greater proportions, poverty level was not statistically significantly associated with late-preterm birth, $\chi2(1) = 3.58$, $p = .058$. Associated, those born late-preterm had greater percentages of mothers with at least some

college education (FT, 64%; LPT, 70%); although overall, mother's education level was not statistically significantly associated with late-preterm birth ($\chi 2(8) = 13.43$, $p = .098$).

Table 7

Socio-economic Status (SES) of ECLS-K Sample[1], Eighth-Grade

	Full-term		Late-preterm	
Indicator variable	*%*	*N*	*%*	*N*
Food security status				
Food secure	93	4494	93	276
Food insecure without hunger	5	243	4	12
Food insecure with hunger	2	116	3	9
Categorical SES measure				
First Quintile	14	682	11	34
Second Quintile	19	950	15	47
Third Quintile	20	1009	21	66
Fourth Quintile	22	1070	23	70
Fifth Quintile	25	1245	30	91
Poverty level				
Below poverty threshold	14	688	10	31
At or above poverty threshold	86	4268	90	277
Mother's education level				
8th grade or below	3	164	2	6
9th - 12th grade	5	227	6	18
High school diploma/equivalent	23	1107	17	51
Vocational/tech program	5	264	5	16
Some college	30	1447	37	112
Bachelor's degree	20	973	21	63
Graduate/professional school-no degree	3	167	2	7
Master's degree (MA, MS)	8	367	7	21
Doctorate or professional degree	3	140	3	8

[1] Eighth-grade age participants born late-preterm or full-term, within range weight, N = 5764

Measurement and analyses descriptions

Research objective and questions

The primary objective of the present study was to identify the impact of challenges, potentially associated with late-preterm birth, on outcomes in two primary areas related to academics (disability and mathematics achievement). Using ECLS-K public-use datafile, the researcher analyzed measures of participant school outcomes, to piece together an academic phenotype, in adolescence, for this sample, as compared with full-term peers. Each measure of school outcomes correlated with related indicators; each indicator had corresponding ECLS-K variables included in analyses. The following research questions guided data analyses:

Research Question 1

To what extent does late-preterm birth impact disability-related school outcomes of adolescents born as late-preterm infants, compared with full-term peers, as measured and indicated by:

1. Measure of disability: Presence of special education services
    a. Indicator: School report of IEP
    b. Indicator: Field management report of provided special education services
2. Measure of disability: Presence of learning disability or other disability
    a. Indicator: Parent report of child with disability
    b. Indicator: Parent report of concerns, evaluations, or diagnoses
3. Measure of disability: Presence of increased behavioral or attention needs
    a. Indicator: Parent report of concerns, evaluations, or diagnoses

Table 8 provides an overview of measures investigated, with noted corresponding ECLS-K indicator variables, related to disability.

Table 8

Measures of Disability-Related Academic Outcomes

Outcome measure
Presence of special education services
School report of IEP[1]
Field management system report of provided special education services[2]
Presence of learning disability or other disability
Parent report of child with disability[3]
Parent report of concerns, evaluations, or diagnoses[4]
Presence of increased behavioral or attention needs
Parent report of concerns, evaluations, or diagnoses[5]

1 School record abstract: U2RIEP, U4RIEP, U5RIEP, U6RIEP

2 Field management system report: F2SPECS, F4SPECS, F5SPECS, F6SPECS, F7SPECS

3 Parent interview: P1DISABL, P4DISABL, P5DISABL, P6DISABL, P7DISABL

4 Parent interview: P7EVALUA, P7DIAGNO, P7COMMUN, P7COMMU2, P7DIFFHR, P7DIFFH2, P7SIGHT, P7ASTHMA, P7ASTTRT

5 Parent interview: P7INDTHR, P7FAMTH, P7CONBEH, P7EVBEH, P7CONEMO, P7EVEMO, P7BEHAVE, P7WELBHV, P7ATTENI, P7DSTRCT, P7SUSPND

To reiterate, an investigation of disability-related outcomes transpired at three levels of measure: presence of special education services; presence of learning disability or other disability; and presence of increased behavioral or attention needs.

The first measure of disability-related school outcomes was presence of special education services, as reported by school, parent, and field management system personnel. The researcher considered data across all grades available in ECLS-K public-use datafile, to provide a descriptive measure of trend for participants, in disability-related outcomes. School report of an IEP, obtained from school record abstracts, and collected in Grades K, 1, 3, and 5, provided the first indicator within this measure. As a study limitation, field management personnel did not collect school record abstracts in Round 7 (eighth-grade age), so presence of an IEP was not reported in public-use eighth-grade datafile (although IEP report is included in eighth-grade restricted datafiles, through special education teacher report). The second indicator of presence

of special education services was field management system personnel report of provided special education services for a participant. Data were available for field management system reports in all rounds of data collection – Grades K, 1, 3, 5, and 8.

The second measure of disability-related school outcomes was presence of learning disability or other disability. The indicators within this measure were parent report of a child with a disability and parent report of concerns, evaluations, or diagnoses related to learning or other disabilities. Variables considered for this indicator included parent report of participant evaluations or diagnoses in the areas of learning, speech, or hearing. In addition, the researcher considered a variable related to parent report of vision ability.

The third measure of disability-related school outcomes was presence of increased behavioral or attention needs. Indicators of increased need included parent report of participant or family therapy related to behavioral or attention needs, as well as concerns and/or evaluation of attention, behavioral or emotional behavioral needs. Also included in the measure of presence of increased behavioral or attention needs was parent report of school suspension.

Research Question 2

To what extent does late-preterm birth impact mathematics outcomes of adolescents born as late-preterm infants, compared with full-term peers, as measured and indicated by:

1. Measure of mathematics achievement: Adolescent participant performance in mathematics
    a. Indicator: Field management system (FMS) personnel administered two-way mathematics assessment
    b. Indicator: Mathematics teacher report of course level
    c. Indicator: Adolescent participant report of course level

    d. Indicator: Adolescent participant report of grades in mathematics
    e. Indicator: Mathematics teacher report of student ability or potential
2. Measure of mathematics achievement: Student engagement in mathematics
    a. Indicator: Mathematics teacher report of engagement and attention in class
    b. Indicator: Adolescent participant report of engagement and interest in mathematics
3. Measure of mathematics achievement: Adverse adolescent participant outcomes in mathematics
    a. Indicator: Mathematics teacher report of adolescent participant "fell behind"
    b. Indicator: Mathematics teacher report of adverse behavior

Table 9 provides an overview of measures investigated, with noted corresponding ECLS-K indicator variables, related to mathematics-related outcomes.

Table 9

Measures of Academic Outcomes Domain-specific to Mathematics

Outcome measure
Adolescent participant performance in mathematics
Field management system administered mathematics assessment[1]
Mathematics teacher report of course level[2]
Adolescent participant of course level[3]
Adolescent participant of grades in mathematics[4]
Mathematics teacher report of student ability or potential[5]
Adolescent participant engagement in mathematics
Mathematics teacher report of engagement and attention in class[6]
Adolescent participant report of engagement and interest in mathematics[7]
Adverse adolescent participant outcomes in mathematics
Mathematics teacher report of adolescent participant "fell behind"[8]
Mathematics teacher report of adverse behavior[9]

1 Field management system report: C7R4MTSC

2 Mathematics teacher report: M7LEVEL

3 Direct child assessment: C7DESMTH

4 Direct child assessment: C7MTHGD

5 Mathematics teacher report: M7HONORS, M7APPLY, M7PROOFS, M7TALKAB, M7WRITE, M7REPRES, M7CALCUL, M7COMPUT

6 Mathematics teacher report: M7RELWEL, M7PASSIV, M7ATTENT

7 Direct child assessment: C7MTHBST, C7ENJMTH, C7LIKMTH, C7SDQMTC

8 Mathematics teacher report: M7HEALTH, M7DISCIP, M7EFFORT, M7DISORG, M7SKILL, M7OTHRES, M7FRQABS, M7EMOPRB

9 Mathematics teacher report: M7TARDY, M7DISBEH

To recap, the researcher investigated outcomes, domain-specific to mathematics, on three levels of measure: adolescent participant performance in mathematics; adolescent participant engagement in mathematics; and adverse adolescent participant outcomes in mathematics. The researcher measured adolescent participant outcomes, as follows: performance in mathematics through analysis of five indicators; engagement in mathematics through analysis of two indicators; and adverse outcomes, also, through analyses of two indicators.

The first measure of academic outcomes domain-specific to mathematics was adolescent participant performance in mathematics. Indicators for this measure included: t-scores from a two-level mathematics assessment administered by field management system personnel; teacher and participant report of mathematics course level; participant report of grades in math; and teacher report of both mathematics-domain specific abilities and participant potential in advanced mathematics classes.

The second measure of academic outcomes domain-specific to mathematics was adolescent participant engagement in mathematics, as indicated by participant's and mathematics teacher's reports of engagement, attention, and interest. Variables examined for student engagement included mathematics teacher reports on participant relation with other students, as well as passivity and attention in class. Additional indicators for this measure included participant report of enjoyment, interest, and competence in math.

The third measure of academic outcomes domain-specific to mathematics was adverse participant outcomes in mathematics. Indicators included mathematics teacher report of participants who "fell behind," with corresponding antecedents; mathematics teacher report of participant tardiness; and counselor intervention due to behavioral need.

Analysis of measures in current study

Outcomes measured in current study

As stated above, the researcher examined disability-related school outcomes for individuals born late-preterm (34-$36^{6/7}$ weeks' gestation) compared with term (39-$40^{6/7}$ weeks' gestation) peers, as measured by:

1. Presence of special education services
2. Presence of learning disability or other disability

3. Presence of increased behavioral or attention needs

While, the researcher examined academic outcomes domain-specific to mathematics for individuals born late-preterm (34-$36^{6/7}$ weeks' gestation) compared with term (39-$40^{6/7}$ weeks' gestation) peers, as measured by:

1. Adolescent participant performance in mathematics
2. Adolescent participant engagement in mathematics
3. Adverse adolescent participant outcomes in mathematics

Analyses approach

The researcher in the present study first descriptively considered each variable level of measure. For scale variables, the researcher used independent samples t-tests to determine if statistically significant differences existed between means of late-preterm and full-term sample groups. Three phases of analyses were performed for each dummy-coded nominal indicator variable.

1. Phase One – LPT and FT status with measured outcome
    a. Raw *n* and corresponding percentile
    b. Absolute risk percentage for whole sample
2. Phase Two – LPT unadjusted status with measured outcome
    a. Chi square test for association (sig. p-value, Cramer's V)
    b. Unadjusted odds ratio (sig. CI)
    c. Unadjusted relative risk (sig. CI)
3. Phase Three – LPT adjusted status with measured outcome
    a. Adjusted odds ratio (sig. CI; Wald test)

i. Logistic regression analysis: independent variable (LPT v. FT) with confounding variables of gender, continuous SES, maternal education level, and race

b. Adjusted relative risk (sig. CI)

i. Conversion protocol delineated by Zhang and Yu (1998)

Confounding variables

The researcher entered demographic characteristics into logistic regressions when analyzing and comparing results, the researcher considered maternal and child confounding variables. Confounding variables included: maternal level of education (some college v. no college), child composite gender (female v. males), race (White v. all others), and continuous SES measure. While birthweight and gestational age at birth are confounding factors in educational outcomes, the researcher in the present investigation reduced confounding potential by comparing only participants born within range weight at specified gestational ages of birth. Although poverty level, food security score, and prestige score for parent occupation were included by field management personnel in the dataset, these variables present a high degree of multi-collinearity with SES measure; consequently, only SES measure was used as a confounder, for present-study analyses. Table 10 provides an outline of potential confounders.

Table 10

Included confounding variables: child and maternal

Child participant	**Maternal**
Composite gender	Education level
Race	
SES	

Study considerations

Validity considerations

Mathematics achievement and presence of special education services are measures of school outcomes analyzed within the present study. Within the thirteen studies included in the above systematic literature review, three studies included direct measures of special education or disability (Chyi et al., 2008; Lipkind et al., 2012; Morse et al., 2009), two included indirect measures – through measures of typical development (Chan & Quigley, 2014; Quigley et al., 2012), and ten included measures on mathematics achievement or proficiency when reporting on school outcomes (Chan & Quigley, 2014; Chyi et al., 2008; ElHassan et al., 2018; Lipkind et al., 2012; Peacock et al., 2012; Quigley et al., 2012; Searle et al., 2017; Shah et al., 2016; Williams et al., 2013; Woythaler et al., 2019).

The researcher used ECLS-K public-use datafile to obtain demographic and disability- and mathematics-related data for the present participant sample. ECLS-K data collection personnel utilized hard- and soft-range edits within interviews, noting or eliminating responses which seemed improbable, later reviewed by project staff. If comments supported outliers, the value remained. Consistency checks were built into the CATI/CAPI instruments, flagging potential errors for the assessor. To compute scale scores data management personnel relied on item response theory (IRT) computation. Personnel used IRT to calculate ability estimates, assessment scores, and comparisons – in an effort to determine a common scale.

Potential impacts to validity included surveying a sample which is not nationally representative; outcome of analyses applied to only the immediate study sample. Other impacts to validity included participant attrition from previous rounds, child mobility, missing data, varying grade levels represented in Round 7 (eighth-grade age collection), varied timing of

assessments, and large-scale sampling by multiple individuals within a field management system.

The eighth-grade age ECLS-K sample population is not nationally representative of eighth grade students, teachers, or schools. Moreover, a lack of publicly accessible direct IEP data from schools and special education teachers in eighth grade greatly impacted the researcher's ability to gain a full picture of disability-related outcomes; although available through restricted data-share, the researcher in the present study included only public-use data. Access to restricted portions of the datafile for the purpose of this investigation would present a more comprehensive study; however, a global pandemic greatly slowed university and federal protocols – so, the public-use ECLS-K datafile was used.

Reliability considerations

Use of a national longitudinal data system provided a lower standard of evidence, as there may be misclassification bias, instrument selection error, typical impacts of maturation, additional confounding variables (such as undocumented comorbidities, or alcohol use in pregnancy), causation cannot be determined, and included data is predetermined. Estimates of gestational age at birth are also dependent on parent report. Further, advances in neonatal and perinatal care may impact the relevancy of data on current students in PK-20 school systems. Also, the rate of preterm birth continues to increase, so associated impacts on medical, school, and societal costs have evolved since survey of the included sample.

Reliability measures for data abstraction involved an interrater reviewing 30% of the data abstracted from ECLS-K data sources. Acceptable reliability, for the present study, is established apriori at 95% or greater. ECLS-K data management personnel adapted several other copyrighted assessment batteries to design direct child assessments. Copyrighted descriptions of

assessments and psychometrics of the direct child assessment (self-description questionnaire), teacher indirect cognitive assessment, and Grade 8 mathematics assessment are readily available online https://nces.ed.gov/pubs2009/2009002.pdf. All items used in the study aligned with acceptable levels of item analysis with a measure of reliability (alpha coefficient) consistent with expectations: typically 0.80. The Cronbach's coefficient alpha for the Perceived Interest and Competence in Math was .89. The coefficient alpha for the eighth-grade Internalizing Problem Behaviors scale was .79. Detailed information about all aspects of this large national database is provided online as noted. Copyrighted overviews of ECLS-K methodology, data quality, comparability, sample design, data collection, processing, instrumentation, scoring, sampling errors, design effects, weighting, and additional psychometrics are found in publicly-available, easily-accessible online reports (Tourangeau et al., 2009; Najarian et al., 2009).

CHAPTER FOUR: RESULTS

Education professionals may struggle to identify and respond to a summative effect of high incidence outcomes evinced in children born late-preterm, which may impact achievement in the classroom (Baron et al., 2012; Church et al., 2012; Johnson et al., 2015). In the present study, the researcher sought to ascertain potential effects of late-preterm birth on adolescent academic outcomes in two domains: disability (Grades K through 8) and mathematics (Grade 8). The researcher used ECLS-K public-use datafile to compare outcomes of adolescents born late-preterm, with full-term peers. The included sample, while not nationally representative, does present a spectrum across gender, race, and SES indicators.

Organization of results report

In the present chapter, the researcher organized report of analyses results by research question. First reported are results of Grades K through 8 disability-related measures, with researcher reporting each measure and related variable indicators; then, reported are results of eighth-grade age mathematics-related measures, in the same fashion.

Research Question 1: To what extent does late-preterm birth impact disability-related school outcomes of adolescents born as late-preterm infants, compared with full-term peers and across grade levels? This question was measured on three levels, each with corresponding indicators and ECLS-K variable indicators: (1) presence of special education services; (2) presence of learning disability or other disability; (3) presence of increased behavioral or attention needs. Table 8 in the previous chapter provided a summary of disability-related measures with corresponding indicators and analyzed ECLS-K variables.

Research Question 2: To what extent does late-preterm birth impact mathematics-related school outcomes of adolescents born as late-preterm infants, compared with full-term peers?

This was also measured on three levels, each with corresponding indicators and ECLS-K variable indicators: (1) adolescent participant performance in mathematics; (2) adolescent participant engagement in mathematics; (3) adverse adolescent participant outcomes in mathematics. Table 9 in the previous chapter provided a summary of mathematics-related measures with corresponding indicators and analyzed ECLS-K variables.

Structure of results report

ECLS-K variable analyses and report

The researcher analyzed variable indicators for association with participant status of late-preterm birth; with initial tests for association, unadjusted odds, and unadjusted relative risk. Follow-up analyses included logistic regression to account for influence of confounding variables on outcomes. Finally, the researcher converted adjusted odds ratios to adjusted risk ratios, per recommendation of Zhang and Yu (1998). Results for the six measures are displayed, one table per measure, comparing outcome results of participants born late-preterm with full-term peers. Included in results are absolute risk; comparison of raw percentile; *n* of each indicator; chi-square test for association, and related strength for statistically significant variable indicators; and adjusted OR and adjusted RR, to account for the presence of confounding variables through logistic regression analyses. Welch's t-tests were used to determine if statistically significant differences existed between means of late-preterm and full-term sample groups, for variables measured on a scale level.

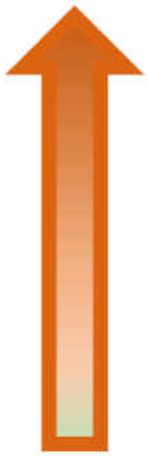
Report of relative risk and odds ratio

The researcher in the present study offered results in both OR and RR. While report of risk is not common within education literature, it is a principal means of report within epidemiological findings (Zhang & Yu, 1998; Osborne, 2006); researchers cited within the

included systematic literature review oscillate between the two. The researcher in the present study reported RR for ease of interpretation and comparison with previous findings, and OR for ease of translation within regression analyses, as:

> ORs are also less easy to express in plain English, and hence less easy to understand, than RRs. For these and other reasons, wherever possible, RRs should be estimated rather than ORs…There are two principal situations in which the computation of ORs is justified: …2. In logistic regression analyses, where ORs are generated as part of the analysis. (Andrade, 2015, p. e860)

Of note, particularly for those who may be unfamiliar with report of relative risk, "it is possible for an RR value to be very close to 1.00 (i.e., probably not clinically significant), yet statistically significant because the study was conducted on a large sample" (Andrade, 2015, p. e860). Andrade (2015) cites statistical significance through confidence interval; if CI includes the value of 1.00, Andrade concludes RR is not statistically significant. As a review, absolute risk considers risk for the entire population, while relative risk, within this study, considers adjusted risk for participants born late-preterm. Figure 1 provides an overview of relative risk interpretation.



aRR	Change in risk
2.00	Two times the risk
1.90	90% increase in risk
1.80	80% increase in risk
1.70	70% increase in risk
1.60	60% increase in risk
1.50	50% increase in risk
1.40	40% increase in risk
1.30	30% increase in risk
1.20	20% increase in risk
1.10	10% increase in risk
1.00	**Baseline**
0.90	10% decrease in risk

Figure 1: *Relative Risk Interpretation Guide*

Disability-related academic outcomes

The following question guided the researcher in conducting data analyses to investigate disability-related academic outcomes of the included sample in the present study: To what extent does late-preterm birth impact disability-related school outcomes of adolescents born as late-preterm infants, compared with full-term peers and across grade levels, as measured by measures and corresponding indicators displayed in Table 8.

Measure: presence of special education services across grade levels

Within the present study, the first measure of disability-related academic outcomes was presence of special education services. Two indicators of participant use of special education services were analyzed: school report of IEP (obtained from school records abstract) and FMS personnel report of provided special education services. School report of IEP was available for Grades K, 1, 3, and 5; however, for Grade 8, Round 7 collection, school report of IEP was obtained by FMS personnel within special education teacher questionnaire, and data were

suppressed for this indicator in Grade 8 public-use datafile. Figure 2 displays comparison of adjusted relative risk of special education services or disability across the grade spectrum for participants born late-preterm; while, Table 11 displays summaries of results associated with the measure of presence of special education services, and related to school report of IEP and FMS personnel report of provided special education services. Across the grade spectrum, participants born late-preterm presented in greater ratio than full-term peers for every special education services indicator variable.

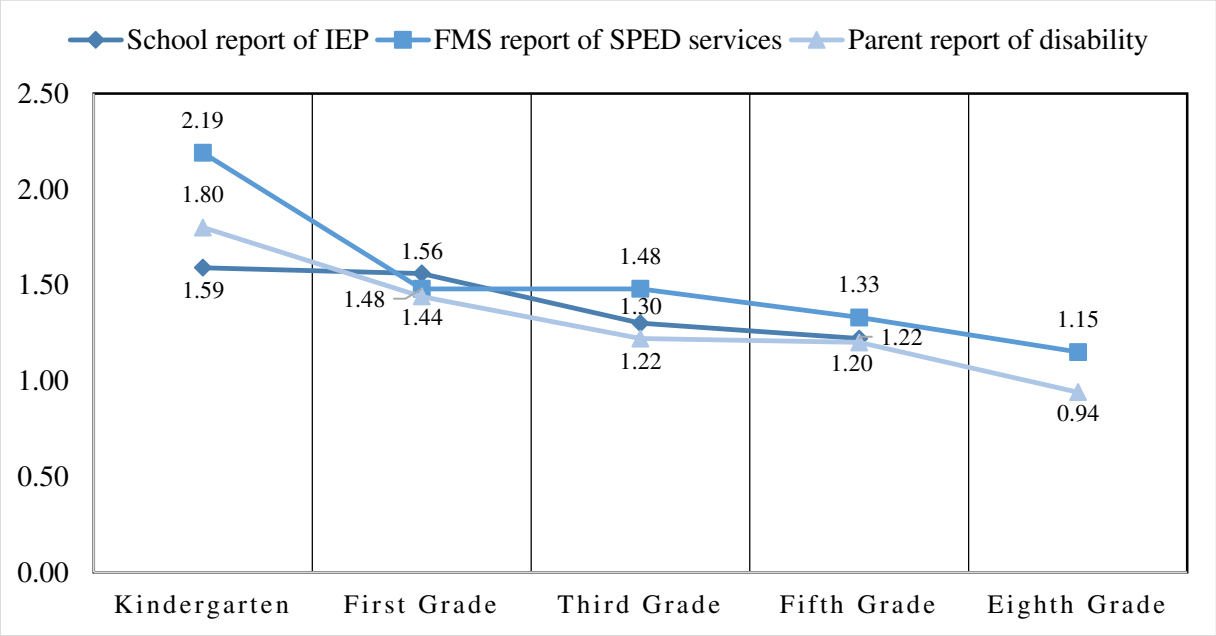


Figure 2: *Adjusted Relative Risk of Disability-Related Indicators, LPT*

Table 11

Presence of Special Education Services Across Grade Spectrum

	Abs. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
School report of IEP										
Kindergarten	6%	19 (8)	252	254 (6)	4188	$\chi^2(1) = 0.90$, p = .344	1.56	0.98, 2.43	1.62	0.98, 2.68
*First grade	8%	26 (10)	257	318 (8)	4225	$\chi^2(1) = 2.30$, p = .130	1.59	1.06, 2.33	1.68[a]	1.07, 2.64
Third grade	10%	30 (11)	278	434 (10)	4374	$\chi^2(1) = 0.22$, p = .639	1.22	0.83, 1.76	1.25	0.81, 1.92
Fifth grade	11%	35 (13)	264	445 (11)	4198	$\chi^2(1) = 1.83$, p = .176	1.30	0.91, 1.82	1.35	0.90, 2.03
FMS report of SPED										
*Kindergarten	3%	20 (6)	326	171 (3)	5369	$\chi^2(1) = 8.25$, p =.004[d]	2.19	1.35, 3.50	2.27[b]	1.36, 3.79
First grade	5%	17 (5)	320	239 (5)	5249	$\chi^2(1) = 0.40$, p = .529	1.33	0.79, 2.18	1.35	0.78, 2.33
Third grade	7%	32 (10)	323	368 (7)	5223	$\chi^2(1) = 3.72$, p = .054	1.48	1.00, 2.15	1.53	1.00, 2.35
*Fifth grade	8%	34 (10)	329	406 (8)	5402	$\chi^2(1) = 3.48$, p = .062	1.48	1.01, 2.11	1.54[c]	1.01, 2.33
Eighth grade	8%	29 (9)	330	444 (8)	5434	$\chi^2(1) = 0.16$, p = .692	1.15	0.77, 1.68	1.16	0.76, 1.79

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use
Note: School report of IEP not available in eighth-grade public-use datafile
*statistical significance
[a] (p = .024); Adjusted: Wald tests sig. Gender, Continuous SES
[b] (p = .002); Adjusted, Wald test sig. Gender, Continuous SES
[c] (p = .044); Adjusted, Wald test sig. Gender, Continuous SES, Race
[d] $\varphi = 0.04$, p = .004

School report of IEP

The first indicator variable measuring presence of special education services was school report of IEP. In fifth grade, all participant (full-term and late-preterm) faced greatest absolute risk (11%) for school report of IEP; congruently, students born late-preterm presented in greatest percentiles in fifth grade (13%), and in greater ratio compared with full-term peers (11%). Participants born late-preterm faced increased relative risk of school report of IEP in all grades, with greatest risk over full-term peers in kindergarten (56% increased aRR) and first grade (59% increased aRR, sig.). Before entry into middle school, fifth-grade participants born late-preterm continued to face 30% increased adjusted relative risk of school report of IEP.

FMS personnel report of provided SPED services

The second indicator variable measuring presence of special education services was FMS personnel report of provided special education services. This trend of increased risk of special education services for those born late-preterm continued with FMS report of provided special education services across the grade spectrum, with statistically significant (unadjusted) association in kindergarten (chi-square test for association), and two-fold increased adjusted risk of services compared with full-term peers. In eighth grade, participants born late-preterm continued to face 15% increased adjusted risk of FMS personnel report of provided special education services.

Within the measure of provided special education services, variable indicators with both increased adjusted relative risk and statistically significant adjusted odds ratios were first grade school report of IEP, along with kindergarten and fifth grade FMS personnel report of special education services. The researcher noted school report of IEP presented in greater percentiles than FMS report of special education services, for every grade level.

Measure: presence of learning disability or other disability

The second measure of disability-related outcomes, within the present study, was presence of learning disability or other disability. The researcher measured presence of learning disability or other disability through parent report of child with disability or parent report of concerns, evaluations or diagnoses – related to disability. The researcher acquired parent report from parent interviews, collected across all data collection rounds. Table 12 provides a summary of variable indicators and related results.

Parent report of disability, across all grade levels

The first indicator variable within this measure was parent report of disability, as reported in all measured grade levels. Across the grade spectrum, except third grade, participants born late-preterm faced increased adjusted risk of parent report of disability – with greatest increased adjusted risk and statistical significance in kindergarten (80% increased aRR) and first grade (44% increased aRR). Participants in eighth-grade continued to face 20% increased adjusted risk of parent report of disability, compared with full-term peers.

Parent report of concerns, evaluations, or diagnoses, at eighth-grade age

The second indicator variable measuring presence of learning disability or other disability was parent report of concerns, evaluations, or diagnoses, at eighth-grade age, Round 7 data collection. Participants born late-preterm faced increased and statistically significant adjusted relative risk of evaluation of attention or learning needs (68% increased aRR) and asthma diagnosis (42% increased aRR). The researcher included asthma diagnosis, as it can impact instructional time or student absences (Sullivan et al., 2018). Adolescents born late-preterm also faced increased risk of parent report of attention or learning diagnoses (13% increased aRR) and hearing difficulty in normal conversation (41% increased aRR).

Table 12

Presence of Learning Disability or Other Disability

	Abs. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
Parent report disability										
*Kindergarten	13%	72 (25)	291	680 (13)	5431	$\chi2(1) = 36.14$, $p < .001$[c]	1.80	1.41, 2.26	2.04[a]	1.50, 2.78
*First grade	15%	66 (21)	314	748 (15)	5158	$\chi2(1) = 9.93$, $p = .002$[d]	1.44	1.12, 1.81	1.56[b]	1.15, 2.11
Third grade	26%	78 (26)	303	1340 (26)	5080	$\chi2(1) = 0.06$, $p = .807$	0.94	0.75, 1.15	0.92	0.69, 1.22
Fifth grade	15%	60 (19)	314	796 (15)	5224	$\chi2(1) = 3.40$, $p = .065$	1.22	0.94, 1.57	1.27	0.93, 1.75
Eighth grade	15%	55 (18)	300	714 (15)	4872	$\chi2(1) = 3.02$, $p = .082$	1.20	0.90, 1.55	1.24	0.89, 1.71
Eighth-grade parent report										
Attention or learning	14%	50 (15)	330	780 (14)	5464					
*Evaluation	63%	38 (76)	50	482 (62)	780	$\chi2(1) = 4.05$, $p = .044$[f]	1.68	0.92, 2.78	1.89	0.91, 3.92
Diagnosis	84%	34 (89)	38	405 (84)	482	$\chi2(1) = 0.80$, $p = .373$	1.13	0.71, 1.41	1.43	0.48, 4.26
Other diagnoses										
Spch/hrng concerns	3%	14 (4)	330	182 (3)	5464					
Speech evaluation	61%	7 (50)	14	112 (62)	182	$\chi2(1) = 0.73$, $p = .394$	0.74	0.32, 1.21	0.52	0.15, 1.87
Speech diagnosis	81%	5 (71)	7	91 (81)	112	Fisher's exact, $p = .619$	0.68	0.18, 1.10	0.29	0.04, 1.90
Hearing difficulty	16%	4 (29)	14	28 (15)	182	Fisher's exact, $p = .252$	1.41	0.32, 3.88	1.52	0.29, 7.91
Hearing evaluation	69%	3 (75)	4	19 (68)	28	Fisher's exact, $p = 1.00$	0.62	0.00, 1.45	0.34	0.00, 28.27
*Asthma diagnosis	14%	59 (20)	299	659 (14)	4866	$\chi2(1) = 9.02$, $p = .003$[g]	1.42	1.09, 1.80	1.52[e]	1.11, 2.07
Asthma treatment	68%	38 (64)	59	451 (68)	659	$\chi2(1) = 0.41$, $p = .525$	1.00	0.79, 1.17	1.00	0.55, 1.80

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use
Note: School report of IEP not available in eighth-grade public-use datafile
*statistical significance
[a] ($p < .001$); Adjusted: Wald tests sig. Gender, Race
[b] ($p = .004$); Adjusted, Wald test sig. Gender, Continuous SES
[c] $\varphi = 0.079$, $p < .001$
[d] $\varphi = 0.043$, $p = .002$
[e] ($p = .008$); Adjusted: Wald tests sig. Gender
[f] $\varphi = 0.070$, $p = .044$
[g] $\varphi = 0.04$, $p = .003$

Measure: presence of increased behavioral or attention needs

The third measure of disability-related outcomes, within the present study, was presence of increased behavioral or attention needs. The researcher in the present study measured presence of increased behavioral or attention needs through parent report of participant attention level, therapy related to attention, behavior in relation to other children, behavioral evaluation, emotional behavior concerns or evaluation, or school suspension. Table 13 provides summary of presence of increased behavioral or attention-related variable indicators and results.

Table 13

Parent Report of Increased Behavioral or Attention Needs in Eighth Grade

	Abs. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
Parent concerns										
Child attention	13%	41 (14)	299	609 (13)	4866	$\chi^2(1) = 0.37$, $p = .545$	1.02	0.74, 1.39	1.02	0.71, 1.47
Child distraction	39%	114 (38)	298	1893 (39)	4859	$\chi^2(1) = 0.06$, $p = .809$	0.93	0.78, 1.09	0.89	0.69, 1.15
Therapy - attention										
Individual	29%	15 (38)	39	160 (29)	559	$\chi^2(1) = 1.71$, $p = .192$	1.25	0.74, 1.87	1.39	0.67, 2.89
Family	13%	7 (18)	39	68 (12)	560	$\chi^2(1) = 1.12$, $p = .289$	1.26	0.51, 2.73	1.31	0.48, 3.58
Behavior or emotional										
Poor behavior	19%	51 (17)	298	915 (19)	4863	$\chi^2(1) = 0.53$, $p = .465$	0.89	0.68, 1.17	0.87	0.63, 1.22
Poor behavior peers	6%	19 (6)	299	277 (6)	4860	$\chi^2(1) = 0.22$, $p = .636$	0.95	0.57, 1.56	0.95	0.55, 1.62
Behavior concern	60%	13 (68)	19	163 (59)	276	$\chi^2(1) = 0.65$, $p = .421$	1.10	0.64, 1.44	1.29	0.42, 3.93
Behavior evaluation	55%	7 (54)	13	90 (55)	163	$\chi^2(1) = 0.01$, $p = .924$	0.84	0.34, 1.38	0.70	0.19, 2.59
Emo. behavior conc.	15%	37 (12)	299	716 (15)	4867	$\chi^2(1) = 1.24$, $p = .266$	0.80	0.57, 1.10	0.77	0.53, 1.12
*Emo. behavior eval.	47%	25 (68)	37	327 (46)	716	$\chi2(1) = 6.77$, $p = .009$[b]	1.42	1.02, 1.74	2.21[a]	1.04, 4.70
School suspension	12%	42 (14)	298	596 (12)	4871	$\chi2(1) = 0.90$, $p = .344$	1.00	0.71, 1.40	1.00	0.68, 1.48

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use
*statistically significant
[a] ($p = .039$); Adjusted: Wald tests sig. Race;
[b] $\varphi = 0.10$, $p = .009$

Parents of participants born late-preterm reported near typical levels of concern regarding child attention. The researcher noted greater increased risk in areas of therapy related to attention, both individual (25% increased aRR) and family (26% increased aRR), for individuals born late-preterm – compared with full-term peers. 19% of all parents reported concerns with behavior or emotional behavior. Of those, 68% of parents of participants born late-preterm and 59% of parents of participants born full-term specified concerns as behavior-related (not emotional). While parents of participants born late-preterm reported, in less ratio, concerns with emotional behavior, 68% of those parents followed-up with professional evaluation, compared with 46% of parents of participants born full-term – representing 42% increased adjusted risk and statistical significance.

Overall, participants born late-preterm faced decreased adjusted risk of parent report of child distraction concerns, poor behavior, and behavior (without emotional component) evaluation. While initial results indicated greater ratios of parents of individuals born late-preterm reporting school suspension, adjustment for confounders indicated no increased risk. Figure 3 displays comparison summary of increased adjusted relative risk for participants born late-preterm on disability-related measures and corresponding variable indicators.

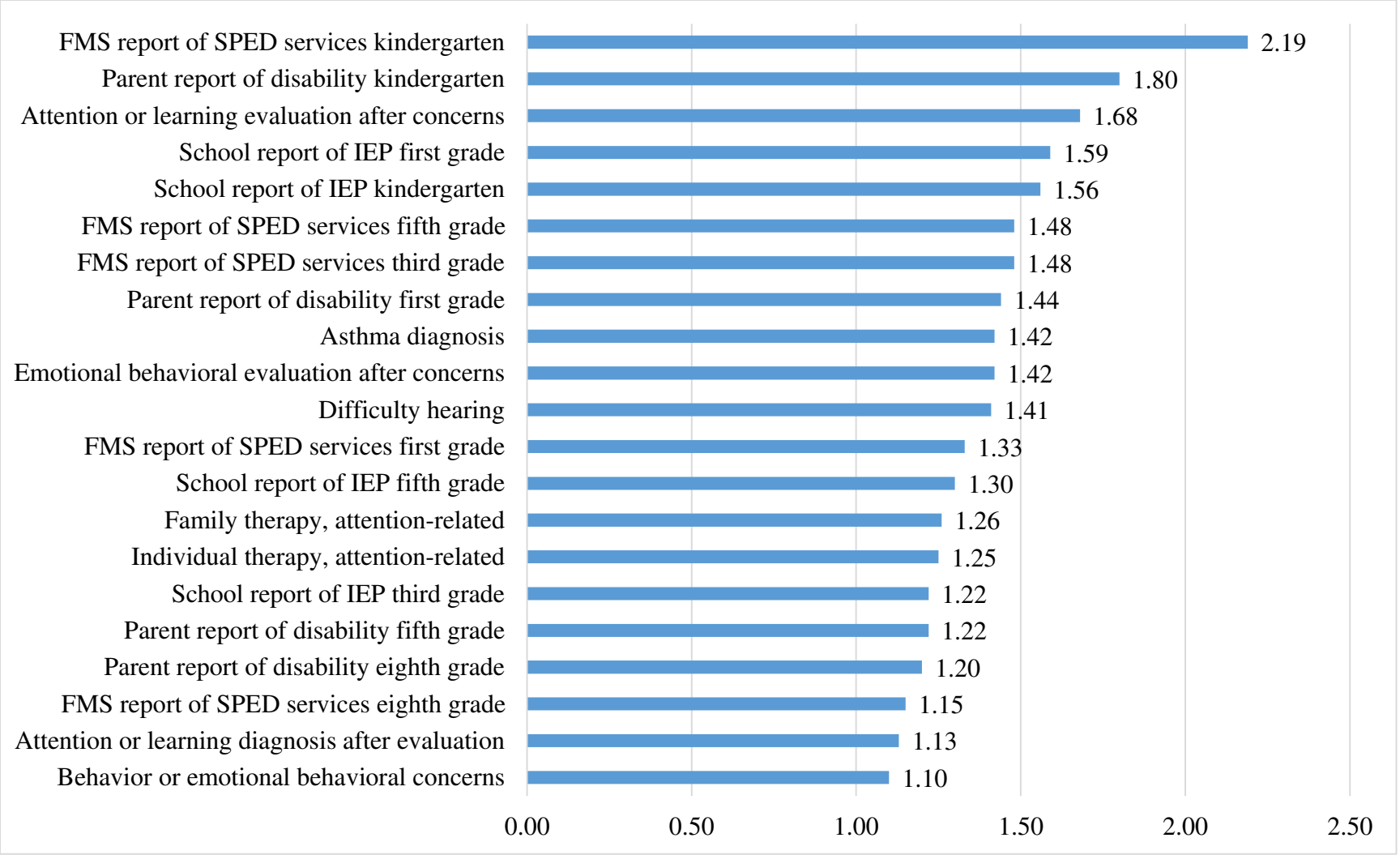


Figure 3: *Increased Adjusted Relative Risk of Disability-related Indicators, LPT*

Mathematics-related academic outcomes

The following question guided the researcher in conducting data analyses to investigate mathematics-related academic outcomes of the included sample in the present study: To what extent does late-preterm birth impact mathematics-related school outcomes of adolescents born as late-preterm infants, compared with full-term peers, as measured by: (1) adolescent participant performance in mathematics; (2) adolescent participant engagement in mathematics; (3) adverse adolescent participant outcomes in mathematics? Table 9 in the previous chapter provides a summary of mathematics-related measures with corresponding ECLS-K indicator variables.

Measure: Adolescent participant performance in mathematics

To investigate mathematics outcomes for adolescent participants, the researcher examined two sources within ECLS-K public-use datafile: eighth-grade age direct child assessment and eighth-grade age mathematics teacher report of outcomes. The researcher analyzed six indicators of student performance in mathematics: t-score resulting from field management system administered mathematics assessment; mathematics teacher report of course level; adolescent participant report of course level; adolescent participant report of grades in mathematics; mathematics teacher report of homework completion; and mathematics teacher report of student ability or potential.

FMS-personnel administered mathematics assessment

The first indicator of adolescent participant performance in mathematics was two-way mathematics assessment scale-score results – an assessment administered by FMS personnel. For the eighth-grade sample of full and late-preterm participants, n = 5521 (FT, n = 5203; LPT, n = 318), t-scores were reported as record of the assessment. The researcher performed an independent-samples t-test to determine mean differences of mathematics t-scores between

participants born late-preterm compared with those born full-term. With no extreme outliers in data, near normal distribution (light tails), and homogeneity of variances (Levene's, $p = .930$), participant mathematics t-score means were slightly greater in participants born late-preterm (M = 52.44, SD = 9.23) compared with participants born full-term (M = 51.88, SD = 9.42), with no statistically significant difference, t(5519) = 1.03, $p = .305$, 95% CI [-0.51, 1.62].

Mathematics teacher report of course level

The second indicator of adolescent participant performance in mathematics was mathematics teacher report of participant current course level. For the eighth-grade sample of full-term and late-preterm participants, FMS personnel provided half of all mathematics teachers a child-level questionnaire, which included identification of current mathematics course level for related participants. Distribution of mathematics course level was nearly identical by percentages of students across course levels (below grade level, regular, or honors), between participants born late-preterm and those born full-term. Of the $n = 2678$ teacher respondents (FT, $n = 2523$; LPT, $n = 155$), 10.3% of teachers of students born late-preterm ($n = 16$), and 9.6% of teachers of students born full-term ($n = 243$) reported participant performing below grade level in mathematics.

Adolescent participant report of course level

The third indicator of adolescent participant performance in mathematics was participant report of current course level. Within the direct child assessment questionnaire, participants described the course most closely aligned with their current class (General Mathematics, Introduction to Algebra/Pre-algebra, Algebra, Integrated or Sequential Mathematics, Algebra II or Geometry). Of the $n = 5484$ participant respondents (FT, $n = 5166$; LPT, $n = 318$), distribution was similar between the two measured groups, with percentile differences seen in those reporting

General Mathematics as current (FT, 16%, *n* = 829; LPT, 18%, *n* = 58) and Algebra (FT, 39%, *n* = 5166; LPT, 38%, *n* = 121).

Adolescent participant and eighth-grade mathematics teacher report of performance.

Table 14 provides a summary of results for sample participant performance in eighth-grade mathematics, including participant report of grades, and mathematics teacher report of homework completion, perceived potential, and perceived ability. The fourth indicator of adolescent participant performance in mathematics was participant report of good grades in mathematics. Compared with an absolute risk of 71% - and compared with 71% of participants born full-term, 73% of those born late- preterm responded to "I get good grades in math" as mostly or very true, representing a slight increased adjusted relative risk (4% increased aRR). Eighth-grade participants born late-preterm faced 13% increased adjusted relative risk of teacher report of homework non-completion, compared with full-term peers.

Table 14

Participant Performance in Eighth-grade Mathematics

	Abslt. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
Participant report										
Math good grades	71%	231 (73)	315	3657 (71)	5154	$\chi2(1) = 0.82$, $p = .366$	1.04	0.96, 1.12	1.17	0.87, 1.57
Math teacher report										
No rcommd honors	69%	100 (74)	135	1472 (68)	2153	$\chi2(1) = 1.92$, $p = .166$	1.49	0.97, 2.28	1.49	0.97, 2.28
Low HW complete	21%	33 (21)	154	532 (21)	2509	$\chi2(1) = 0.04$, $p = .947$	1.13	0.71, 1.79	1.13	0.71, 1.79
Decreased ability to										
* Apply to real world	63%	109 (70)	155	1573 (62)	2523	$\chi2(1) = 3.98$, $p = .046$[d]	1.72	1.17, 2.53	1.72[a]	1.17, 2.53
Perform proofs	67%	105 (71)	148	1550 (66)	2334	$\chi2(1) = 1.29$, $p = .256$	1.24	0.83, 1.84	1.24	0.83, 1.84
Verbal reasoning	63%	107 (70)	153	1579 (63)	2515	$\chi2(1) = 3.17$, $p = .075$	1.46	1.00, 2.14	1.46	1.00, 2.14
* Written reasoning	67%	113 (75)	151	1602 (67)	2399	$\chi2(1) = 4.19$, $p = .041$[e]	1.54	1.02, 2.31	1.54[b]	1.02, 2.31
* Math modeling	66%	107 (73)	146	1546 (66)	2359	$\chi2(1) = 3.68$, $p = .055$	1.59	1.05, 2.41	1.59[c]	1.05, 2.41
Use calculator	38%	55 (39)	142	888 (38)	2347	$\chi2(1) = 0.05$, $p = .831$	1.14	0.77, 1.68	1.14	0.77, 1.68
Use computer	55%	37 (57)	65	524 (55)	961	$\chi2(1) = 0.14$, $p = .707$	0.99	0.56, 1.72	0.99	0.56, 1.72

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use
*statistically significant
[a] $p = .006$; Wald test: continuous SES measure
[b] $p = .038$; Wald test: Gender, continuous SES measure
[c] $p = .027$; Wald test: Gender, continuous SES measure
[d] $\phi = 0.04$, p = .046
[e] $\phi = 0.41$, p = .041

Mathematics teacher report of recommendation for advanced mathematics

The next indicator of adolescent participant performance in mathematics measured mathematics teacher perception of student potential, and included teacher report of recommendation for advanced mathematics courses. Of teacher responses to, "Have you recommended this student for academic honors, advanced placement, or honors classes?" – 26% of teachers with students born late-preterm and 32% of teachers with students born full-term affirmed they recommended the student participant for advanced mathematics classes. Results indicate participants born late-preterm faced 49% increased relative risk of not being recommended for advanced or honors mathematics classes.

Mathematics teacher report of student ability

Mathematics teachers also ranked their estimation of participant mathematics ability by concept domain. Compared with full-term peers, those born late-preterm had the following adjusted relative risks of teachers rating participant ability within the lower quartiles of "good, fair, or poor" – rather than upper quartiles of "very good or outstanding":

1. Ability to "apply mathematical concepts to real world problems" – 72% greater adjusted risk of poorer ability rating, with statistical significance
2. Ability to "complete or conduct proofs or demonstrations of his/her mathematical reasoning" – 24% greater risk of poorer ability rating
3. Ability to "talk about his/her reasoning or thinking in solving a problem" – 46% greater risk of poorer ability rating
4. Ability to "explain his/her reasoning in solving a problem in writing" – 54% greater risk of poorer ability rating, with statistical significance

5. Ability to "use representations to model mathematical ideas" – 59% greater risk of poorer ability rating, with statistical significance
6. Ability to "use a calculator to solve problems" – 14% greater risk of poorer ability rating
7. Ability to "use a computer to complete mathematics assignments" – typical rating

Measure: Adolescent participant engagement in mathematics

The researcher in the present study analyzed two indicators of student engagement in mathematics, including teacher report of adolescent participant engagement and attention in class, and participant report of engagement and interest in mathematics. The researcher obtained teacher report from mathematics teacher questionnaire, while adolescent participant report was obtained from direct child assessment – both from Round 7 (eighth-grade) ECLS-K data collection.

FMS scale measure of adolescent participant mathematics competence and interest

The current indicator of adolescent participant report of engagement and interest in mathematics class was measured on scale level. For the eighth-grade sample of full and late-preterm participants, n = 5501 (FT, n = 5184; LPT, n = 317), perceived interest and competence in mathematics was reported as a scale score by FMS personnel. The researcher performed an independent-samples t-test to determine mean differences of mathematics interest in participants born late-preterm compared with those born full-term. With no extreme outliers, the data were normally distributed, with homogeneity of variances, (Levene's, p = .892). Participant mathematics interest means were slightly greater in participants born late-preterm (M = 2.68, SD = 0.88) compared with participants born full-term (M = 2.65, SD = 0.88), with no statistically significant difference, t(5499) = 0.63, p = .527, 95% CI [-0.07, 0.13].

Adolescent participant engagement and interest in mathematics

Table 15 provides a results summary of analyses of student engagement in mathematics, with corresponding ECLS-K variable indicators. Six indicators of student engagement and interest in mathematics were included in the present study, including both participant self-report and teacher report of participant engagement in eighth-grade mathematics.

Table 15

Participant Engagement in Eighth-grade Mathematics

	Abs. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
Participant report										
Math best subject	54%	178 (56)	317	2776 (54)	5184	$\chi2(1) = 0.81$, $p = .367$	1.04	0.92, 1.15	1.08	0.84, 1.39
Enjoyment math	45%	136 (43)	317	2304 (45)	5157	$\chi2(1) = 0.38$, $p = .537$	0.95	0.82, 1.09	0.92	0.72, 1.18
Liking math	55%	178 (57)	315	2829 (55)	5155	$\chi2(1) = 0.32$, $p = .573$	1.04	0.93, 1.15	1.09	0.85, 1.40
Math teacher report										
*Poor inter-relation	9%	26 (17)	157	231 (9)	2556	$\chi2(1) = 9.76$, $p = .002$[a]	2.13	1.30, 3.48	2.13[b]	1.30, 3.48
Poor attention	22%	43 (27)	157	539 (21)	2542	$\chi2(1) = 3.34$, $p = .067$	1.40	0.92, 2.13	1.40	0.92, 2.13
*Excessively passive	13%	28 (18)	157	324 (13)	2552	$\chi2(1) = 3.45$, $p = .063$	1.49	1.01, 2.13	1.61[c]	1.01, 2.56

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use
*statistically significant
[a] $\varphi = 0.06$, $p = .002$
[b] $p = .003$; Wald test: Gender, maternal education level, continuous SES measure
[c] $p = .045$; Wald test: Gender, continuous SES measure

Adolescent participant report of participant engagement in eighth-grade mathematics

Indicators of adolescent self-report included participant response to "math is one of my best subjects," "I enjoy doing work in math," and "I like math" – results represent participant risk of reporting "very true" or "mostly true" to each indicator variable. Within these indicators, students born late-preterm indicated similar levels of enjoyment and engagement in mathematics to peers born full-term, including slightly increased adjusted relative risk (4% increased aRR) to mathematics as a best subject and in response to, "I like math."

Mathematics teacher report of participant engagement in eighth-grade mathematics

Indicators of participant engagement and attention in class, as reported by eighth-grade mathematics teachers, included examining teacher perception of how well participants related to others, attentiveness, and excessive passivity in class, at eighth-grade age. Within these indicators, the researcher noted greater differences between sample groups than within participant self-report of engagement in mathematics. Teachers of participants born late-preterm had statistically significant adjusted relative risk of reporting late-preterm participants relating poorly to others (113% increased relative risk, sig.) excessive passivity in class (49% increased relative risk, sig.), and poor attention, with 40% increased relative risk.

Measure: adolescent participant propensity toward adverse outcomes in mathematics

Ten indicators of adverse adolescent participant outcomes in mathematics were analyzed, including teacher report of "student fell behind" in class, teacher report of student tardiness, and outside referral due to disruptive student behavior. Table 16 provides a summary of measures of adverse student outcomes in mathematics and corresponding ECLS-K variables.

Table 16

Eighth-grade Age Mathematics Teacher Report of Participant Adverse Outcomes

	Abslt. Risk	LPT n (%)	LPT n	FT n (%)	FT n	Chi-square test for association	LPT aRR	LPT aRR 95% CI	LPT aOR	LPT aOR 95% CI
Fell behind antecedent										
Health problem	9%	5 (10)	52	63 (9)	731	Fisher's exct, $p = .798$	0.82	0.29, 2.15	0.81	0.27, 2.42
Discipline problem	14%	5 (10)	52	103 (14)	731	$\chi2(1) = 0.82$, $p = .366$	0.78	0.25, 2.12	0.75	0.22, 2.59
Lack of effort	74%	43 (83)	52	537 (73)	731	$\chi2(1) = 2.15$, $p = .142$	1.14	0.94, 1.26	1.80	0.80, 4.05
Disorganized	35%	20 (38)	52	257 (35)	731	$\chi2(1) = 0.23$, $p = .630$	1.12	0.72, 1.60	1.20	0.62, 2.35
Lack of skills	30%	11 (21)	52	225 (31)	731	$\chi2(1) = 2.14$, $p = .144$	0.91	0.51, 1.46	0.88	0.42, 1.85
Other reason	24%	7 (13)	52	179 (25)	731	$\chi2(1) = 3.33$, $p = .068$	0.66	0.31, 1.25	0.59	0.25, 1.37
Frequent absences	9%	3 (6)	52	66 (9)	731	Fisher's exct, $p = .612$	0.81	0.25, 2.34	0.79	0.23, 2.70
Emotion/family	4%	3 (6)	52	25 (3)	731	Fisher's exct, $p = .424$	2.22	0.63, 6.98	2.31	0.62, 8.56
Tardiness	6%	11 (7)	157	164 (65)	2542	$\chi2(1) = 0.08$, $p = .784$	1.12	0.89, 1.29	1.44	0.73, 2.82
Referral for disruptive	17%	15 (20)	74	216 (17)	1249	$\chi2(1) = 0.43$, $p = .512$	1.21	0.68, 2.00	1.27	0.64, 2.52

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use

Mathematics teacher report of adolescent participant adverse outcomes

The first eight indicators of adverse student outcomes in mathematics pertain to teacher affirmative response to, "Has this student fallen behind in school work in this class?" and nominal follow-up response to, "Why has this student fallen behind in school work? Health problem, disciplinary problem, lack of effort, disorganized, lacks prerequisite skills, some other [specified] reason." In response to whether the participant fell behind in mathematics, greater ratios of teachers of participants born late-preterm reported students fell behind in eighth-grade mathematics class. This was compared to teachers of participants born full-term - 29% (n = 731) of teachers of full-term participants versus 33% (n = 52) of teachers of participants born late-preterm.

Participants born late-preterm had less adjusted relative risk of teacher report of falling behind due to health or discipline problems, lack of skills, other reasons, or frequent absences. Teacher-reported antecedents of lack of effort and disorganization posed a 14% and 12% increased adjusted relative risk, respectively, for participants born late-preterm, compared with full-term peers. Finally, participants born late-preterm had 12% greater adjusted relative risk of mathematics teacher report of tardiness and 21% greater adjusted relative risk of referral for disruptive behavior. Figure 4 provides a summary comparison of adjusted relative risk of mathematics-related indicators, for participants born late-preterm.

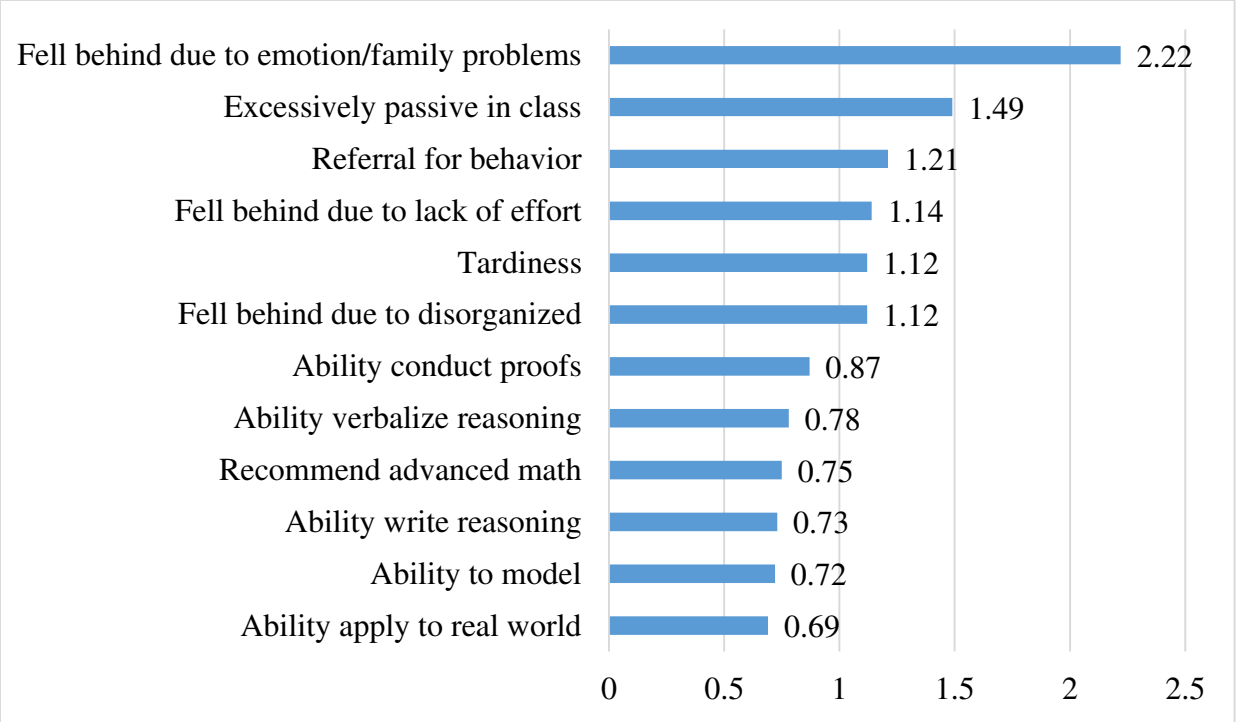


Figure 4: *aRR for Participants Born LPT: Comparison of Mathematics-related Indicators*

Disability- and mathematics-related outcomes of adolescents, in review

Summary of disability-related outcome results

Using public-use ECLS-K datafile, the researcher in the present study examined risk of disability-related outcomes for participants born late-preterm, across Grades K, 1, 3, 5, and 8, by analyzing measures of presence of special education services; presence of learning disability or other disability; and presence of increased behavioral or attention needs. Table 17 provides a summary of parent-reported, disability-related adjusted risk results; red indicates statistically significant results; yellow indicates outcomes with greater relative risk; green indicates outcomes with typical or reduced risk. Results indicated participants born late-preterm, compared with full-term peers, had greater adjusted relative risk of:

1. School report of IEP, across K-5
    a. Statistical significance in Grade 1
2. FMS personnel report of provided special education services to participant across K-8
    a. Statistical significance in Grades K and 1
3. Parent report of disability in Grades K, 1, 5, and 8
    a. Statistical significance in Grades K and 1
4. Parent report in eighth-grade of:
    a. Attention or learning evaluation, with statistical significance
    b. Attention or learning diagnosis
    c. Attention-related individual and family therapy
    d. Behavior-related concerns
    e. Communication or hearing difficulty
    f. Emotional behavioral evaluation following concern, with statistical significance

Table 17

Summary of Eighth-grade Disability Outcomes for Participants Born LPT

Statistically significant increased relative risk	
Attention or learning evaluation	
Asthma diagnosis	
Emotional-behavioral evaluation	
Greater relative risk	**On par with full-term peers**
Communication or hearing difficulty	Attention concerns
Therapy, attention-related	School suspension
Attention or learning diagnosis	
General behavior concerns	
Reduced relative risk	
Behavior concerns, compared with peers	Emotional-behavior related concerns
Distraction concerns	Speech-related evaluation or diagnosis
Excessively poor behavior concerns	
Behavior-related evaluation	

Summary of mathematics-related outcome results

The researcher analyzed mathematics-related academic outcomes of the present sample through adolescent-aged (eighth-grade) mathematics-related school outcomes, including adolescent participant performance in mathematics; adolescent participant engagement in mathematics; and adverse adolescent participant outcomes in mathematics. Table 18 provides summary of mathematics-related adjusted risk results; color coding follows Table 17 indicators. Results indicated eighth-grade participants born late-preterm, compared with full-term peers, demonstrated:

1. Slightly greater mean t-scores on standardized mathematics assessment
2. Teacher and participant report of typical, age-appropriate course level
3. Typical levels of mathematics engagement and enjoyment, as reported by participant
4. Statistically significantly increased adjusted relative risk
    a. Poor relations with peers in mathematics class
    b. Excessive passivity in mathematics class
    c. Mathematics teacher perception of decreased ability to apply concepts to real-world, modeling, and written reasoning
5. Greater adjusted relative risk of mathematics teacher report
    a. Homework non-completion in mathematics
    b. Non-recommendation for honors or advanced mathematics classes
    c. Poor attention in mathematics class
    d. Falling behind in class due to lack of effort or disorganization
    e. Tardiness to mathematics class
    f. Referral to administration or counselor due to disruptive behavior

Table 18

Summary of Eighth-grade Mathematics Outcomes for Participants Born LPT

Statistically significant increased relative risk	
Relates poorly with peers	
Teacher perception of poorer ability to apply concepts to real-world	
Teacher perception of poorer ability to model in mathematics	
Teacher perception of poorer ability in written reasoning	
Excessively passive in class	
Greater relative risk	**On par with full-term peers**
Not recommended for advanced classes	Standardized mathematics t-score
Teacher perception of poorer ability to verbalize reasoning	Participant self-concept of good math grades
Poor attention in class	Participant self-concept of math enjoyment
Teacher perception of poorer ability to conduct proofs	Participant self-concept of math engagement
Outside referral for disruptive behavior	Fall behind due to health problems
Fall behind due to lack of effort	Fall behind due to discipline
Homework non-completion	Fall behind due to lack of skills
Fall behind due to disorganization	Fall behind due to frequent absences
Excessive tardiness	Ability to use technology/computer

Present study outcomes with greater adjusted relative risk and statistical significance

Table 19 displays summary comparisons of aRR of statistically significant outcomes, for participants born late-preterm compared with full-term peers. Results indicate greatest statistically significant, relative risk of disability-related outcomes in kindergarten and first grade. Statistically significant, increased adjusted relative risk indicates provided special education services continued into fifth grade, for participants born late-preterm.

For eighth-grade participants born late-preterm, mathematics teachers reported adverse outcomes of excessive passivity and poor inter-student relations, with statistical significance. Additionally, mathematics teachers statistically significantly reported lower ability levels of participants born late-preterm compared with full-term peers, in the areas of real-world application, written reasoning, and modeling.

Table 19

Comparison of Sig. Study Outcomes, for Participants Born LPT

Outcome	LPT aRR	LPT aRR 95% CI
Disability-related outcomes		
FMS personnel report services Grade K	2.19	1.35, 3.50
Parent report of disability kindergarten	1.80	1.41, 2.26
Parent report of IEP first grade	1.59	1.06, 2.33
FMS personnel report services Grade 5	1.48	1.01, 2.11
Parent report of disability Grade 1	1.44	1.12, 1.81
Asthma diagnosis	1.42	1.09, 1.80
Emotional behavior evaluation	1.42	1.02, 1.74
Mathematics-related outcomes		
Excessively passive in class	1.49	1.01, 2.13
Decreased ability to apply concepts to real world	1.72	1.17, 2.53
Decreased ability to write reasoning	1.54	1.02, 2.31
Decreased ability to model	1.59	1.05, 2.41
Relates poorly to others in class	2.13	1.30, 3.48

* statistically significant difference in adjusted relative risk for all included outcomes

Reliability

To test reliability within the present study, an interrater validated current sample data abstraction from ECLS-K database into statistical analysis software. The researcher trained the interrater observer to follow step-by-step procedures to abstract selected data from public-use ECLS-K dataset, using provided data abstraction software. The researcher selected a 0.10 convenience sample of indicator variables, including binary and continuous variables, from the overall sample of included variables. The observer extracted 0.02 of the selected convenience sample with the researcher – while following provided procedural guidelines, and was able to pose queries or concerns with the process. The rates of abstraction between observer and researcher were 100% in the training phase. The observer then extracted the other 8% of the convenience sample. Inter-observer agreement was determined point-by-point, with percentage of agreement calculated. The percentage of agreement was determined by multiplying by 100 total agreements, divided by sum of agreements and disagreements. A minimum of 0.80 reliable data was required for the present study, with preferred agreement of 0.90. The researcher scored all abstracted data within the convenience sample; agreement was 100%.

Validity

Results from the included systematic literature review indicated a gap in empirical findings on school outcomes for individuals born late-preterm in adolescence. A call for literature on the long-term outcomes of this population was made in 2005 and 2015, by multiple national organizations, including the NIH (Raju et al., 2006; Raju et al., 2017); the researcher responded to the call with the present investigation. Findings within the current study parallel those found by other researchers in earlier school grades (Chyi et al., 2008; Lipkind et al., 2012;

Morse et al., 2009). Validity is restricted, as the study has not been replicated, and research (to date) on school outcomes of the late-preterm population is limited to a handful of studies.

Regarding criterion-related validity, current study results rely on the extent of ESLS-K study validity, including instruments, surveys, delivery, collection, and assessments used within current study analyses. Extensive effort was given to verify ECLS-K instrument predictive and concurrent validity – psychometric reports for each grade level and instrument are easily accessed through the IES National Center for Education Statistics website. FMS personnel used trained assessors, the direct child assessment was un-timed, and inclusive and accessible data collection methods were employed to include family members and children in data collection activities (discussed within ECLS-K psychometric reports). Although the eighth grade ECLS-K sample was not nationally representative, demographics indicated a diverse sample across gender, race, SES, location, and gestation at birth.

CHAPTER FIVE: DISCUSSION

Children born late-preterm represent 8% of students in today's classroom. Late-preterm birth carries with it an (often) undetected summative effect of challenges (Church et al., 2012). Individuals born late-preterm are recommended for personalized, multidisciplinary surveillance, with "no recognized endpoint to long-term follow-up" (Gallini et al., 2014; Phillips et al., 2013, p. S17). While at higher risk of disability and adverse school outcomes, empirical investigations across the entire grade spectrum for this population are largely missing.

Previous findings indicate those born late-preterm are at risk for specific academic deficiencies complexed by compromised social, behavioral, emotional, or physical development (Amor et al., 2012; Woythaler et al., 2015). Disruptive impacts of late-preterm birth can increase struggle within the classroom; yet, individuals born late-preterm remain largely un-surveilled and potentially underserved by the academic community (Church et al., 2012). Within the past decade, medical researchers have examined school outcomes of children born late-preterm, with little to no directive input from the education community. Educators are now called to respond (Johnson et al., 2015) – including special educators, who often serve students who struggle.

To better understand potential impacts of late-preterm birth on academic outcomes in adolescence, the researcher in the present study surveilled outcomes of ECLS-K participants across two domains – disability and eighth-grade mathematics. Discussion centers on differences between groups within current study findings, with comparison to previous findings in the literature. The researcher concludes with implications of findings for special education and the secondary mathematics classroom, including proposed means of support for parents, classroom teachers, and counselors. In addition, the researcher provides suggestions for future empirical investigation, with note of limitations to the present study.

Comparison of current study findings with previous empirical findings

The researcher in the current study sought to explore outcomes of individuals born late-preterm in adolescence, in an effort to determine outcomes of a population previously examined in early school years. As background, one other group of researchers examined ECLS-K datafiles for school-related outcomes of individuals born late-preterm (Chyi et al., 2008); Chyi and colleagues (2008) explored direct child assessment test scores, teacher academic rating scales, and presence of IEP in Grades K, 1, 3, and 5. Unlike the present study, Chyi et al. (2008) included weeks' 32-$36^{6/7}$ gestation in analyses, whereas the present researcher included weeks' 34-$36^{6/7}$ gestation, per NIH guidelines for late-preterm birth categorization (Raju, 2006b).

Current disability-related findings compared with previous empirical findings

School report of IEP compared with previous findings. The researcher in this study found increased risk of school report of IEP across all measured levels (Grades K, 1, 3, 5). These findings align with ECLS-K elementary-age findings by Chyi and colleagues (2008), who also reported a dip in school report of IEP in third grade, followed by an increase in fifth-grade, which are similar to outcomes of the present study. Lipkind and colleagues (2012), in a retrospective examination of third-grade outcomes within Longitudinal Study of Early Development data warehouse in New York City (n = 215,138), found 34% greater adjusted *odds* of special education enrollment in third-grade children born late-preterm, compared with 25% greater adjusted *odds* in the present study. In an examination of kindergarten outcomes in Florida (n = 159,813), Morse and colleagues (2009) found 10% greater adjusted risk of disability or special education enrollment at age five. Comparatively, within the present study, there was 56% greater adjusted relative risk of school report of IEP in kindergarten and 80% increased adjusted relative risk of parent report of child disability in kindergarten.

Parent report of disability compared with previous findings. Present study results show greater ratios of parents with children born late-preterm reporting concerns with attention or learning. Of parents expressing concern with attention or learning, those with children born late-preterm were statistically significantly more likely to have their children evaluated by a professional. Heightened concerns with attention align with findings of Cosentino-Rocha and colleagues (2014), who found preterm birth associated with problems of attentional focusing. Regarding adverse outcome of suspension, impacting school attendance and instructional time, Morse and colleagues (2009) found 19% greater risk of suspension in kindergarten, for children born late-preterm; current study findings indicated 15% greater unadjusted risk, but no greater adjusted relative risk in eighth grade, after considering confounders of gender, SES, race, and maternal education levels.

Disability-related findings compared with previous international findings. International findings on disability-related outcomes for individuals born late-preterm is limited. However, Wiingreen et al. (2018) examined all children registered in Danish compulsory school, in school-year 2015-2016, and found 40% greater adjusted *odds* ratios for children born between 35-36 weeks' gestation (does not include gestation week 34, as analyzed in the current study). It is difficult to compare, as Wiingreen et al (2018) examined all children, rather than differentiating by grade level; but within the present study, participants born late-preterm continued to face 35% greater adjusted *odds* in fifth-grade of school report of IEP.

Current mathematics-related findings compared with previous empirical findings

Mathematics-related findings compared with previous U.S. early school findings. In the mathematics domain, Shah and colleagues (2016) and Woythaler et al. (2015), found greatest adjusted odds of poor mathematics readiness in early childhood. Yet, by eighth grade,

participants within the present study demonstrated typical levels of standardized test performance. Similarly, Chyi et al. (2008) reported greatest risk of poor mathematics outcomes for participants born late-preterm in kindergarten and first grades, compared with third and fifth grades. Risk of poor mathematics outcomes decreased with increasing grade level. Notably, Chyi and colleagues (2008) found mathematics t-scores demonstrated less risk than teachers anticipated, as did the researcher in the current study. Eighth-grade mathematics teachers rated student ability statistically significantly lower than full-term peers, yet standardized test means were at or above full-term levels.

Findings of teacher ratings versus findings of standardized test results. In contrast to findings within the current study in eighth grade, Williams (2013), ElHassan (2018), and Lipkind and colleagues (2012) found greater risk of mathematics failure or lower mean on competency tests, for individuals born late-preterm, in first and third grades. Overall, findings of mathematics performance amongst adolescent participants indicate typical performance on scaled, standardized achievement tests, contrasted with lower teacher ratings of late-preterm student potential in mathematics. Findings within the current study align with those of Chyi and colleagues (2008), who examined mathematics outcomes within ECLS-K database in Grades K through five. Seemingly, this pattern of teachers rating the potential of students born late-preterm lower than actual performance continues into eighth grade for these learners, as evidenced in present study findings for mathematics.

Mathematics-related findings compared with previous international findings. As mentioned, current study findings indicated eighth-grade participants within the current study performed at or above full-term peers on standardized mathematics assessment. Searle and colleagues (2017) found just 12% greater adjusted relative risk of being at or below minimum

standard in numeracy for Grade 3, in a retrospective examination of Southern Australian national assessment data. No researchers, to date, examined secondary mathematics outcomes in individuals born late-preterm, so comparison to eighth-grade mathematics outcomes is restricted.

Implications of current study findings

Measured areas of potential non-concern, based on current findings

The researcher found three potential areas of non-concern, regarding eighth-grade mathematics outcomes of adolescents born late-preterm, within the present study sample. First, eighth-grade participants born late-preterm performed at or above full-term peers, on measured standardized mathematics assessment. Second, the current late-preterm sample remained on-pace to graduate, with typical mathematics course progression, based on eighth-grade mathematics teacher report of late-preterm participants not falling behind due to health, absences, or discipline – compared with full-term peers. Third, eighth-grade participants born late-preterm reported positive self-concept in mathematics, reporting enjoyment, "good grades," and confidence in mathematics on par with full-term peers. Based on above-mentioned study results, included late-preterm sample participants presented characteristics of students needing minimal support in areas of conceptual ability and content acquisition. Table 20 displays eighth-grade mathematics outcome areas of non-concern, based on current study findings.

Table 20

Resultant Potential Areas of Non-concern Within Current Study

Areas of non-concern, based on current findings
On-grade-level mathematics assessment performance
On pace to graduate with typical mathematics course progression, based on not falling behind due to health, absences, or discipline
Strong positive self-concept about mathematics, both as a subject and performance

Measured areas of potential concern, based on current findings

While the researcher in the present study found three potential areas of non-concern, results indicated adolescent participants within the present study presented with potential outcomes, and awareness of potential concerns may benefit parents and education professionals. Results within the current study indicate eighth-grade participants born late-preterm were at greater adjusted risk of the following outcomes of potential concern: struggle with inter-peer relations; excessively passive behavior in class; attention difficulties or disability; speech or hearing concerns in normal conversation; disruptive behavior in class; and struggle with organizational or time management skills. Figure 5 provides an awareness checklist based on outcome results for the present sample of eighth-grade participants born late-preterm. Within Figure 5, highlighted awareness areas are accompanied by researcher-proposed means, elevating the awareness of these potential concerns for parents, teachers, or counselors.

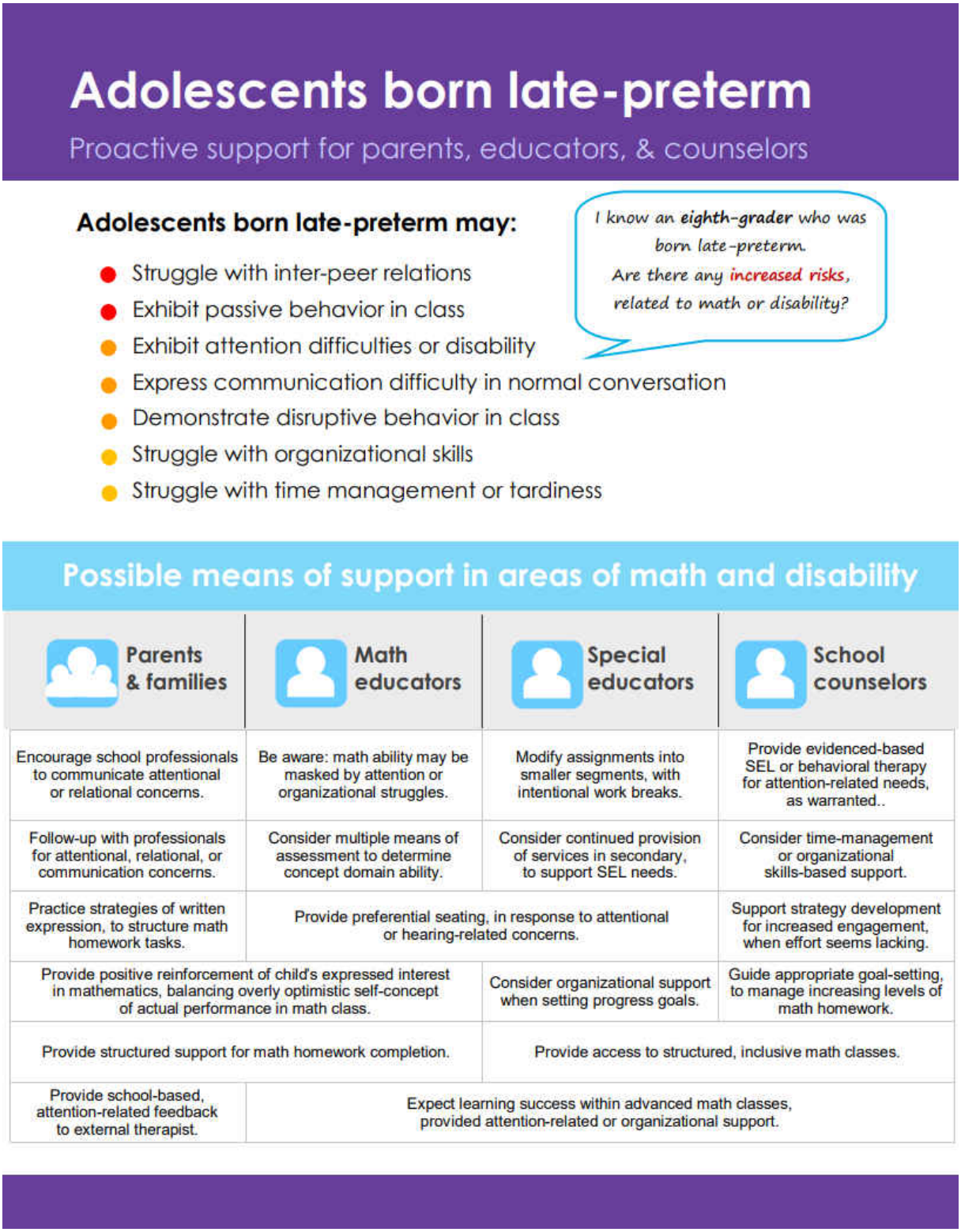


Figure 5: *Sample Awareness Checklist for Parents, Educators, and Counselors*

Implication of current study findings for parents of adolescents born late-preterm

The first level of support for students born late-preterm is the parent advocate, whose role is to promote awareness and provide longitudinal surveillance of individual child's needs. As background, researchers in the medical profession spearheaded an effort to provide multidisciplinary guidelines for the care of individuals born late-preterm (Phillips et al., 2013). A key provision within said guidelines is continued communication between professionals and families of individuals born late-preterm regarding potential risks for disability, development, and special education-related services. Phillips and colleagues (2013) emphasize educating caregivers to recognize signs of developmental or cognitive delay, behavioral or emotional needs, and attention or hyperactivity disorders; however, guides to monitor developmental outcomes often are provided by professionals to parents within early-intervention years, but may taper off as children progress in school and development. Although risks may still be present for those born late-preterm, as indicated in target areas in this study, awareness of risks may not be communicated by professionals to parents throughout the spectrum of child development.

The above multidisciplinary guidelines encourage parents to advocate for the needs of their children born late-preterm. As suggested by Phillips and colleagues (2013), parents should follow-up with professionals regarding attention, relational, or communication concerns. Notably, participants within the current study had 25% greater adjusted relative risk of individual or family-based attention-related therapy; as such, the present researcher encourages parents to relate school-based feedback on attention needs, with outside therapists, to promote positive child growth and development in areas related to attention. In reverse, parents are encouraged to communicate risks or diagnosed presence of attention-related disorders to school professionals, to promote awareness and proactive support.

To provide home support to the late-preterm, eighth-grade student who struggles with written expression in mathematics (as noted in the present study), parent advocates could request teachers provide structure models for each problem type, and provide models of written expression, to help students respond. Students born late-preterm, in the present study, were reported with greater adjusted relative risk of struggling with verbal reasoning in mathematics; parents can encourage their children to use "think alouds," which are strategies to verbalize and shape mathematical reasoning, before moving into written expression of process.

Also, based on current study results, which demonstrated greater participant self-concept of performance in mathematics than teacher report of performance, parents are encouraged to communicate directly with teachers, to ensure their child's report of success matches that of the teacher – thereby promoting early communication and subsequent student success. Through greater awareness of potential risks, identification of present need, and ongoing communication with professionals, the parent advocate can provide a first line of defense and support for the adolescent born late-preterm to ensure greater success and access to higher-level mathematics content.

Implication of current study findings for mathematics educators

Within the eighth-grade mathematics classroom, the general education setting is primary for students born late-preterm; yet, struggles persisted for adolescent participants born late-preterm, within the present study. As previously noted, performance on mathematics standardized testing demonstrated typical levels of achievement in eighth-grade, while teacher perspective of behavior and attention indicated late-preterm students struggled in these areas. This struggle may be validated, as eighth-grade participants born late-preterm faced 20% greater adjusted relative risk of parent report of disability, and 15% greater adjusted relative risk of

ECLS-K report of provided special education services. Within the current study, results from both teacher and parent perspectives noted the late-preterm adolescent struggled in areas of attention, behavior, or sensory-related issues (41% increased risk of hearing difficulty, following reported communication concerns).

Of note to the eighth-grade mathematics teacher working with students born late-preterm who struggle with attention, previous empirical study demonstrated a statistically significant negative association between inattentiveness and problems in mathematics (Tosto et al., 2015), with contributory factors of organizing, planning, inhibitory control, and "increased continuous attention and regular independent seat work, resulting in difficulty in learning" (Tosto et al., 2015, p. 11). Proactive educator response and support within the eighth-grade mathematics classroom could minimize adverse outcomes for students struggling with attention-related needs.

Proposed supports provided by the general education mathematics teacher. The researcher proposes proactive Universal Design for Learning (UDL)-based supports within general education mathematics, to enhance success of adolescents born late-preterm who struggle. The following ideas could benefit any student, but for the adolescent born late-preterm, these strategies could minimize adverse effects of attention- or learning-related issues found within the current study. These ideas include:

- providing a flipped classroom model to promote multiple means of access to content before classroom entry, thereby freeing class-time to provide explicit multi-step modeling and problem-solving support
- reducing rote written homework requirements; instead, provide ample opportunities for in-person questions and guided problem-solving

- providing collaborative learning groups to promote verbal discussion of concepts between learners, and between learners and teacher facilitator
- providing frequent checks for understanding through multiple media, such as individual white boards or technology/app supports
- providing multiple and explicit models to guide problem-solving
- providing tangible and relatable applications to real-world scenarios, while activating background knowledge

Again, these recommendations may optimize learning for all students, but also may provide adolescent students born late-preterm who struggle with attention (such as participants within the present study), a pathway to access advanced mathematics courses.

As students progress in levels of mathematics, the above-mentioned strategies become increasingly vital to ensure students successfully navigate through complex, multi-step processing and modeling. Results within the present study indicated eighth-grade students born late-preterm faced 49% increased adjusted risk of teachers not recommending them for honors or advanced classes. This finding is troubling, with students performing at or above peers on standardized assessments; it seems logical, equal achievement should equal access to advanced or college-preparatory classes. Yet, evidence indicated eighth-grade mathematics teachers, within the present study, did not agree. Parents can serve as an advocate to encourage educators to consider expanding access to advanced classes; rich coursework can provide valuable experiences designed to prepare students for post-secondary content and quality, and future job success. Students born late-preterm, regardless of struggles with attention or engagement, deserve equal access. These findings warrant further exploration of outcomes at the high school level, or within advanced levels of mathematics for students born late-preterm.

Implication of current study findings for special educators

Approximately 3.5 million children born late-preterm are currently educated in the K-12 system; preterm birth rate continues to rise – with a rate of 7.28% late-preterm (Martin et al., 2018). To those in special education, even minute increases are significant – increasing percentage points represent swelling numbers of students headed for a special education system beset with teacher and budget shortages (Mason-Williams et al., 2020). In the current study, schools reported 13% of students born late-preterm have an IEP in fifth grade, compared with 11% of those born full-term – numbers consistent with previous early-school findings. Increased risk of parent report of disability, for participants born late-preterm, remained above full-term peers, into eighth grade (20% greater adjusted relative risk). Over the course of 13 years in the public school system, the impact of additional risk for the individual born late-preterm may be substantial. As the rate of late-preterm birth continues to rise, associated impacts on adolescent outcomes in mathematics and disability may follow.

Proposed support through educator-based special services. While students born late-preterm in the present study did not struggle with content comprehension in mathematics, eighth-grade participants saw greater risk of attention-related disability or difficulty – which present potential adverse impacts to the learning process. Student engagement is often an integral piece of the learning experience; findings within the current study suggest students born late-preterm may struggle with both engagement and inter-personal classroom relationships (evidenced by decreased attention, excessive passivity, and poor inter-personal relations). The researcher proposes the following supports to meet the needs of eighth-grade mathematics students born late-preterm: preferential seating, modification of assignments into smaller segments, reduction of workload, distraction-reduced workspace, and advocation for continued services in secondary

grades to support the SEL needs of the eighth-grade student born late-preterm. Notably, the majority of students born late-preterm will be provided special education services in the general education classroom – reiterating AACTE's call for general education teachers to be prepared to meet the needs of all learners, including those with disabilities (Blanton et al., 2011).

Implication of current study findings for school-based counselors

The researcher in the present study also proposes proactive school counselor support, as a supplemental line of service for students born late-preterm. Contemporary counselors are prepared to engage all learners in developing healthy SEL strategies and growth. For the late-preterm adolescent who struggles in the mathematics classroom, organizational and explicit time management coaching may be beneficial, in addition to support in areas of engagement, work activation, and goal-setting for homework completion. Counselors, despite large caseloads, with further awareness and information tracking systems, could identify students born late-preterm, at the secondary grade-levels, and provide group or individual proactive supports, with each year's grade progression. The researcher proposes counselors be aware of potential increased risk of adverse school outcomes, related to impacts of late-preterm birth. Through a team approach, counselors can provide tertiary support in meeting the needs of this population.

Implications of current study findings for future research

When considering the limitations of the current study regarding the public-use portion of the ECLS-K datafile, a need exists for a more accurate snapshot of special education outcomes, through analyses of restricted portions of the database, which include eighth-grade school report of IEP and disability-specific data. Through future investigation of restricted portions of the ECLS-K datafile, the researcher could gain a more comprehensive understanding of disability-related outcomes for the present study sample in eighth grade. Available to approved researchers

within restricted portions of the datafile are school reports of IEP in eighth-grade, special education teacher detailed questionnaires (teacher- and child-level), and parent reports of specific disability, with approximate dates of evaluation and diagnosis. Further categories and areas of concern could emerge from this more specific and restricted data. Table 21 provides a display of areas of future inquiry, based on current findings.

Table 21

Areas of Future Inquiry, Based on Current Findings

Areas of future inquiry, based on current findings
IEP status in eighth-grade (restricted ECLS-K)
Eighth-grade intersection of IEP status, parent report of disability, and FMS report of services
Specific disability diagnoses of participants born late-preterm (restricted ECLS-K)
Timing of disability diagnoses of participants born late-preterm (restricted ECLS-K)
Intersection of discrepancies between participant self-concept, teacher perception of ability, and actual performance on standardized mathematics assessment
Performance in advanced or honors classes – does struggle with attention impact performance

Suggestion for a comprehensive, real-time approach to student support. The researcher from this study envisions a future, rich with accessible, real-time data analysis of performance, designed to meet individual K-12 student needs. Imagine a dashboard which monitors multiple zones of performance on current goals and objectives; real-time analyses could ping indicators of struggle in attention, mathematics, problem-solving, or social emotional learning. Perhaps included within this dashboard are measures of student success across content areas, with accompanied suggestions or awareness indicators for educational or parental support. The student may struggle with problem-solving, or written expression across all content areas, including mathematics. The dashboard indicators could alert both parents and teachers, thereby

promoting proactive intervention. For the student born late-preterm, supplemental suggestions of responsive support, with awareness of risk, may be built into the dashboard, based on parent and teacher feedback. A comprehensive, real-time team approach to promote awareness and support may be especially valuable at the secondary level, especially at a time when students are presented with upward of 45 teachers over the course of six years and with teachers who serve over 150 students per day. The researcher recognizes proposing increased individualized attention to "one more" category of learners by overwhelmed teachers may seem unrealistic; however, by gaining awareness of potential areas of concern, teachers could be encouraged to see beyond the relative risk of behavioral or social emotional issues, as identified for this population, to the true mathematical skillset of these learners, leading to consideration for advanced learning opportunities in mathematics.

Suggestions for future inquiry, based on current study findings. Based on current study findings, suggestions for future inquiry include emphasis on attention- or learning-related evaluations, or diagnoses within the late-preterm sample; present study results demonstrated increased need within this area of disability at eighth-grade level. Heightened awareness is warranted to ensure adolescents born late-preterm receive ongoing support with and access to advanced mathematics, as a key component to future academic and lifetime success. The researcher also recommends additional investigation into social-emotional-related evaluations or diagnoses for the present sample, as eighth-grade mathematics teachers reported excessive passivity in class, poor inter-student relations, and notable disparity between parent and teacher reports of attention needs and disruptive behavior concerns.

In addition, movement from large retrospective datafiles may be warranted in future investigations, to examine outcomes of present eighth-grade students. To gain understanding of

late-preterm adolescents in today's mathematics classroom, a large *n* quantitative research design may be appropriate, including follow-up questions on engagement and ability in mathematics classes. Perhaps analyses of current test scores in addition to adolescent participant and teacher surveys could provide a more comprehensive representation of current classroom dynamics. Further research could also include observations of potential deficit areas in classroom settings.

Finally, the ECLS-K datafile measured disability through parent, FMS, and school report. Additional insight may be gained by exploring report of 504 versus IEP within this population of students reported to have typical IQ, but lower achievement in other areas. Examination of IEP, 504, and counselor support at the school level could certainly provide greater understanding of the late-preterm disability-related phenotype in adolescence, as opposed to a retrospective analysis approach, as demonstrated within the current study.

Study Limitations

Limitations to the current study include those associated with retrospective quantitative study, including: inability to access participants; inability to control study instruments; inability to control data collection processes, correction, or follow-up; inability to control population or sample demographics or sampling; inability to assign causation; data collection prone to misclassification bias or error; influence of confounding variables; and limited application of results to general population. The present study sample was neither population representative nor current. The kindergarten class of 1998-1999 graduated in 2011; political, social, and educational policies, standards, and goals have evolved numerous times since their entry into and graduation from the K-12 education system. In addition, neonatal and pediatric care they received may be inferior to that which individuals born late-preterm receive today – as medical policies and best-practices continue to evolve.

Further, as with any retrospective study, the public-use datafile limits the findings to analyses of measures included in the initial study. The researcher in the present study examined disability-related outcomes with variable outcomes limited to the restricted datafile, which was not available due to the pandemic. Key statistics, such as school report of IEP in eighth grade, were unavailable within the public-use datafile. Finally, the researcher in the present study included parent report of child disability, child birth weight, and child gestational age at birth – all of which are subject to error, thereby restricting validity of present study results.

Summary

In response to increased risks faced by 7.3% of U.S. schoolchildren, the fields of teacher preparation in mathematics and special education should, together, ensure all teachers are prepared to reach students with heightened attention and learning needs. The inclusive, co-taught eighth-grade mathematics classroom provides a foundation to ensure student success in high school and subsequent post-secondary experiences. By preparing preservice teachers to deliver content-rich material in evidence-based UDL format, within the mathematics classroom, teacher preparation programs pave the way for students with disabilities to access STEM careers. This provision of access and equity to rich mathematical experiences ensures today's struggling eighth-graders become tomorrow's 21st century problem-solvers and innovators. When given opportunities to flourish in mathematics, through parent, educator, and specialized support, the late-preterm student can evolve from an adolescent who may struggle with peer relationships, passive behavior, and attention difficulties into a confident, out-of-the-box-thinker who develops the cure to the next global pandemic.

APPENDIX A: UNADJUSTED ODDS AND RISK OUTCOMES

Mathematics-related Academic Outcomes for Eighth-grade Sample Participants Born LPT

	LPT uOR	LPT uOR 95% CI	LPT uRR	LPT uRR 95% CI
Participant report				
Mathematics good grades	1.13	0.87, 1.46	1.03	0.96, 1.11
Math teacher report of participant				
Decreased hwk completion	1.01	0.68, 1.51	1.01	0.74, 1.38
No rcommd honors	1.32	0.89, 1.96	1.08	0.98, 1.20
*Decreased ability apply real	1.43	1.01, 2.04	1.13	1.02, 1.25
Decreased ability proofs	1.24	0.86, 1.78	1.07	0.96, 1.19
Decreased ability verbal rea	1.38	0.97, 1.97	1.11	1.00, 1.24
*Decreased ability write rea	1.48	1.02, 2.16	1.12	1.02, 1.23
*Decreased ability to model	1.44	0.99, 2.10	1.12	1.01, 1.24
Decreased ability calculator	1.04	0.73, 1.47	1.02	0.83, 1.27
Decreased ability computer	1.10	0.66, 1.83	1.04	0.84, 1.30
Participant report				
Math best subject	1.11	0.88, 1.40	1.05	0.95, 1.16
Enjoyment math	0.93	0.74, 1.17	0.96	0.84, 1.09
Liking math	1.07	0.85, 1.34	1.03	0.93, 1.14
Math teacher report				
*Not relate well others	2.00	1.28, 3.11	1.83	1.26, 2.66
Not attentive in class	1.40	0.98, 2.02	1.29	0.99, 1.68
*Excess passivity in class	1.49	0.98, 2.28	1.40	0.99, 2.00
Math teacher report “fell behind”				
Antecedent to falling behind				
Health problem	1.13	0.43, 2.94	1.12	0.47, 2.65
Discipline problem	0.65	0.25, 1.67	0.68	0.29, 1.60
Lack of effort	1.73	0.83, 3.61	1.13	0.99, 1.28
Disorganized	1.15	0.65, 2.06	1.09	0.77, 1.56
Lack of skills	0.60	0.31, 1.20	0.69	0.40, 1.17
Other reason	0.48	0.21, 1.08	0.55	0.27, 1.10
Frequent absences	0.62	0.19, 2.03	0.64	0.21, 1.96
Emotion/family problems	1.73	0.50, 5.93	1.69	0.53, 5.40
Participant adverse behavior				
Tardiness	1.09	0.58, 2.06	1.09	0.60, 1.96
Referral for behavior	1.22	0.68, 2.18	1.17	0.73, 1.87

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use

Disability-related Academic Outcomes for Sample Participants Born LPT

	LPT uOR	LPT uOR 95% CI	LPT uRR	LPT uRR 95% CI
School report of IEP				
Kindergarten	1.26	0.78, 2.05	1.24	0.79, 1.95
*First grade	1.38	0.91, 2.11	1.34	0.92, 1.96
Third grade	1.10	0.74, 1.63	1.09	0.77, 1.54
Fifth grade	1.29	0.89, 1.86	1.25	0.91, 1.72
FMS report of SPED services				
*Kindergarten	1.99	1.23, 3.20	1.93	1.23, 3.02
First grade	1.18	0.71, 1.95	1.17	0.72, 1.88
Third grade	1.45	0.99, 2.12	1.41	1.00, 1.98
*Fifth grade	1.42	0.98, 2.05	1.38	0.99, 1.92
Eighth grade	1.08	0.73, 1.60	1.08	0.75, 1.54
Parent report disability				
*Kindergarten	2.30	1.74, 3.03	1.98	1.60, 2.44
*First grade	1.57	1.18, 2.08	1.45	1.16, 1.81
Third grade	0.97	0.74, 1.26	0.98	0.80, 1.19
Fifth grade	1.31	0.98, 1.76	1.25	0.99, 1.59
Eighth grade	1.31	0.97, 1.77	1.25	0.98, 1.60
Eighth-grade parent report				
*Attention or learning evaluation	1.96	1.01, 3.81	1.23	1.04, 1.45
Attention or learning diagnosis	1.62	0.56, 4.69	1.06	0.95, 1.20
Speech evaluation	0.63	0.21, 1.86	0.81	0.48, 1.39
Speech diagnosis	0.58	0.11, 3.18	0.88	0.55, 1.42
Hearing difficulty	2.20	0.65, 7.51	1.86	0.76, 4.55
Hearing evaluation	1.42	0.13, 15.64	1.11	0.59, 2.06
*Asthma diagnosis	1.57	1.17, 2.11	1.46	1.15, 1.85
Asthma treatment	0.84	0.48, 1.46	0.94	0.77, 1.15
Child attention	1.11	0.79, 1.56	1.10	0.82, 1.47
Child distraction	0.97	0.76, 1.24	0.98	0.85, 1.14
Individual therapy, attention	1.56	0.80, 3.05	1.34	0.88, 2.04
Family therapy, attention	1.58	0.67, 3.73	1.48	0.73, 3.00
Poor behavior	0.89	0.65, 1.22	0.91	0.70, 1.18
Poor behavior peers	1.12	0.70, 1.82	1.11	0.71, 1.75
Behavior concern	1.50	0.55, 4.07	1.16	0.84, 1.60
Behavior evaluation	0.95	0.31, 2.94	0.98	0.58, 1.64
Emo. behavior conc.	0.82	0.58, 1.17	0.84	0.62, 1.15
*Emo. behavior eval.	2.48	1.23, 5.01	1.48	1.17, 1.88
School suspension	1.18	0.84, 1.65	1.15	0.86, 1.54

Data source: Early Childhood Longitudinal Study-Kindergarten Cohort, US Department of Education, public-use

APPENDIX B: IRB DETERMINATION OF EXEMPTION LETTER

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

NOT HUMAN RESEARCH DETERMINATION

March 2, 2020

Dear Annette Romualdo:

On 3/2/2020, the IRB reviewed the following protocol:

Type of Review:	Initial Study
Title of Study:	Academic outcomes of students born late-preterm in kindergarten and first grade
Investigator:	Annette Romualdo
IRB ID:	STUDY00001447
Funding:	None
Grant ID:	None
Documents Reviewed:	• HRP-251 - FORM - Faculty Advisor Review ADR_Diekersigned.pdf, Category: Faculty Research Approval; • ECLSK_K8_Manual_part1.pdf, Category: Other; • ECLSK_K8_Manual_part2.pdf, Category: Other; • HRP-250 - FORM - Request for NHSR - ARomualdo_v_1.docx, Category: IRB Protocol;

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human in which the organization is engaged, please submit a new request to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

Racine Jacques, Ph.D.
Designated Reviewer

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