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Early school readiness predictors of grade retention from kindergarten through eighth grade: A multilevel discrete-time survival analysis approach

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ABSTRACT

The literature on predictors and effects of grade retention is vast. Known predictors of grade retention include gender, ethnicity, poverty, parental education, and academic skills. The subsequent effects of grade retention are hotly debated; however, many studies have shown grade retention to be detrimental to the student. The current study used a multilevel discrete-time survival analysis to investigate when grade retention is most likely in addition to whether school readiness predictors influenced grade retention at both the child- and school-level above and beyond background and demographic factors using data from the Early Childhood Longitudinal Study—Kindergarten Cohort. The results suggested that grade retention was most likely by third grade. Importantly, results indicated that school readiness predictors, specifically low early academic skills (i.e. reading, math, and general knowledge skills), were the strongest predictors of grade retention. When school readiness predictors were controlled for, within schools, variables previously shown to be risk factors (e.g. ethnicity and language spoken at home) were protective factors, underscoring the importance of including school readiness factors when studying grade retention and examining school- and child-level effects.

School performance of children in the U.S. is a topic of great concern. Ever since the passing of the No Child Left Behind Act (No Child Left Behind Act of 2001, 2002), there has been immense pressure on schools nationwide to show improvements in their test scores at earlier grades. NCLB introduced high stakes testing into the education system, requiring students to take standardized tests on designated years throughout their schooling. In addition, schools and teachers were held accountable for children's academic performance. Numerous factors can influence a child's academic success, many starting before the child begins formal schooling. For example, several studies have found early factors such as reading, math, general knowledge, fine motor, and gross motor skills to predict later academic achievement (Cunha, Heckman, Lochner, & Masterov, 2006; Duncan et al., 2007; Entwisle, Alexander, & Olson, 2005; Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010). However, some children continue to fall behind expected levels of academic performance.

One popular, yet controversial, policy implemented to improve children's academic achievement is to retain (hold back) students who appear to be falling behind in order to give them the chance to meet the requirements of their current grade level (Abidin, Golladay, & Howerton, 1971; Bali, Anagnostopoulos, & Roberts, 2005; Jimerson, 2004; Lorence, 2006; Owings & Magliaro, 1998). Thus, grade retention has been implemented as a means of improving low-achieving students' academic performances (Bali et al., 2005; Warren & Saliba, 2012). Currently, 2.4 million students are retained each year, costing 13 billion dollars to pay for the extra year of schooling (Anderson, Whipple, & Jimerson, 2002).

Although grade retention appears as a viable solution to ensure academic success, several studies have shown no positive effect of grade retention on academic achievement (Hong & Raudenbush, 2005; Wu, West, & Hughs, 2008). Grade retention has been associated with several negative outcomes, such as school-drop out (Alexander, Entwisle, Dauber, & Kabbani, 2004; Andrew, 2014; Eide & Showalter, 2001; Jimerson, Anderson, & Whipple, 2002), increases in disruptive behaviors (Jimerson & Ferguson, 2007; Pagani, Tremblay, Vitaro, Boulerice, & McDuff, 2001), and higher rates of absenteeism (Jimerson, 2001). In Jimerson's (2001) comprehensive meta-analysis, 20 studies spanning kindergarten

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through 12th grade were analyzed for effects of grade retention on academic and socioemotional outcomes. Samples of retained students were matched with promoted students on academic achievement, IQ, socioemotional adjustment, SES, and gender. Overall, 80% of the studies reported unfavorable outcomes for retained students. Although initial gains may be evident for retained students, in the long run, grade retention appears to be detrimental to students (Holmes, 1989; Jimerson, 1999). In a similar meta-analysis, Holmes and Matthews (1984) showed that retained students had lower scores in math, reading, social adjustment, and attitude toward school than their classmates who were not retained. In their study examining the impact of grade retention on adolescence, Jimerson and Ferguson (2007) found that not only did grade retention not lead to better academic achievement, but it led to greater rates of aggression among those held back. In addition, retained students were five times more likely to drop out of high school. Thus, the evidence shows that grade retention can be harmful to students in the long-term, yet it is still practiced at alarming rates. Because of this, more emphasis needs to be placed on understanding when exactly children are at most risk for grade retention, and the best way to identify children who are at risk for grade retention early on in their academic careers. Early interventions could then be put into place that would preserve students' expected grade trajectory.

Determining the factors that lead to grade retention help identify students who are at risk for grade retention. Established factors found to influence grade retention include living in poverty, low maternal education level, being male, being a minority, younger age at kindergarten entry, child behavioral problems, having special needs, exposure to household smoking, being an English-Language Learner (ELL) student, and poor academic performance (Anderson et al., 2002; Byrd & Weitzman, 1994; Mantzicopoulos, 2003; Shepard, 1997; Winsler et al., 2012). Dauber, Alexander, and Entwisle (1993) analyzed data from the Beginning School Study, a longitudinal study that followed children in Baltimore City Public School, and found that children who were retained were typically male, African-American, and living in poverty with less educated parents. In a similar study, when investigating predictors of grade retention in kindergarten, Mantzicopoulos, Morrison, Hinshaw, and Carte (1989) found children who were retained were more likely to be younger, male, of lower IQ, and had poorer academic test scores, in addition to attention deficits. In a more recent study, Winsler et al. (2012) examined kindergarten grade retention in a sample of ethnically diverse children and found ELL students were less likely to be retained compared to native language speakers, and that Caucasian children and children with lower social skills were more likely to be retained. Indeed, there is no lack of research examining the predictors of grade retention. Some reasons why these children are more at risk for grade retention include males maturing later than females, children not having school readiness skills, and minorities who live in poverty tend to have parents who are less educated.

Still, what is lacking in the grade retention literature is the use of advanced methodology to examine both the occurrence and timing of grade retention while studying school-level and child-level associations because schools and school districts vary in their demographic composition and potentially vary in their likelihood of retaining students. For example, in the grade retention literature, studies rarely examined the timing of grade retention, used large nationally representative samples, controlled for early childhood academic and behavioral characteristics, accounted for the nesting of children within schools, or examined grade retention at the school level, all of which can lead to a false understanding of grade retention and its predictors. In fact, many studies have acknowledged the methodological challenges in studying grade retention (Allen, Chen, Wilson, & Hughes, 2009; Andrew, 2014; Pagani et al., 2001). Some researchers have attempted to address some of these issues by using structural equation modeling to investigate the effects of grade retention on behavior over time (Pagani et al., 2001), or by re-evaluating published studies on the effects of grade retention using more advanced multilevel modeling methods to account for the clustered nature of the data (Allen et al., 2009). However, such studies often examine the effects of grade retention and not the predictors of grade retention. To our knowledge, no studies to date have used advanced methods to examine the timing and occurrence of grade retention, as well as predictors of the timing and occurrence of grade retention at both the child- and school-level.

In the current study, we examine the effect of early academic skills (mathematics, literacy, and general knowledge), early childhood behavior, such as interpersonal or social skills, approaches to learning, internalizing and externalizing behavior, and self-control, and early fine and gross motor skills on the occurrence of grade retention while controlling for demographic and background variables. Previous studies have found these school readiness factors (i.e., academic, behavior, and motor skills) to be highly predictive of later academic success (Cunha et al., 2006; Duncan et al., 2007; Entwisle et al., 2005; Grissmer et al., 2010). Therefore, we were interested in whether these same school readiness factors were predictive of grade retention, a different but important indicator of academic success. We were also interested in confirming previous research on the nature of associations between demographic factors and grade retention. Specifically, the goals of the current study were to (1) examine the occurrence and timing of grade retention using advanced statistical methods, (2) parse out child-level and school-level predictors of the occurrence of grade retention, (3) identify demographic and background variables that influence the occurrence of grade retention, (4) ascertain if early school readiness factors (e.g., academic and motor skills) and behavioral factors (e.g., social skills) affect the likelihood of grade retention, above and beyond demographic and background variables at both the child- and school-levels, and (5) explore whether the associations between occurrence of grade retention and academic and behavioral measures varied as a function of demographic factors.

Due to the nesting of children within schools, multilevel discrete time survival analysis was used to model the relation between these predictors and grade retention from kindergarten through 8th grade using data from the Early Childhood Longitudinal Study—Kindergarten (ECLS-K) Cohort, a nationally representative sample of 21,260 children who were in kindergarten in 1998–1999. This data structure allows us to distinguish between school- and child-level effects on grade retention. That is, previous research has been unable to determine if the observed associations are partly due to differences between schools. For example, previous research has found that lower income students are more likely to be retained; however, this association is a combination of school- and child-level associations and it is unclear how much each attributes to the overall likelihood of being retained. Is it that schools serving lower income children are more likely to retain students, *and* children who are low income compared to their peers are more likely to be retained? Or are schools that serve lower income children *less* likely to retain students, but children who are low income compared to their peers are more likely to be retained?

At both the child- and school-levels, we hypothesize that children with greater early school readiness skills will be at less risk for grade retention, above and beyond demographic and background predictors. However, we also believe that certain demographic characteristics such as gender, socioeconomic status, maternal education, ethnicity, language spoken at home, age at which the child begins kindergarten, and whether s/he has special needs will influence the likelihood of grade retention. Specifically, as previous research has shown, we believe that children who are younger at

the start of kindergarten, live in poverty, are male, are minority, have special needs, and speak a language other than English at home will be at more risk for grade retention. Lastly, we explore whether the relation between the occurrence of grade retention and academic and behavioral factors will differ depending on gender, poverty status, ELL status, and ethnicity.

Method

Participants

Data from the ECLS-K were used in the study. Since we only wanted to examine the first occurrence of grade retention, we limited our sample to first-time kindergarteners ($N = 17{,}219$). The ECLS-K followed a cohort of children who were in kindergarten in 1998–1999. The children were followed for nine years (i.e., most children were completing 8th grade at study completion). Data were collected from multiple sources at seven time points (fall and spring of kindergarten and first grade, and spring of third, fifth, and eighth grade) on a multitude of factors including academics, behavior, and demographics. Males and females were equally represented. Mean age at kindergarten entrance for first-time kindergarten children was 65 months and ranged from 54 to 79 months. Sixty-eight percent of the sample was European–American, 14% was African-American, and 18% was Hispanic. Sixteen percent lived below the poverty threshold and 13% were non-English speakers. Mean education level for mothers was 13.46 years ($SD = 2.49$) and ranged from eight to 20 years. Ten percent of the children had special needs.

Measures

All the predictors used in this study were collected in the fall of kindergarten because of our interest in evaluating early predictors of grade retention. Unfortunately, most ECLS-K scales and tests were not available for public consumption, so access to actual scales/tests and specific items were not available. Therefore, the reported psychometric properties were garnered through various reports posted on the National Center for Education Statistics website. Readers are referred to the website for more information (www.nces.ed.gov/ecls).

Early academic measures

Measures of early academic success were collected through direct cognitive assessments. These assessments included measures of reading, math, and general knowledge. The cognitive battery was developed through a five-step process, which included a review of current instruments, creation of an item pool, and field tests carried out on the measures to determine their psychometric properties. The measures were field tested four different times to evaluate their properties. The reading assessment measured basic skills such as letter recognition, recognition of common words, print familiarity, and beginning and ending sounds. The internal consistency (alpha) coefficients ranged from 0.93 to 0.97. The math assessment included number and shape recognition, counting from 1 to 10, and relative sounds and patterns. Alpha coefficients ranged from 0.92 to 0.94. The general knowledge assessment measured the children's understanding of the physical and natural world. Alpha coefficients ranged from 0.88 to 0.89. Each student was administered an adaptive test and scores represent the student's Item Response Theory (IRT) scale score.

Behavioral measures

Behavioral measures were collected through a social rating scale (SRS), which was derived from the Social Skills Rating System (Gresham & Elliott, 1990). Both the children's teachers and parents reported the frequency of certain behaviors using a 4-point Likert-type scale where four represented more of the behavior and one represented less of the behavior. For the purposes of our study, we only included teacher's social rating scale scores. Exploratory and confirmatory factor analyses were used to construct and validate the scales. The split half reliability ranged from 0.78 to 0.90 across behavioral measures.

The behavioral measures included Self-Control, Approaches to Learning, Interpersonal Skills, Externalizing, and Internalizing Behaviors. The Self-Control Scale included four items assessing the child's ability to respect the property of others, accept peer ideas for group activities, control behavior and temper, and appropriately respond to pressure from peers. The Approaches to Learning Scale had six items measuring perceived attentiveness, eagerness to learn, learning independence, task persistence, flexibility, and organization. The Interpersonal Skills Scale included five items measuring the child's ability to get along with other children, express feelings, maintain friendships, and comfort others. Five items made up the Externalizing Problem Behaviors Scale: frequency with which the child argues, fights, gets angry, disrupts the classroom, and acts impulsively. Lastly, the Internalizing Problem Behaviors Scale included four items: presence of anxiety, loneliness, low self-esteem, and sadness. Exploratory and confirmatory factor analyses were used to construct and validate the scales. The split half reliability ranged from 0.78 to 0.90 across behavioral measures (ECLS-K Psychometric Report, 2002).

Psychomotor measures

The fine and gross motor skills measures were derived from the motor scale of the Early Screening Inventory-Revised (Meisels, Marsden, Wiske, & Henderson, 1997). The fine motor scale was comprised of seven tasks: build a gate, draw a person, and copy five simple figures. Children received up to two points for the first two tasks, and one point for the remaining five tasks for a possible total of nine points. The gross motor scale was comprised of four tasks, each worth up to two points (nine possible points total): balancing, hopping, skipping, and walking backwards. The internal consistency (alpha) coefficient was 0.57 for the fine motor scale and 0.51 for the gross motor scale; however, the authors of the report note that the low values were most likely due to the fact that the scales had few items and little variance (ECLS-K Psychometric Report, 2002).

Analytic techniques

Since children were nested within schools we evaluated the intraclass correlations of our variables to determine if a multilevel model was appropriate. Intraclass correlations ranged from 0.003 to 0.498, indicating that a multilevel model would be useful for our analyses. Thus, a multilevel discrete-time survival analysis model was fit to the data to study the associations between the occurrence of grade retention in grades 1, 3, 5, and 8 and academic, behavioral, and motor predictors while controlling for demographic and background variables. The advantage of using survival analysis is that this method examines if and when an event occurs (the event in this case is grade retention) as well as what factors influence the probability of the event occurring while taking into account those individuals for which the event did not occur during the study (Singer & Willett, 1991). Two methods for describing the data are the survival and hazard functions. The survival function represents the probability that a randomly selected student will not be held back over time (i.e., will progress through the grade levels as expected), whereas the hazard function is the conditional probability that a student will be held back in a particular time interval, given the student has not already

been held back. The hazard function provides information about the time interval at which students are most at risk for grade retention.

In discrete-time survival analysis, the proportional hazard model represents the relation between the hazard function and predictors; however, a logit transformation of the hazard is required to maintain a linear relation between the predictors and the hazard function (Singer & Willett, 1991). The baseline hazard represents the risk of event occurrence at each time point when all other predictors are zero. Each predictor's coefficient represents a vertical shift from the logit baseline hazard. This shift may be positive or negative, depending on the sign of the coefficient. The model is said to be proportional because it makes the assumption that all raw hazard profiles corresponding to each value of the predictor are approximately proportional (Singer & Willett, 1991).

Data analysis

After initial inspection of the correlations between all continuous variables (Table 1), we began our analyses by exploring the dimensionality of the early academic and behavior variables. We wanted to determine if fewer factors could adequately account for the correlations between these variables in order to isolate more fundamental aspects of school readiness. We ran an exploratory factor analysis (EFA) including the reading, math, general knowledge, externalizing behavior, internalizing behavior, approaches to learning, self-control, and social skills variables on half of our sample. We fit a one, two, and three-factor model to the data. After we determined the proper number of factors from the EFA, we used the second half of the data to run a confirmatory factor analysis (CFA).

To begin the survival analysis, we first fit a baseline multilevel discrete-time survival model. At first, third, fifth, and eighth grades, a dichotomous *event* variable was created which equaled 1 if the event had occurred (i.e., student was held back), 0 if the event had not occurred, and missing if the observation was censored. For each time of data collection (i.e., grade) the ECLS-K data set had a variable stating the student's current grade. In order to determine whether a student was held back a grade, we used information from the current grade of the student and the grade he/she should be in. If the student was in a grade lower than the grade he/she should be, he/she was considered to be held back. For example, if during the fifth time point (3rd grade), a student's current grade variable was less than three, he/she was considered retained. A latent variable representing survival was indicated by the *event* variables with factor loadings equal to 1 at both the within- and between-school levels. The variance of the survival factor was fixed at 0 at both levels. To derive estimates of the baseline hazard function, the threshold for each event variable was estimated.

Effects of school and child demographic variables were then added as predictors of the survival factor. Before analyses were conducted, all categorical variables were dummy coded. Categorical variables included whether a student was African-American (non-African-American = 0, African-American = 1), or Hispanic (non-Hispanic = 0, Hispanic = 1), as well as gender (male = 0, female = 1), socioeconomic status (above poverty line = 0, below poverty line = 1), primary language (English = 0, Non-English = 1), and special needs (no = 0, yes = 1).

In the third model, measures of the child's abilities were entered into the model. These included fine and gross motor ability and estimated factor scores of the academic and behavioral latent variables. Estimated factor score were utilized because estimation issues were encountered when attempting to fit a joint multilevel factor and multilevel survival model.

Finally, the interactions between academic, behavior, gender, socioeconomic status, and both ethnicity variables were included in the fourth model. The interaction variables were simply the product of each school readiness variable with each demographic variable.

For all predictor variables, with the exception of gender, school mean centered values were entered at level 1 and school means were entered at level 2. Thus, we model both school-level differences and child-level differences within schools. All analyses were conducted using full information maximum likelihood estimation in the M*plus* v.6 statistical software (Muthén & Muthén, 1998–2011). Incomplete data on the predictor variables were handled by specifying their distributions in M*plus* v.6. We note that 257 participants had missing values on all predictor variables and outcome variables because they were lost to follow-up in first grade; therefore the final sample size was reduced to 16,962.

Results

The results are organized into four sections. First, we describe results from the exploratory and confirmatory factor analyses of early academic and behavior skills variables. Second, we discuss the baseline hazard function without any predictors. Third, we describe the associations between demographic and background variables as well as school readiness skills with the occurrence of grade retention at both the school- and child-levels. Lastly, we describe interaction effects between school readiness and demographic and background variables on the grade retention.

Exploratory and confirmatory factor analysis of school readiness variables

The total sample was split into two through random sampling. Fit information and model comparisons of the EFA models are presented in Table 2. We statistically compared the fit of the models using a likelihood-ratio test. The difference in the −2 log-likelihood (−2LL) values for nested models follows a chi-square distribution with degrees of freedom equal to the differences in the number of parameters of the two models. If the difference in the −2LL is significant, then we conclude that the more complex model fits better. If the difference is not significant, we retain the simpler model. When we compared the fit of the models, the three-factor model fit reasonably better than the two-factor model, although the two-factor model's fit was good (χ^2 (13) = 859, $p < 0.0001$, CFI = 0.973, TLI = 0.947, RMSEA = 0.088). However, when we examined the standardized factor loadings (the correlation between that item and the factor) and eigenvalues (Table 3), the three-factor solution appeared to overextract factors (e.g., factor loadings above 1, uninterpretable factors), whereas the two-factor model was reasonable. Thus, we decided the two-factor model fit the data best. The strength and significance of the standardized factor loadings suggested that Factor 1 represented academic achievement, which was strongly indicated by the math, general knowledge, reading, and approaches to learning variables. Factor 2 represented behavioral problems and was strongly indicated by the internalizing, externalizing, approaches to learning, self-control, and social skills variables. It is worth noting that approaches to learning loaded strongly onto both factors in the EFA, which was not surprising because the scale measures eagerness to learn, organization, attention, and learning independence, all of which are important for academic achievement. In fact, previous research has shown self-regulated learning (ability of a student to be organized, display effort and persistence with learning, self-motivated, flexible, etc.) is highly correlated with positive academic achievement (Duncan et al., 2007; Zimmerman, 1990; Zimmerman & Schunk, 2001).

Taking the results from the two-factor EFA model, a CFA model was fit on the remaining half of the sample ($N = 8496$) with the academic factor indicated by the math, reading, general knowledge, and approaches to learning variables, and the behavior factor indicated by the social skills, internalizing behavior, externalizing

Table 1
Correlations between continuous variables.

Variable	Kindergarten age (1)	Reading score (2)	Math score (3)	General knowledge score (4)	Ext. behavior (5)	Int. behavior (6)	Approaches to learning (7)	Self-control (8)	Social skills (9)	Fine motor skills (10)	Gross motor skills (11)
1	–										
2	0.147	–									
3	0.255	0.717	–								
4	0.276	0.500	0.617	–							
5	−0.020	−0.131	−0.145	−0.149	–						
6	−0.042	−0.135	−0.174	−0.157	0.249	–					
7	0.141	0.353	0.414	0.354	−0.497	−0.359	–				
8	0.051	0.174	0.198	0.208	−0.696	−0.275	0.661	–			
9	0.058	0.208	0.243	0.250	−0.554	−0.344	0.698	0.780	–		
10	0.215	0.329	0.432	0.370	−0.159	−0.142	0.358	0.179	0.207	–	
11	0.132	0.143	0.196	0.180	−0.095	−0.113	0.212	0.101	0.136	0.250	–

Table 2
Comparison of a one, two, and three-factor model ($N = 8466$).

	No. of parameters	−2LL	RMSEA	CFI	TLI	Δ No. of parameters	Δ −2LL
1 Factor	24	225,537.818	0.250	0.668	0.536		
2 Factors	31	215,832.146	0.088	0.973	0.943	7	9705.672*
3 Factors	37	214,989.930	0.013	1.000	0.999	6	842.216*

Note: *$p < .05$.

Table 3
Summary of two and three-factor model results for academic and behavior variables.

Model	Variable	Factor 1	Factor 2	Factor 3
2 Factor solution	Mathematics	**0.935**	0.231	
	Reading	**0.779**	0.195	
	General Knowledge	**0.669**	0.256	
	Externalizing	−0.148	**−0.717**	
	Internalizing	−0.197	**−0.353**	
	Approaches to Learning	**0.455**	**0.749**	
	Interpersonal Skills	0.287	**0.852**	
	Self-Control	0.219	**0.917**	
3 Factor solution	Mathematics	**0.949**	0.316	0.155
	Reading	**0.770**	0.269	0.130
	General knowledge	**0.659**	0.334	0.174
	Externalizing	−0.142	**−0.620**	**−0.608**
	Internalizing	−0.182	**−0.425**	−0.235
	Approaches to learning	**0.438**	**0.825**	**0.571**
	Interpersonal skills	0.268	**0.852**	**0.674**
	Self-control	0.200	**0.820**	**1.144**
Eigenvalue		3.691	1.756	0.836

Note: Standardized loadings above 0.35 appear in bold.

Table 4
Summary of two-factor confirmatory model of academic and behavioral variables.

Variable	Standardized factor loadings	
	Academic	Behavior
Mathematics	0.924	
Reading	0.765	
General knowledge	0.661	
Externalizing		−0.703
Internalizing		−0.355
Approaches to learning	0.270	0.679
Interpersonal skills		0.862
Self-control		0.906

Note: All estimated factor loadings were significant. Factors correlated significantly at 0.272.

behavior, approaches to learning, and self-control variables. The two-factor CFA model fit the data well (χ^2 (28) = 30,788, $p < 0.0001$, CFI = 0.965, TLI = 0.946, RMSEA = 0.084). Standardized factor loadings for both factors are reported in Table 4. Estimates were almost identical to those of the two-factor EFA, but the factor loading of the approaches to learning variable on the academic factor dropped from 0.455 to 0.270. Nevertheless, all but two factor loadings across both factors were above |0.65|. We decided the school readiness variables could justifiably be represented by our two factors: academics and behavior.

Baseline hazard function

To investigate the influence of the background and school readiness variables, we fit four multilevel discrete-time proportional hazard models to the data. Model comparison statistics are included in Table 5 and parameter estimates from all four models can be found in Table 6. Table 6 includes both the child-level (within-school) and school-level (between-school) estimates for all models.

The first model assessed the probability of being retained in four different grade levels. This model builds the baseline hazard function and is as follows

$$\text{logit}\left(h_{ijt}\right) = \alpha_1 \cdot E_{ij1} + \alpha_2 \cdot E_{ij2} + \alpha_3 \cdot E_{ij3} + \alpha_4 \cdot E_{ij4} \quad (1)$$

where $\text{logit}h_{ijt}$ is the logit of the hazard for individual i in school j at time t, α_1, α_2, α_3, and α_4 represent the threshold or intercept coefficients for each grade's event variable (E_1, E_2, E_3, and E_4 = grade 1, 3, 5, and 8). By first grade, the conditional probability of a child

Table 5
Comparison of four discrete-time survival models.

	No. of parameters	−2LL	Δ No. of parameters	Δ −2LL
Model 1	385	379,135.40	.	.
Model 2	400	378,042.19	15	1093.21*
Model 3	408	376,999.91	8	1042.28*
Model 4	410	376,952.17	2	47.74*

Note: $^{*}p < .05$.

being retained was 3.6%. By third grade, that probability increased to 5.8%. By fifth and eighth grade, the probability of being retained decreased to 2.1% and 1.7%, respectively. The results of the baseline hazard model indicated that a child had the highest probability of being retained between first and third grade. Overall, 87% of the children never experienced grade retention from kindergarten through 8th grade meaning that 13% were retained.

Predictors of grade retention

In the next three models, we included demographic characteristics, then added school readiness indicators, and then included the interaction of academic and behavior skills with gender, poverty status, ELL status, and ethnicity at both levels. These models can be written as:

$$\text{log it}\left(h_{ijt}\right) = \alpha_1 \cdot E_{ij1} + \alpha_2 \cdot E_{ij2} + \alpha_3 \cdot E_{ij3} + \alpha_4 \cdot E_{ij4} + \beta \cdot \text{child}_{ij} + \gamma \cdot \text{school}_j \quad (2)$$

where child_{ij} represents the collection of child-level predictors (gender and school-centered child demographics in Model 2, school-centered school readiness skills added in Model 3, and interaction of school-centered academic and behavior skills with school-centered gender, poverty status, ELL status, and ethnicity in Model 4), $\boldsymbol{\beta}$ is a vector of child-level regression coefficients, school_j represents the collection of school-level predictors (school mean demographics in Model 2, school mean school readiness skills added in Model 3, and the interaction of school academic and behavior means with school gender, poverty status, ELL status, and ethnicity means in Model 4), and $\boldsymbol{\gamma}$ is a vector of school-level regression coefficients.

In Model 2, which only included child and school demographics, age at kindergarten entrance, gender, socioeconomic status, mother's education, and special needs were significant predictors of the risk of grade retention within schools. Children who began kindergarten at a younger age, males, lower-income children, children with special needs, and children whose mothers had less education compared to the students in their school were more likely to be retained. Briefly, we mention some of the larger effects: the odds of males being retained was 1.7 times greater compared to females and the odds for children below the poverty line and children with special needs were two times greater compared to those above the poverty line and without special needs.

At the school level, on average, schools with younger students, more African-American students, more children living below the poverty line, more students' with lower educated mothers, and more students who primarily spoke English at home were more likely to retain children. Most notably, the odds for schools below the poverty line to retain children were almost four times higher compared to schools above the poverty line. In addition, the odds for schools in which most children spoke English at home to retain students was three times greater compared to schools where children primarily spoke something other than English at home, schools with more children whose mothers had higher education levels had twice the odds of retaining students compared to schools with more children whose mothers' had lower education levels, and schools with more African-American children had 1.5 times greater odds in retaining children compared to schools with more children of other ethnicities.

In the third model, we added the school readiness indicators. With the addition of the motor, behavioral, and academic predictors, all predictors at the child-level were significantly associated with grade retention with the exception of special needs. Children whose mothers had lower levels of education, children who began kindergarten at a younger age, European–American/Asian children, males, children living below the poverty line, children who primarily spoke English at home, children who had lower fine and gross motor skills, and who had lower behavioral and academic skills were more likely to be held back. Academic skills had the biggest impact on retention. For every one standard deviation decrease in academic skills, children were at five times greater odds to be retained. Also, the inclusion of the school readiness predictors altered the associations of the background variables with grade retention. For one, special needs were no longer a significant predictor, but language spoken at home and whether children were African-American or Hispanic were now significant predictors of grade retention. Notably, children who primarily spoke English at home and who were not African-American or Hispanic, were approximately at 1.4 times greater odds to be retained, indicating that African-American and Hispanic children and children who did not speak English at home were less likely to be retained when controlling for early school readiness skills.

At the school level, the inclusion of school readiness predictors did not change the effects of the background variables with the exception of the mother's education level variable, which was no longer significant. Schools below the poverty line had a little over two times greater odds to retain students compared to schools above the poverty line, schools with more African-American students were at 1.3 greater odds to retain students compared to those with more children of an ethnicity other than African-American, and schools with children that primarily speak English at home were at 2.3 greater odds to retain students compared to schools with more ELL students. Gross motor skills and behavioral skills were not significant predictors of grade retention, whereas the association between academic skills and grade retention at the school level was large, indicating that on average, with one standard deviation decrease in schools' mean academic skills, children were at three times greater odds to be retained.

In the final model (Model 4), we examined interactions between academic and behavior skills and gender, ethnicity, and poverty. Interaction terms were entered one at a time at both the within and between-school levels. The only significant interaction was found between academic skills and poverty within schools. We note that all previous effects found in Model 3 remained the same in Model 4, thus we only interpret the interaction effect. Compared to children living above poverty and at the mean for academic skills, children who were living below poverty and were at the mean for academic skills were at two times greater odds to be retained a grade. However, children living below poverty but who were two standard deviations above the mean on academic skills were actually less likely to be retained. Conversely, children below poverty and two standard deviations below the mean were at 18 times greater odds

Table 6
Parameter estimates for multilevel discrete-time proportional hazard models ($N = 16{,}962$).

Within schools (child-level)																
Predictor	Model 1				Model 2				Model 3				Model 4			
	Estimate	SE	*P*	Odds ratio	Estimate	SE	*P*	Odds ratio	Estimate	SE	*P*	Odds ratio	Estimate	SE	*P*	Odds ratio
E1(intercept)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E2(intercept)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E3(intercept)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E4(intercept)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
K-age					−0.144	0.008	<0.05	0.866	−0.079	0.009	<0.05	0.924	−0.080	0.009	<0.05	0.923
African-American					0.081	0.113	n.s.	1.084	−0.352	0.113	<0.05	0.703	−0.347	0.114	<0.05	0.707
Hispanic					0.045	0.105	n.s.	1.046	−0.285	0.109	<0.05	0.752	−0.278	0.109	<0.05	0.757
Gender					−0.547	0.056	<0.05	0.579	−0.414	0.059	<0.05	0.661	−0.415	0.059	<0.05	0.660
SES					0.747	0.090	<0.05	2.111	0.422	0.092	<0.05	1.525	0.685	0.126	<0.05	1.984
Primary language					−0.195	0.112	n.s.	0.823	−0.250	0.115	<0.05	0.779	0.071	0.086	<0.05	1.074
Mother's education					−0.550	0.059	<0.05	0.577	−0.072	0.086	<0.05	0.931	−0.192	0.062	<0.05	0.825
Special needs					0.702	0.080	<0.05	2.018	0.076	0.086	n.s.	1.079	0.073	0.086	n.s.	1.076
Fine motor									−0.066	0.016	<0.05	0.936	−0.067	0.016	<0.05	0.935
Gross motor									−0.035	0.015	<0.05	0.966	−0.037	0.016	<0.05	0.964
Behavior									−0.119	0.034	<0.05	0.888	−0.118	0.034	<0.05	0.889
Academic									−1.600	0.069	<0.05	0.202	−1.621	0.070	<0.05	0.198
SESXAcad													0.501	0.172	<0.05	1.650
Note: We only report results from significant interactions, all other interaction paths were set to 0 and model was rerun																
Between schools (school-level)																
	Model 1				Model 2				Model 3				Model 4			
E1(intercept)	−3.300	0.046	<0.05	0.037	3.866	1.064	<0.05	47.751	−0.091	1.203	n.s.	0.913	−0.143	1.210	n.s.	0.867
E2(intercept)	−2.786	0.039	<0.05	0.062	4.463	1.064	<0.05	86.747	0.591	1.203	n.s.	1.806	0.541	1.210	n.s.	1.718
E3(intercept)	−3.862	0.076	<0.05	0.021	3.444	1.066	<0.05	31.312	0.352	1.205	n.s.	1.422	−0.400	1.212	n.s.	0.670
E4(intercept)	−4.080	0.091	<0.05	0.017	3.263	1.067	<0.05	26.128	0.497	1.207	n.s.	1.644	−0.545	1.213	n.s.	0.580
K-age					−0.101	0.016	<0.05	0.904	−0.048	0.018	<0.05	0.953	−0.047	0.018	<0.05	0.954
African-American					0.396	0.110	<0.05	1.486	0.282	0.120	<0.05	1.326	0.282	0.121	<0.05	1.326
Hispanic					−0.231	0.195	n.s.	0.794	−0.352	0.207	n.s.	0.703	−0.337	0.207	n.s.	0.714
SES					1.298	0.169	<0.05	3.662	0.847	0.182	<0.05	2.333	0.923	0.304	<0.05	2.517
Primary language					−1.096	0.239	<0.05	0.334	−0.880	0.250	<0.05	0.415	−0.903	0.250	<0.05	0.405
Mother's education					−0.680	0.128	<0.05	0.507	−0.006	0.155	n.s.	0.994	0.013	0.162	n.s.	1.013
Special needs					0.306	0.284	n.s.	1.358	−0.129	0.298	n.s.	0.879	−0.166	0.298	n.s.	0.847
Fine motor									−0.142	0.046	<0.05	0.868	−0.134	0.048	<0.05	0.875
Gross motor									−0.004	0.049	n.s.	0.996	−0.007	0.050	n.s.	0.993
Behavior									−0.037	0.079	n.s.	0.964	−0.061	0.080	n.s.	0.941
Academic									−1.096	0.128	<0.05	0.334	−1.104	0.139	<0.05	0.332

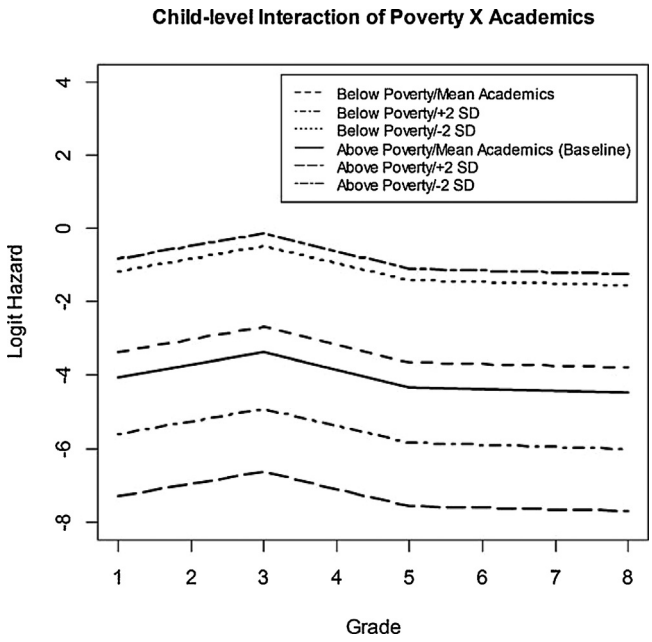

Fig. 1. Interaction plot of child-level academic skills by poverty status.

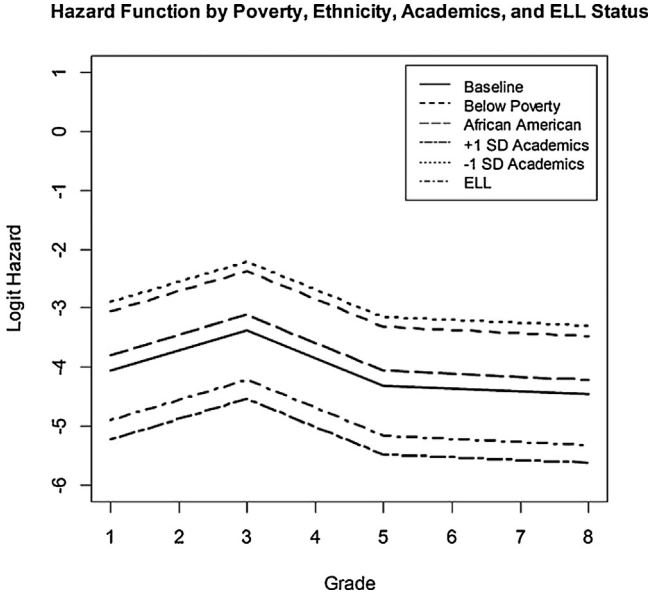

Fig. 2. School-level hazard functions based on poverty status, ethnicity, academic skills, and ELL status. Baseline represents children above poverty, children who are an ethnicity other than African-American, children at the mean of academic skills and who are non-ELL.

to be retained a grade. Children living above poverty but two standard deviations below the mean on academic skills were the most at risk for being retained a grade. They were at 25 times greater odds to be retained compared to children living above poverty but at the mean of academic skills. Fig. 1 graphically displays this interactive association.

Between schools, all variables that were significant from Model 3 remained and no interactive effects were significant. Fig. 2 depicts the differences in likelihoods of grade retention for four variables–poverty status, ethnicity, ELL status, and academic skills. The comparisons are made between schools who are below or above the poverty line, schools with predominantly African-American students or students who were an ethnicity other than African-American, schools with more ELL students or more students who primarily speak English at home, and schools at the grand mean of academic skills, one standard deviation above the grand mean, or one standard deviation below the grand mean on academic skills.

Discussion

In this study, we used advanced statistical methods to examine the timing of grade retention and predictors of the occurrence of grade retention from kindergarten through eighth grade. Our primary interest was to investigate whether early school readiness predictors (i.e., academic, behavior, and motor skills) were significantly associated with the occurrence of grade retention, above and beyond demographic and background variables. Although many previous studies have examined the predictors of grade retention, very few have used nationally representative samples or multilevel survival model to account for school- and child-level effects. This study was an attempt to fill this gap in the literature. Given the negative outcomes associated with grade retention at the student level, as well as at the larger level of society and the economy, examining early predictors of grade retention in order to minimize the need for grade retention or to develop interventions is important.

Our results illuminate just how important early academic skills are for potentially preventing grade retention. In regards to the timing of grade retention, we found that children were most likely to be retained by third grade. When the No Child Left Behind Act passed in 2001, children were required to take annual tests starting in third grade (No Child Left Behind Act of 2001, 2002). High stakes testing held teachers accountable for student's academic performance, so it is not surprising that children were at highest risk for being retained prior to the grade in which testing began.

Through the use of multilevel modeling techniques, we were able to find predictors of the occurrence of grade retention at both the child- and school-level. By fitting four multilevel discrete-time survival models, we investigated the influence of blocks of predictors while controlling for other factors. We found that our fourth model, which added school readiness and interaction effects, fit the data the best, thus we only interpret results from this final model.

At the child-level, all of our predictors and the interaction between academic skills and poverty were significant except for special needs. Males were 70% more likely to be retained compared to females, even when controlling for background and school readiness factor. This could be attributed to males maturing later than females (Daubner et al., 1993). With each month increase in age at kindergarten entry, children were 8% less likely to be retained a grade. The benefit of a child entering schooling at an older age is that it allows the child more time to develop school readiness skills. In addition, for each one-year decrease in maternal education, the child was 5% more likely to be retained a grade. Low maternal education is also associated with poverty, which puts children at greater risk for grade retention. These results add more support to the already established risk factors for grade retention (Anderson et al., 2002; Byrd & Weitzman, 1994; Mantzicopoulos, 2003; Shepard, 1997). We also found behavior, fine, and gross motor skills had substantial influence on grade retention within schools. Children who exhibited worse fine and gross motor skills and children who had more behavior problems at school entry compared to their peers within their school at kindergarten entry were more likely to be retained. The fine and gross motor finding is in line with Grissmer et al. (2010) finding regarding its importance as a school readiness indicator, and further as a predictor of grade retention. Through the use of neuroimaging, Diamond (2000) examined the link between motor skill and cognitive function and found that during motor tasks, not only was the part of the brain responsible for motor movement activated, but the parts of the

brain responsible for cognitive functioning were also activated. For young children, poor motor skills can make learning difficult when considering the motor skills necessary for reading, speaking, and writing.

Interestingly, children who were African-American, Hispanic, and spoke a language other than English at home were significantly *less* likely to be held back a grade compared to children who were an ethnicity other than African-American or Hispanic and who spoke English at home, when controlling for early academic and behavioral skills. By including important factors associated with grade retention, such as academics, behavior, and motor skills, we were able to uncover relations between previously non-significant predictors of grade retention. At least one other study found similar results (Winsler et al., 2012). In their study, Winsler et al. (2012) examined the likelihood of children being retained in kindergarten while controlling for demographic and school readiness predictors. However, they used a cross-sectional sample based in Miami. In our study, we confirm their results with a nationally representative longitudinal sample. As Winsler et al. (2012) mentioned, a potential reason why African-Americans and Hispanics were less likely to be retained could be due to the fact that previous studies did not control for school readiness predictors. If that is the case, then our study only confirms the importance of school readiness in determining if a child will be held back a grade.

In regards to ELL students being less likely to be retained a grade, perhaps teachers recognize if an ELL student is struggling in class, it may be more a reflection of the language barrier as opposed to a lack of competence of the subject matter, and therefore be more lenient in regards to grade retention. This could be especially true since studies have shown first-generation immigrants to have less behavioral issues and higher social skills compared to non-immigrant children and even second-generation immigrant children (De Feyter & Winsler, 2009).

We also found the interaction between academic skills and poverty to be significant. Children at most risk for grade retention where those with low academic skills, specifically those living above poverty. Although living in poverty was associated with grade retention, it was mostly the child's academic skills that put them at risk for retention. For example, children below the poverty line, but above average on academic skills were actually less likely to be retained than children living above poverty but at the mean of academic skills. Thus, it appears that level of academic skills was the most important factor in determining if a child was at risk for grade retention. Again, these results confirm the substantial influence of school readiness skills, specifically academic skills on grade retention. Even a child living below poverty, but above the average on academic skills reduces his/her likelihood of being held back a grade, at least throughout elementary and middle school. To reiterate the importance of academic skills, compared to children living above poverty and at the mean of academic skills, children living above the poverty line and two standard deviations below the mean were 25 times more likely to be retained, and children living below the poverty line and two standard deviations below the mean were 18 times more likely to be retained. The impact of academic skills on grade retention is undeniable. Regardless of whether children live below or above the poverty line, academic skills should be the focus of interventions to reduce the risk of being retained.

Finally, at the school-level, school composition was related to the likelihood of grade retention. Notably, the percent of students who spoke a language other than English at home, the percent of low-income students, the percent of students who were African-American, and the average age of kindergarteners were all related to the likelihood of grade retention. Schools with younger students were more likely to retain students at a rate of increase of 5% for every month. Age of kindergarten entrance varies across states and districts. Recently, there have been shifts in entrance age for kindergartens in some states. For example, California has been moving the birthday cut-off from December 1 to September 1 over the past few years, which, based on our work, is expected to reduce grade retention rates by 15% by allowing children more time to gain school readiness skills before starting formal schooling. Schools with a greater percentage of African-American children were more likely to retain students, even after controlling for school readiness predictors. It is difficult to determine why, after controlling for all other predictors, schools with a higher percentage of African-American students were more likely to retain students. Unfortunately, our study did not allow us to examine the reasons for grade retention. Lastly, schools with a greater proportion of students who spoke a language other than English at home were less likely to retain students. This same result was found at the child level, and the reasoning translates to the school level as well. However, it also may be that schools with a high percentage of ELL students teach instruction in more than one language. Under Title 1 of the No Child Left Behind Act of 2001 (2002), schools with children with limited English proficiency are eligible to receive extra funding and bilingual education services. This potentially explains why schools with a higher percentage of ELL children had lower rates of retaining students.

Although school composition was important in predicting grade retention, once again, school readiness predictors, specifically academic skills and fine motor skills, were the strongest predictors of grade retention. Schools with children with higher levels of fine motor skills were less likely to retain students than schools with children with greater academic skills. The significance of the school-level effect highlights how grade retention varied over schools and that low performing schools were not just passing their students along. It is interesting that other school readiness factors (i.e., behavioral skills and gross motor skills) were not predictive of grade retention at the school-level. These factors were probably more important within-schools. Children with behavioral issues in a school with polite, well-behaved children will stand out more for their behavioral issues compared to children with behavioral issues in a school with other children with behavioral issues.

Limitations

The presented research is not without limitations. Although the ECLS-K data has much strength, including its representativeness and large sample size, we could only assess whether students were retained at four discrete time points. In other words, we could only determine whether students had been retained by first, third, fifth, and by eighth grade. Our observed spike in the hazard at third grade suggests an increase in the likelihood of being retained in first, second, or the beginning part of third grade. Thus, we were unable to precisely know when students were retained. Future research should include more time points to get a clearer picture of the timing of grade retention.

A second limitation is related to the way in which the students were clustered within schools-based on their school in the fall of kindergarten. Most students likely transition through multiple schools even if they remained within the same district. Additionally, many students moved between districts. Attempting to account for such shifts with a cross-classified survival model is likely possible, but we are unaware of any work on this type of model. This is a possibility for future research. Additionally, we focused on early school readiness skills and therefore thought it was most reasonable to cluster at school entry. In a sensitivity analysis, we clustered by first, third, fifth, and eighth grade schools. Results were similar when the data were organized around first and third grade schools. However, due to the low frequency of grade

retention and reduced sample size as the study progressed, certain models were unstable.

Concluding remarks

Grade retention has been explored in several studies, however many methodological issues remain when studying grade retention. Without the use of proper methodologies, studies may obtain an inaccurate and skewed view of predictors of grade retention. Understanding early predictors of grade retention is valuable. Students who are retained in school are more likely to suffer from depression and drop out of school. Further, when a student is retained a year in school, money is spent on the repeated year of schooling. This study used a longitudinal, nationally representative sample of children in kindergarten through eighth grade to parse out predictors of grade retention at both the child- and school-level and showed that early school readiness predictors, specifically academic skills, were the most significant predictors of grade retention. Importantly, at the child-level, once school readiness predictors were controlled for, previously established risk factors of grade retention were no longer risk factors and in fact were protective factors. Previous studies have contributed grade retention to factors such as ethnicity, ELL status, and poverty, but in truth, it is these children's lack of school readiness and academic skills that has been putting them more at risk for retention. Once these factors are accounted for, racial bias goes away. The results of the current study provide a direct target for teachers, schools, and policy makers when assessing whether children are at risk for being held back a grade and where to implement interventions.

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