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Early educational milestones as predictors of lifelong academic achievement, midlife adjustment, and longevity

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Abstract

This study gathered follow-up data from the Terman Life Cycle Study (N = 1,023) to examine how age at first reading and age at school entry relate to grade school academic performance, lifelong educational attainment, midlife health and mental adjustment, and longevity across eight decades. Early reading was associated with early academic success, but less lifelong educational attainment and worse midlife adjustment. Early school entry was associated with less educational attainment, worse midlife adjustment, and most importantly, increased mortality risk. Personality, midlife adjustment, and educational attainment partially mediated the school entry-longevity association (controlling for age, sex, personal characteristics, and home environment factors). Although the sample is limited in some respects and care should be taken in generalizing the results, findings do confirm the importance of lifespan approaches in understanding the effects of education on individual patterns within social contexts.

Keywords

School Readiness; Reading Ability; Academic Achievement; Psychosocial Factors; Lifespan Mortality Risk

1. Introduction

Learning to read and entering school are important early educational milestones. Reading is one of the most valuable skills developed during childhood, but is also one of the most cognitively challenging proficiencies to acquire (Lyon, 1998). Although reading is formally introduced and cultivated in the primary grades, some children begin to read before starting school, while others struggle throughout elementary school. Many believe that early success may set a positive life-course trajectory, leading to good academic and psychosocial outcomes, whereas hampered reading skills may lead to less desirable outcomes (e.g., Butler, Marsh, Sheppard, & Sheppard, 1985; Senechal & LeFevre, 2002; Stainthorp & Hughes, 2004; Wagner et al., 1997).

In a related vein, there is much debate on the optimal age of initiating school attendance. Despite numerous studies and multiple policy changes throughout the 20th century, the field remains

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divided (Jones, 2001; Sharp, 1998). The appropriate timing of school entry is necessarily a complex issue with no clear answers, due to the host of influences involved. One approach to advancing our understanding is to consider which factors may be relevant to important later life outcomes. This study uses a lifespan analysis to explore long-term academic and psychosocial correlates of the ages of learning to read and initiating formal schooling.

1.1. Precocious Reading Ability

Some studies have found that early reading abilities are both directly and indirectly related to long-term reading success (Butler et al., 1985; Lonigan, Burgess, & Anthony, 2000; Senechal & LeFevre, 2002; Stainthorp & Hughes, 2004; Wagner et al., 1997). Reading abilities measured in kindergarten are predictive of reading achievement through the fourth and sixth grades (Butler et al., 1985; Stainthorp & Hughes, 2004; Wagner et al., 1997). Nonetheless, at least one study found that differences in emergent literacy abilities did not distinguish reading ability by second grade when the first grade program explicitly focused on developing reading skills (Crone & Whitehurst, 1999).

Long-term correlates of early literacy, beyond elementary school, have not been fully explored (Torrey, 1979; Wagner et al., 1997). One possibility is that early ability offers a distinct advantage that continues throughout the educational career, resulting in better grades, greater interest in school, and higher levels of overall achievement, even among individuals of above-average intelligence. Conversely, any advantages of precocious ability may dissipate over time, or worse, although a child may be advanced academically, socio-emotional skills may not keep pace, leading to worse psychosocial adjustment (Callahan, 2006; Keitel, Kopala, & Schroder, 2003). One purpose of this study, therefore, is to extend the existing developmental research on early reading achievement to academic and psychosocial outcomes across the lifespan.

1.2. Age at School Entry: Chronological Age vs. Relative Age

One concern for both parents and policy makers revolves around school readiness. The age at which children enter school is primarily dictated by state and district laws, but parents may choose to push their child ahead or delay entry until the child is deemed “ready.” Such practices have led to kindergarten and first grade classes in which students differ in over a year of age (Meisels, 1992). Consequently, it remains unclear whether outcomes associated with school entry age relate to chronological age and the accompanying maturity levels or whether these are driven by a student’s age relative to his or her peers.

Questions regarding readiness and school entry age have existed since the 1930s (Bigelow, 1934) and, as with precocious reading, findings are mixed. Academically, some studies have found later entry is associated with better academic performance (e.g., Brenitz & Teltsch, 1989; Carter, 1956; Crossner, 1991; Dickinson, 1963; Hallwell & Stein, 1964; Jones & Mandeville, 1990; Maddux, Stacy, & Scott, 1981; Sweetland & De Simone, 1987), whereas others have found that early differences dissipate over time (e.g., Baer, 1958; Crone & Whitehurst, 1999; Davis, Trimble, & Vincent, 1980; Mayer & Knutson, 1999; Russell & Startup, 1986; Stipek & Byler, 2001; Warren, Levin, & Tyler, 1986).

Psychosocially, young age (relative to peers) has been associated with worse outcomes, including lowered self-esteem (Thompson, Barnsley, & Battle, 2004) and higher risk of attempted suicide during adolescence (Thompson, Barnsley, & Dyck, 1999; Uphoff & Gilmore, 1986). Several studies have suggested that older entrants are better adjusted socially (Baer, 1958; Bigelow, 1934; Gagne & Gagnier, 2004; Langer, Kalk, & Searls, 1984; Teltsch & Brenitz, 1988). Conversely, delaying school entry or slowing a child’s progress may relate to increased psychosocial problems (Byrd, Weitzman, & Auinger, 1997; Malone, West, Flanagan, & Park, 2006; Miller & Norris, 1967) suggesting that postponing school entry may

not be the optimal solution (Graue & DiPerna, 2000; Shepard & Smith, 1988). A second purpose of the present study, therefore, is to examine the long-term effects associated with chronological age of school entry and the relative age match with peers.

1.3. Home Environment and Personal Characteristics

Individual patterns of readiness and literacy necessarily take place within specific social contexts, determined at both individual and social levels. At an individual level, personal characteristics such as personality, intelligence (IQ), and gender may differentiate when children begin to read, their perceived readiness, and early academic and adjustment outcomes. For example, some children may be more motivated to achieve, appear more “ready”, and enter the school environment earlier than others (Durkin, 1966). Precocious reading ability and early school entry are commonly perceived as markers of intelligence, yet they are not necessarily related (Dickinson, 1963; Jackson, 1988; Kundert, May, & Brent, 1995). In addition, girls and boys mature at different rates. Numerous studies have found lower achievement levels and more adjustment problems for boys than for girls (e.g., Crossner, 1991; Dietz & Wilson, 1985; DiPasquale, Moule, & Fiewelling, 1980; Gagne & Gagnier, 2004; Hirst, 1970; Langer, Kalk, & Searls, 1984).

At the social level, socioeconomic status, attributes of the home environment, and parental attitudes and styles may create a context for learning and influence the child’s literacy interests (Fitzgerald, Spiegel, & Cunningham, 1991), which in turn may affect later academic achievement (National Institute of Child Health & Development, 2005; Ortiz, Stowe, & Arnold, 2001; Scarborough & Dobrich, 1994) and psychosocial outcomes (Berlin, Brooks-Gunn, & Aber, 2001; Burgess, Hecht, & Lonigan, 2002). Literacy achievement in the early school years appears to be rooted in early childhood experiences with activities such as storybook reading, having books available in the home, and engaging in literary activities with older family members (DeBaryshe, Binder, & Buell, 2000; Evans & Carr, 1985; Lonigan et al., 2000; Senechal & LeFevre, 2002; Sigel, McGillicuddy-DeLisi, & Goodnow, 1992). Personal attributes and early home factors are potentially influential in early educational milestones and subsequent academic and psychosocial outcomes; thus, these characteristics were included in the present study as baseline control variables.

1.4. The Present Study

One of the best ways to consider long-term consequences and trajectories is through longitudinal research that follows a group over many years. The Terman Life Cycle Study was initiated in 1922 by Lewis M. Terman as a study of gifted children in California (Terman et al., 1925). Participants were followed throughout their lives, with evaluations occurring every five to ten years. Our research team has supplemented this information with the collection of death certificates and the construction and validation of new psychosocial indices, including measures of personality, alcohol use, and mental adjustment (Friedman et al., 1993; Martin et al., 1995; Martin & Friedman, 2000; Tucker et al., 1995). Thus, the Terman data offer a unique opportunity to look at the lifelong sequelae of early educational milestones. The present study aimed to use data from this sample to examine lifelong outcomes associated with ages at first reading and school entry.

Based on a review of the literature, we hypothesized that precocious reading would set a positive trajectory, resulting in better performance in elementary school, higher educational attainment overall, and better psychosocial adjustment across the lifespan. Conversely, we expected that entering school at a relatively early age would be associated with lower academic performance and worse psychosocial adjustment across the lifespan, including increased mortality risk. In addition, we examined educational achievement, midlife health and mental adjustment, and alcohol use as potential mediators of these relations.

2. Methods

2.1. Participants

Participants were drawn from the ongoing Terman Life Cycle Study (see Friedman et al., 1993, for a complete description). In 1922, teachers across California were asked to identify both the youngest and the most intelligent children in their classes (Terman et al., 1925). The children were tested using the Stanford Binet Intelligence test, and were invited to join the study if they had an IQ of 135 or greater. Several others were added through 1928, yielding a total sample of 1,528 children (856 M, 672 F). To be consistent with previous studies and to have a relatively age-homogenous, school-age initial sample, participants born before 1904 or after 1915 were excluded (N = 155). To allow sufficient time between the initial assessment and subsequent outcomes, those who died or were lost to follow-up prior to 1930 were excluded (N = 15). Additionally, individuals missing all reading and school entry data were excluded (N = 334), leaving a final sample of 1,023 participants (508 M, 515 F). The mean birth year was 1910 (SD = 2.88 years).

Those excluded began reading at an earlier age ($t(1153) = 3.53$, $p < .001$), began school at an earlier age ($t(1159) = 12.00$, $p < .001$), came from a higher SES level ($t(1183) = 2.52$, $p < .05$), were more likely to be male ($t(1526) = 7.25$, $p < .001$), and were more likely to attend kindergarten ($t(1344) = 3.11$, $p < .01$). These differences narrow the range and decrease the statistical power somewhat, but do not introduce internal biases and adequate power remained. Those excluded did not differ from those included on childhood IQ (t (1526) = 1.05, *ns*) or on any of the personality variables.

2.2. Predictor Variables

2.2.1. Age of learning to read—In 1922, parents specified the age their child began to read ("*Did your child learn to read before starting school? At what age?*"). As the average student was almost twelve years old when first studied by Terman, the average time lag from age of reading to parental report was 5.94 years (SD = 2.91 years); this time lag introduces some unreliability and so any associations that emerge may underestimate the size of the true effect.

2.2.2. Age at school entry—In 1922, parents also noted the age and grade their child began attending school ("*Age of entering school above kindergarten*") and whether or not the child attended kindergarten. School entry age indicates the participants' age upon starting first grade. The average time lag between starting school and parental report was 5.97 years (SD = 2.79 years), which again introduces some unreliability that may underestimate true effect sizes.

2.3. Control Variables and Potential Moderators

In 1922, parents responded to various questions regarding their own backgrounds, and both parents and teachers rated the children on various physical, intellectual, and psychosocial attributes. To increase reliability, single item responses were combined to create composite variables, as specified below. Means, standard deviations, and variable ranges are summarized in Table 1.

2.3.1. Childhood intelligence (IQ)—In 1922, participants were given the Stanford Binet Intelligence exam. Additional tests were later administered to determine the reliability of these IQ scores. From these different tests, an overall best-estimated childhood IQ level was determined by Terman and his colleagues (Terman et al., 1925). IQ data were available for all 1,023 participants.

2.3.2. Childhood personality—In the initial assessment, parents and teachers rated the children on 25 different personality traits. Through factor analysis, six different personality

dimensions have previously been identified: cheerfulness (α =.52), conscientiousness (α =.76), high energy (α =.43), high motivation/self esteem (α =.71), sociability (α =.65), and permanency of moods (single item) (Friedman et al., 1993). Personality information was available for all 1,023 participants.

2.3.3. Socioeconomic status (SES)—In 1922, parents self-reported their educational and occupational backgrounds. Education for the mother and father was designated by two items: "*highest grade level completed*" and "*additional schooling experiences*". Occupation was coded according to the census categories of the time, ranging from unskilled to professional levels (Terman et al., 1925). Many women at the time did not work outside the home; if the mother was a homemaker, the occupational level of the father was used to represent the family's status. The parental education and occupation levels were standardized and summed to create a composite SES score (α =.90). SES data were available for 990 participants (491 M, 499 F).

2.3.4. Pre-school home instruction—In 1922, parents noted how often they did the following activities with their child at ages 2 to 3 and 4 to 5: reading storybooks with the child; directly teaching the child to read or write; engaging in number work (such as simple mathematics); doing scientific (nature) work with the child; and engaging in other teaching activities. These items were averaged to create a composite pre-school home instruction score (0 = *no home instruction*; 3 = *frequent home instruction*; α =.81). Pre-school home instruction scores were available for all participants.

2.3.5. Age of pubertal development—Parents and teachers most likely proposed enrollment for very young students only if they seemed relatively mature; therefore, there was likely some initial matching on maturity. However, differences in physical development may have been relevant to the processes under investigation. Pubertal age was thus included as a control variable to indicate physical development and maturity. In 1922 and 1928, parents reported age of menstruation (for females) or voice change (for males). Puberty data were available for 849 participants (354 M, 495 F).

2.4. Outcome Variables

2.4.1. Early school progression—In 1922, parents listed the number of grades the child skipped or repeated after kindergarten, in half-year increments. The total number of grades skipped and repeated was computed for each participant and used to denote elementary school progression. Data were available for 1,016 participants (502 M, 514 F) for grades skipped and 1,022 participants (507 M, 515 F) for grades repeated.

2.4.2. Teacher-rated academic performance—In 1922, teachers rated the children on their performance in various academic areas. Ratings on grammar, literature, spelling, and reading were averaged to create an overall verbal performance score (α =.77; 1 = *very poor performance*; 6 = *excellent performance*). Mathematical performance was designated by a single item (1 = *poor*; 4 = *excellent*). Math and verbal performance ratings were available for 947 participants (465 M, 482 F).

2.4.3. Teenage mental adjustment—In 1928, parents and teachers rated the child's mental adjustment. Parent and teacher ratings were combined and participants were categorized on a 3 point adjustment scale (1 = *serious maladjustment*, 2 = *some maladjustment*, 3 = *well-adjusted*).Teenage adjustment data were available for 432 participants (215 M, 217 F).

2.4.4. Age match with peers—As students, the participants followed different paths through school, starting at different ages and progressing at different speeds. To consider age in respect to other children, we created a variable that reflects age match with peers, upon

eighth grade graduation. Information regarding entry age (reported by parents in 1922), grades skipped and repeated (reported by parents and teachers in 1922 and 1928, and by participants in 1936 and 1940), and education information reported across the early assessments (years of graduating from eighth grade and high school, age of graduation, interruptions in schooling) was used to classify participants as in-synch with peers (same age, within a year), or out-of-synch (more than a year younger or older than peers). Age match information was available for 1,008 participants (500M, 508 F).

2.4.5. Overall educational attainment—In 1940, 1950, 1955, and 1960, participants indicated their highest level of completed education and any additional schooling accomplished during each interlude. Based on these responses, a total educational attainment score was constructed, ranging from 10 years (two years of high school or equivalent) to 22 years (obtained Ph.D. and completed additional coursework). Educational attainment information was available for 930 participants (466 M, 464 F).

2.4.6. Midlife health and adjustment—In 1950 and 1960, participants self-reported their general physical health in recent years on a 5-point Likert scale. The majority of the participants were in good or very good health at both time periods. Ratings from the two years were averaged, and then participant health was categorized on a four point scale (1 = *poor/very poor health*, 4 = *very good health*). Physical health data were available for 891 participants (447 M, 444 F).

Participants also specified whether they had experienced any nervousness, worry, or special difficulties in recent years, and the nature of these difficulties. Based on these responses, case histories, and personal correspondence, Terman and his colleagues categorized the participants' overall adjustment on a three point scale (1 = *serious maladjustment*, 2 = *some maladjustment*, 3 = *well-adjusted*). Mental adjustment data were available for 890 participants (446 M, 444 F).

2.4.7. Alcohol use—Excessive alcohol use may offer an alternative marker of adjustment. In 1950 and 1960, participants disclosed their alcohol use on a four point scale (1 = *no alcohol*, 4 = *alcohol is a serious problem*). Responses from the two years were averaged to indicate midlife alcohol use. Data were available for 891 participants (447 M, 444 F).

2.4.8. Mortality—We have collected death certificates (from county and state agencies throughout the country) through 2005 to ascertain and verify the year and age of death. For some participants ($N = 84$), death certificates could not be located, but relatives reported death information. Mortality information was ascertained for 876 participants (460 M, 416 F).

2.5. Data Analysis

Descriptive statistics and correlations between all predictor, control, and outcome variables were computed. To address the possibility that bivariate correlations are a function of baseline characteristics, we regressed the lifespan outcome variables (early academic performance, total education, and midlife health and adjustment) on ages at first reading and school entry, controlling for baseline characteristics (SES, IQ, pre-school home instruction, physical development, and personality), using the general linear model.

Ages of reading and school entry were then used to predict all-cause mortality from 1930 through 2005 using Cox proportional hazards regression. A step-up procedure was used: first, ages of reading and school entry were considered alone, relevant control variables were added to the model, and then possible explanatory mechanisms were added. Age and sex were controlled in all analyses. The Cox model makes no assumptions about the underlying hazard

function, but does assume that the effect of each variable is multiplicative and constant across time; therefore, a Gompertz (parametric) analysis was also used to allow effects to vary as a function of age (Allison, 1995).

Gompertz analyses were performed using RATE (Tuma, 1980); all other analyses were performed using SAS® software, version 9.1. For the continuous variables (age of reading, age of school entry, age of puberty, childhood IQ, overall educational attainment), the coefficients estimate the expected change for a single year (for age and years in school) or single point (for IQ) increase. The personality scales and the SES scale lack a natural metric; therefore, the beta coefficients were rescaled so that a one point change equals the interquartile range of that scale. This scaling makes the coefficients in the proportional regression equation estimate the difference in the log hazard ratio between a person at the 25^{th} and 75^{th} percentiles of the personality and SES scales, holding the other variables in the equation constant.

3. Results

Descriptive statistics for the predictor, control, and outcome variables are given in Table 1. On average, the sample began to read early (M = 5.65 years, SD =.92), with 35.29% of the participants reading before starting school, as expected in an intelligent sample. About half the sample (52.8%) began first grade at age six (M = 5.63 years, SD =.79). Females and males began reading at the same age ($M_{females}$ = 5.64 years; M_{males} = 5.66 years; $t(1021)$ =.38, p =.71); females began school at a slightly younger age than males ($M_{females}$ = 5.57 years; M_{males} = 5.69 years; $t(1021)$ = 2.48, p <.05).

Age of learning to read was moderately related to age at school entry, $r(1021)$ =.44, p <.001. Table 2 denotes the correlations between predictor and baseline variables.

Early reading was associated with higher IQ, higher family SES level, and more pre-school home instruction. Early school entry was associated with higher IQ, higher family SES level, and for girls, more energy. Early reading and early school entry were both related to earlier pubertal development, (reading: $r(847)$ =.10, p <.01; school entry: $r(847)$ =.18, p <.0001). For girls, early reading and early school entry were related to being rated as less conscientious.

3.1. Academic Achievement

The sample generally advanced quickly through elementary school; in 1922, only 53 students had repeated any grades, and 796 students had skipped at least one half-grade. The sample as a whole was well-educated: more than 90% completed at least high school or an equivalent level of schooling, 70.5% obtained at least a bachelor's degree (or equivalent), and 56.67% pursued post-bachelor education.

Correlational analyses indicated that both early reading and early school entry were associated with skipping more grades in school (reading: $r(1014) = -.14$, p <.001; school entry: $r(1014) = -.09$, p <.01). However, early school entry was also related to mediocre math performance in 1922 ($r(945)$ =.07, p <.05). These relations remained significant, though partially reduced, after controlling for IQ, SES, pre-school home instruction, physical development, and personality. Surprisingly, both later reading and later school entry were positively associated with more overall education (reading: β =.19, p <.05; school entry: β =.22, p <.05), when personal and home attributes were controlled.

3.2. Long-term Psychosocial Outcomes: Midlife Health and Adjustment

We examined how these predictor variables related to teenage mental adjustment (rated in 1928) and midlife health and adjustment (rated in 1950 and 1960). Correlational analyses indicated that for males, normal-aged reading was associated with better long-term adjustment,

both in their teens ($r(213) = .15$, $p < .05$), and at midlife ($r(444) = .12$, $p < .01$), and was associated with less alcohol use ($r(445) = -.09$, $p < .05$). For females, normal-aged reading was marginally associated with better teenage adjustment ($r(215) = .13$, $p < .05$), but was not significantly associated with midlife health and adjustment. For males, early school entry was marginally associated with worse midlife adjustment ($r(444) = -.08$, $p < .08$); for females, early school entry was related to increased alcohol use ($r(442) = -.12$, $p < .05$).[1] These relations remained after controlling for childhood IQ, SES, pre-school home instruction, physical development, and personality.

3.3. Long-term Associations of Chronological Age and Relative Age

Theories that relate chronological age with achievement and adjustment suggest that age alone (and the accompanying maturity level) is the most important factor (i.e., older entrants will be better adjusted). To further examine this theory, we split school entry into three groups and compared outcomes by group. Among school entrants, 394 participants (38.51%) were classified as early entrants (i.e., began first grade at or before age 5), 540 participants (52.79%) were classified as on-time entrants (i.e., began first grade at age 6), and 89 (8.70%) were classified as late entrants (i.e., began school at or after age 7). Table 3 indicates mean values for the different outcome variables, separately by group.

Due to the low number of late entrants, we combined the latter groups and compared early entrants to on-time/late entrants. Although early entrants were not at a disadvantage academically, they displayed worse psychosocial outcomes including worse midlife adjustment ($t(888) = -2.43$, $p < .05$) and more midlife alcohol use ($t(889) = 2.05$, $p < .05$).

Conversely, relative age theories contend that a child's age relative to peers is more important for adjustment (i.e., being significantly younger or older than one's peers increases the likelihood of adjustment problems). Students entered school at different ages, and some skipped or repeated grades, such that by the end of the primary grades, some students were relatively the same age as their classmates (in-synch), whereas others were significantly older or younger (out-of-synch). To consider the effect of relative age, we compared in-synch and out-of-synch students at the end of eighth grade. 668 participants (66.3%) were classified as in-synch and 340 participants were classified as out-of-synch. Early entrants were more likely to be out-of-synch with their peers ($t(1006) = 6.16$, $p < .001$). Being out-of synch related to more lifelong schooling ($t(924) = 2.68$, $p = .01$), but was marginally associated with increased midlife alcohol use ($t(884) = 1.86$, $p < .07$). Relative age did not significantly alter the relations between ages at reading and school entry and later achievement and adjustment outcomes.

3.4. Mortality Risk

By 2005, 460 males (90.6%) and 416 females (80.8%) in the sample had died. Using the Kaplan-Meier estimate, the median age of death was 78.67 years (95% confidence interval [*CI*] = 77.03, 79.86) for males and 81.63 years (*CI* = 79.96, 82.81) for females. The average age of those still alive, as of 2005, was 93.54 years (*SD* = 2.65) for males and 93.18 years (*SD* = 2.50) for females.

3.4.1. Mortality risk for ages of reading and school entry—Cox proportional hazards regression analyses were used to investigate the relation between all-cause mortality and ages of reading and school entry. As expected, age and sex were related to mortality risk, with a

[1]An additional analysis was performed to determine whether the relation between early school entry and increased alcohol use for females was driven by a linear increase in alcohol use or by moderate alcohol use (a quadratic). Alcohol was dummy coded to compare high versus low alcohol use, and moderate versus either high or low alcohol use. Early school entry significantly predicted high alcohol use ($\beta = -.30$, $p < .01$) rather than moderate use ($\beta = -.07$, $p > .37$).

lower mortality risk for females (*rh*(1,021) =.83 [*CI* =.73,.95], *p* <.01 [*rh* = relative hazard]). Table 4 indicates the results of six different models.

First, we estimated the mortality risk associated with ages of reading and school entry individually (controlling for sex and age; Model A). Across more than seven decades (1930 through 2005), age of reading was not significantly related to lifespan mortality risk (*rh*(1,021) =.99 [*CI* =.92, 1.08], *p* >.87). In contrast, age of school entry was significantly related to lifespan morality risk, with children who started school at an older age living longer (*rh*(1,021) =.88 [*CI* =.80,.97], *p* <.01). Similar results were found using the Gompertz model, (*rh*(1,021) =.90, *p* <.02). Figure 1 illustrates the relation between sex, age of school entry, and mortality risk by plotting prototypical cumulative hazard functions for entering school at age five (early entry) versus age six (normal entry), for males and females.

3.4.2. Baseline controls—To what extent are these associations a function of baseline characteristics, such as IQ and SES? The second model controlled for childhood IQ, SES, pre-school home instruction, and age of puberty (Table 4, Model B). Age at school entry remained a significant predictor of mortality risk (*rh*(800) =.86 [*CI* =.77,.96], *p* <.01).[2] Age match with peers was not significantly related to mortality risk (*rh*(972) =.97 [*CI* =.84, 1.12], *p* >.66, controlling for age and sex), and did not change any other relation when included in the model.

Previous studies using these data found that personality, specifically conscientiousness and cheerfulness, were predictive of mortality risk, with conscientious children living longer, and cheerful children experiencing an increased risk of early death (Friedman et al., 1995; Friedman et al., 1993; Martin et al., 2002); Model C thus controlled for childhood personality characteristics. As expected, conscientiousness was predictive of mortality risk (interquartile *rh*(1,021) =.84 [*CI* =.76,.95], *p* <.01), with more conscientious children living longer. Although including personality variables reduced the strength of the association, school entry age remained a significant predictor of mortality risk (*rh*(1,021) =.90 [*CI* =.82,.99], *p* <.05).

3.4.3. Explanatory pathways—Previous studies with this sample have suggested that psychological maladjustment and alcohol abuse may increase risk of early mortality (e.g., Martin et al., 1995). Late school entry was related to more educational attainment, better midlife adjustment, and less alcohol use. Thus, these variables were explored as potential explanatory mechanisms. First, we examined educational attainment as a possible mediator. Controlling for age and sex, higher educational attainment was significantly related to a reduced mortality risk (*rh*(928) =.92 [*CI* =.90,.95], *p* <.001). When age of school entry and total education were simultaneously entered (Table 4, Model D), education reduced the association between age of entry and mortality risk, but significant variance remained, indicating that total education only partially mediated this relation (school entry *rh*(928) =.90 [*CI* =.82,.995], *p* <.05).

Second, we examined midlife adjustment and alcohol use as potential mediators (Table 4, Model E). As found in previous studies, poor midlife adjustment and increased alcohol use were both associated with increased mortality risk (adjustment: *rh*(888) = 1.14 [*CI* = 1.02, 1.28], *p* <.05; alcohol use: *rh*(889) = 1.23 [*CI* = 1.13, 1.34], *p* <.001). Once again, the association between school entry and mortality was slightly reduced, but remained significant (*rh*(888) =.88 [*CI* =.80,.97], *p* <.05).

We estimated a final model that included significant baseline and midlife variables from the previous models (Table 4, Model F). When baseline characteristics (IQ, SES, conscientiousness) and midlife mechanisms (total education, adjustment, and alcohol use) were

[2]Missing data on pubertal age reduced the *N* in Model B. To examine the effect using a larger sample, a model was estimated that excluded pubertal age; this did not significantly alter the results (age of school entry *rh*(987) =.88 [*CI* =.80,.97], *p* <.01).

controlled, the confidence interval for school entry did widen to include 1.0, but significant variance still remained, indicating that although education, adjustment, and alcohol use partially play a role, additional mechanisms may still exist.

4. Discussion

The study of an applied, real-life topic within a lifespan developmental framework can deepen our understanding of both the focused social issue and more general developmental processes. The present study extends previous research by examining long-term academic and psychosocial consequences associated with the ages at first reading and entering school, using data from the Terman Life Cycle Study. We found that variables suggesting short-term readiness do not necessarily imply long-term success, thus opening a window on both practical policy and the breadth of relevant concepts.

We predicted that early reading would be associated with better academic performance and better psychological adjustment, whereas early school entry would be associated with worse long-term outcomes. These hypotheses were partially supported. Early reading was associated with early educational success, but was also associated with worse long-term outcomes including less overall educational attainment, worse teenage and adult adjustment, and increased alcohol use. As predicted, early school entry was generally associated with worse outcomes including lower math performance, less overall education, some maladjustment at midlife, increased alcohol use, and a higher mortality risk.

Early reading and early school entry were moderately related and were generally associated with positive baseline characteristics such as higher IQ and SES level. Background home characteristics are important to consider (DeBaryshe, Binder, & Buell, 2000; Fitzgerald, Spiegel, & Cunningham, 1991; Greenberg et. al., 1999), as are parental attitudes regarding when to enroll the child and how much to push the child to progress through school. Interestingly, relations between early entry and worse outcomes persisted, even when these important covariates were controlled.

Although much of the school entry literature has examined academic outcomes, fewer studies have considered long term psychosocial outcomes. In considering pathways possibly involved between early school entry and mortality risk, several potential mechanisms are apparent. Early entrants did not complete as much education as later entrants; total education was subsequently related to mortality risk (that is, more education was related to longer life). Additionally, early entrants were slightly less adjusted at midlife, and were more likely to abuse alcohol than later entrants. In turn, increased alcohol use was associated with an increased mortality risk. Such a long-term analysis suggests some preliminary pieces; lifespan trajectories are necessarily complex and involve multiple pathways and influences.

When one considers long term pathways, the short-term outcomes take on new meaning. For example, in deciding when to enroll their child, parents may believe that advanced ability signals readiness for structured learning. This may have been especially true for the Terman children growing up in the early 20th century, well before research and public policy expressed concern about age requirements. Early entrants showed early signs of success, but were less conscientious and pursued less education down the road, suggesting that, despite being exceptionally bright, they may have been psychosocially unprepared (Wilgosh, Meyer, & Mueller, 1995). The results of this study support existing theories and studies that suggest that psychosocial maturity and overall readiness, rather than age or intelligence alone, are crucial in determining when children should begin school (Byrd, Weitzman, & Auinger, 1997; Green & Simmons, 1962; Shepard & Smith, 1988; Wilgosh, Meyer, & Mueller, 1995).

Overall, these findings do not necessarily mean that age at school entry is a primary causal factor in later outcomes. Rather, this study demonstrates that varied long-term outcomes may differ from what might first be expected from a focused short-term outcome. The present study suggests that issues regarding readiness are important not only to academic outcomes in elementary school, but can extend across the lifespan. Future studies should consider both direct and indirect mechanisms connecting precocious ability and later psychosocial adjustment, and consider how concepts of age and readiness may relate to adjustment during the early school years.

4.1. Limitations and Future Direction

The sample is homogenous regarding intelligence (all high IQ), SES (mostly middle class), and ethnicity (mostly Anglo-American). While this homogeneity presents some limitations to the study, it also presents some important benefits. Comparisons can be made within the group without being confounded by characteristics such as lack of access to or understanding of health care. Previous studies using this sample have found a normal range of psychosocial characteristics and lifestyles (e.g., Friedman et al., 1995; Schwartz et al., 1995; Tucker et al., 1995), and have found significant predictors of mortality that have been replicated in other studies with different samples. The high intelligence and the higher overall educational levels may attenuate the appearance of any associations between ages of reading and school entry and later outcomes.

The Terman sample grew up in the early 20th century, and associations may reflect cohort effects and historical constraints. There was more latitude in requirements for initiating schooling, and family home structures may have differed from many modern-day environments. Further, the participants experienced several major historical events during their lives, including the two World Wars, the Great Depression, the baby boom, and the Vietnam War era (Elder & Pavalko, 1993; Shanahan, Elder, & Miech, 1997); these events may have impacted participant trajectories and outcomes. For example, participants born before 1910 were entering their careers during the Great Depression; many deferred work to pursue inexpensive education options. People born later had more work and education options, especially in the post-World War II prosperity. Despite these potential constraints, a full lifespan study necessarily relies on archival information; findings may still be relevant if they can be replicated in other studies, using contemporary samples (Tomlinson-Keasey, 1993). The prospective nature of the study offers a full lifespan perspective with certain advantages. The main advantage of this design is that Type II errors may be avoided; that is, we can find relations that may exist, which should then be examined in other studies.

The findings, and especially the effect sizes of this study, should not be generalized to other groups where different sociocultural or historical variables are relevant. The sample is clearly not representative of the full United States population at large or of other cultural groups. Nevertheless, future studies should continue to look at long-term academic and psychosocial correlates of these early milestones (especially early school entry), determine whether similar relations exist in other samples, and further investigate causal mechanisms involved.

4.2. Conclusion and Implications

The present study extends previous work on the ages of reading and entering school to academic and psychosocial outcomes across the lifespan. The findings suggest that early reading and school entry can be predictive of favorable early academic outcomes but worse long-term adjustment. The findings also highlight the complex issues regarding school entry and readiness. Policies on entrance age have focused on defining the appropriate age for children to begin school. Readiness issues are clearly important to consider, and the question remains: can readiness be determined by global policies that focus on age alone, or are individual

readiness assessments more effective in the long run? Lifespan approaches to these multifaceted issues will help us better understand the full ramifications of these important early-life developmental milestones.

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This paper is one of a series developed from our multi-year, multidisciplinary project on psychosocial predictors of health and longevity (supported by NIA grant AG08825) using data partly derived from Terman's Life-Cycle Study archives (1922–1999), and partly collected by us as a follow-up to Terman's study. All relevant findings are included in each manuscript to the extent feasible and prior publications from our project are cited when appropriate; care should be taken not to include overlapping findings in meta-analyses or other reviews. Note also that sample sizes change from paper to paper, as old data are refined, new data or death certificates are gathered, or time periods change.

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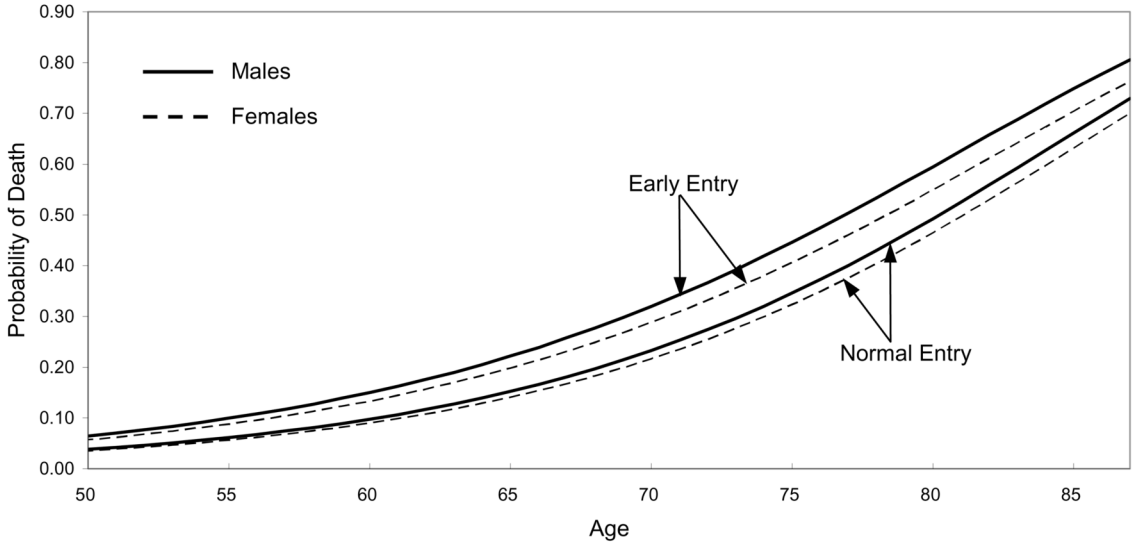

Figure 1.
Probability of death by a given age for entering school at age five (early entry) versus age six (normal entry), for males and females.

Table 1

Descriptive statistics for predictor, control, and outcome variables

Variable	*N*	Mean	*SD*	Min.	Max.
Sex, % female	1023	50.3%			
Year of birth	1023	1910	2.88	1904	1915
Age of reading	1023	5.65	.92	3.5	7.5
Age of starting 1st grade	1023	5.63	.79	3	8
% attended kindergarten	1016	50.5%			
Childhood IQ	1023	148.81	10.00	135	201
Childhood personality					
Cheerfulness	1023	20.86	2.60	13	28
Conscientiousness	1023	21.12	4.88	4	33
High energy	1023	20.98	2.41	10	32
Motivation	1023	20.87	5.24	5	36
Permanency of moods	1023	21.04	1.52	17	25
Sociability	1023	20.97	4.24	5	33
Socioeconomic status [a]	990	12.06	4.91	.45	23.98
Pre-school home instruction	1023	1.29	.97	0	3
Age of puberty [b]	849	13.41	1.44	10	18
Grades skipped	1016	1.01	.80	0	6
Grades repeated	1022	.03	.13	0	1
1922 verbal performance	947	3.30	1.39	1	6
1922 math performance	947	2.61	1.03	1	4
Teenage mental adjustment (1928)	432	2.09	.64	1	3
Age of graduating from 8th grade	1008	12.61	.86	10	14.5
Age match with peers [c]	1008	.66	.47	0	1
Overall educational attainment	930	16.50	2.65	10	22
Mid-life self-rated health [d]	891	3.21	.72	1	4
Midlife mental adjustment [d]	890	2.57	.64	1	3
Midlife alcohol use [d]	891	2.03	.89	1	4
Age of death	876	79.96 [e]	16.06	19.75	100.82

Note. Different sample sizes indicate missing data. Age is given in years. Unless otherwise specified, higher scores indicate a larger amount or higher level.

[a] Composite of father's and mother's occupation and education levels.

[b] Age of menstruation (females) or voice change (males).

[c] At 8th grade graduation, relatively similar in age to peers (within a year; coded 1) or significantly younger or older than peers (coded 0).

[d] Average of 1950 and 1960 ratings.

[e] Median age of death, using Kaplan-Meier estimate.

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Table 2

Correlations between ages of reading and school entry and baseline variables

Variable	Reading	School entry
Childhood IQ (1023)	−.14***	−.18***
Males (508)	−.15***	−.22***
Females (515)	−.12**	−.15***
SES (990)	−.10**	−.14***
Males (491)	−.12**	−.14**
Females (387)	−.09*	−.14**
Pre-school Home Instruction (1023)	−.20***	−.04
Males (508)	−.23***	−.005
Females (515)	−.16***	−.08
Puberty (849)	.10**	.18***
Males (354)	.18***	.25***
Females (495)	.06	.08
Cheerfulness (1023)	−.02	−.01
Males (508)	.003	−.07
Females (515)	−.05	.04
Conscientiousness (1023)	.05	.10**
Males (508)	−.004	.04
Females (515)	.11*	.17***
High energy (1023)	.02	−.05
Males (508)	.06	.002
Females (515)	−.005	−.09*
Motivation (1023)	−.03	−.01
Males (508)	−.06	−.05
Females (515)	−.0004	.03
Permanency of Moods (1023)	−.01	.03
Males (508)	.01	.001
Females (515)	−.02	.05
Sociability (1023)	.04	−.01
Males (508)	.06	.05
Females (515)	.03	−.03

Note. Higher values indicate a higher level or more of the construct or behavior. *N*'s are in parentheses (different numbers indicate missing data).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Outcome variable mean levels for early, on-time, and late school entry

	Mean (SD)		
Outcome Variable	**Early Entry (N = 394)**	**On-Time Entry (N = 540)**	**Late Entry (N = 89)**
Grades skipped	1.09 (.90)	.93 (.72)	1.18 (.75)
Grades repeated	.03 (.14)	.02 (.11)	.06 (.21)
1922 verbal performance	3.35 (1.44)	3.30 (1.36)	3.09 (1.28)
1922 math performance	2.54 (1.06)	2.63 (1.01)	2.84 (1.01)
Teenage mental adjustment (1928)	2.07 (.62)	2.12 (.64)	2.06 (.72)
Age of graduating from 8th grade	12.33 (.83)	12.73 (.81)	13.15 (.84)
Age match with peers	.55 (.50)	.72 (.45)	.80 (.40)
Overall educational attainment	16.49 (2.68)	16.41 (2.60)	17.08 (2.82)
Rated occupational success (1940)	1.98 (.64)	1.98 (.64)	1.98 (.71)
Mid-life self-rated health	3.19 (.75)	3.22 (.71)	3.19 (.62)
Midlife mental adjustment	2.50 (.68)	2.62 (.61)	2.58 (.61)
Midlife alcohol use	2.11 (.91)	1.97 (.88)	2.03 (.91)
Age at death	73.87 (15.55)	74.24 (16.45)	77.19 (15.82)

Table 4

Cox proportional hazards models estimating mortality risk associated with ages of reading and school entry, baseline controls, and potential explanatory mechanisms

Model	b	rh [a]	p	95% CI [b]
Model A (*N* = 1,023)				
School Entry	−.13	.88	.007	[.80,.97]
Age of Reading	−.01	.99	.88	[.92, 1.08]
Model B (*N* = 802)				
School Entry	−.15	.86	.006	[.77,.96]
Age of Reading	−.05	.95	.24	[.86, 1.04]
IQ	.002	1.00	.64	[.99, 1.01]
SES♦	−.09	.92	.17	[.80, 1.00]
Pre-school Home Learning	−.06	.95	.17	[.87, 1.03]
Age of Puberty	−.03	.97	.37	[.91, 1.04]
Model C (*N* = 1,023)				
School Entry	−.11	.90	.03	[.82,.99]
Age of Reading	−.004	.99	.95	[.92, 1.08]
Cheerfulness♦	.10	1.11	.10	[.98, 1.25]
Conscientiousness♦	−.17	.84	.003	[.76,.95]
Energy♦	.04	1.04	.44	[.94, 1.14]
Motivation♦	.10	1.10	.08	[.99, 1.23]
Sociability♦	−.05	.95	.37	[.85, 1.06]
Permanency of Moods♦	−.04	.96	.43	[.87, 1.06]
Model D (*N* = 930)				
School Entry	−.10	.90	.04	[.82,.995]
Age of Reading	−.01	.98	.74	[.91, 1.07]
Total Education	−.08	.92	<.0001	[.90,.95]
Model E (*N* = 890)				
School Entry	−.13	.88	.01	[.80,.97]
Age of Reading	.02	1.02	.61	[.94, 1.12]
Midlife Adjustment	−.11	.90	.07	[.80, 1.01]
Alcohol Use	.19	1.21	<.0001	[1.11, 1.32]
Model F (*N* = 851)				
School Entry	−.10	.90	.06	[.81, 1.004]
Age of Reading	.00	1.00	.99	[.92, 1.09]
IQ	.002	1.00	.53	[.995, 1.01]
SES♦	−.03	.97	.67	[.86, 1.11]
Conscientiousness♦	−.05	.95	.34	[.86, 1.06]
Total Education	−.06	.94	.0002	[.91,.97]
Midlife Adjustment	−.07	.94	.28	[.83, 1.06]
Alcohol Use	.17	1.18	.0003	[1.08, 1.30]

♦*Note.* Indicates interquartile relative hazards.

[a] *rh* = relative hazard.

[b] *95% CI* = 95% confidence interval.