Article

Hammill Institute on Disabilities

Journal of Learning Disabilities
2014, Vol. 47(4) 374–386

DOI: 10.1177/0022219412458323
journaloflearningdisabilities
.sagepub.com
SAGE

Reading Disability and Adult Attained Education and Income: Evidence From a 30-Year Longitudinal Study of a Population-Based Sample

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Abstract

This study examined the impact of childhood reading disability (RD) on adult educational attainment and income. Participants' (*N* = 1,344) RD was assessed at age 7, and adult educational attainment and income were assessed in midlife using categorical variables. Participants with RD at age 7 were 74% (95% CI: 0.18, 0.37) less likely to attain a higher level of education and 56% (95% CI: 0.32, 0.61) less likely to attain a higher level of income as an adult than participants with average or above reading achievement at age 7. Attained education was found to mediate the relationship between RD and attained income.

Keywords

reading, longitudinal research, quantitative research

Reading is a highly valued skill that is critical for both social and economic advancement in adulthood (Snow, Burns, & Griffin, 1998). Children's reading skills in the early elementary years predict their reading skills in later grades (Claessens, Duncan, & Engel, 2009; Cunningham & Stanovich, 1997). Children who were identified as poor readers in first grade were more likely than their peers to be poor readers in fourth grade (Juel, 1988), and children identified as poor readers in fourth grade remained poor readers in ninth grade (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996). In addition, disparities between proficient and poor readers have been found to grow as children progress through school (Juel, 1988; Morgan, Farkas, & Hibel, 2008). The widening of the achievement gap between proficient and struggling readers can set a child on a path for poor academic achievement. As noted by Stanovich (1986), students' academic progress is influenced both positively and negatively by early achievement and can lead to lower levels of educational attainment.

A significant positive association has been established between *reading achievement in adolescence* and young adult outcomes, including educational attainment (Daniel et al., 2006; Lee, Daniels, Puig, Newgent, & Nam, 2008; Maughan, 1995), employment (Caspi, Wright, Moffitt, & Silva, 1998), and wages (Arnbak, 2004; Murnane, Willett, & Levy, 1995). In addition, there is some work exploring the link between *early reading achievement* and later adult outcomes. For example, Currie and Thomas (1999) used data from a longitudinal study of 17,000 children born in Great Britain in 1958. They found that reading and math test scores at age 7 were significant predictors of test scores at age 16 and educational attainment, employment, and earnings at ages 23 and 33, even after controlling for demographic characteristics. Similarly, Hardy, Shapiro, Astone, Miller, and Brooks-Gunn (1997) found that reading scores at age 8 predicted the educational attainment of adults age 27 through 33 among a sample of inner-city children. However, as noted by Kern and Friedman (2008), the correlates between *early reading achievement* and later adult outcomes have not been fully explored. Most studies have examined educational attainment and income or earnings only during early adulthood, and it is important to look beyond early adulthood because it is likely that at this time point individuals have not yet completed their education or training and chosen a specific employment or career track.

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This exploratory study utilizes data from a large longitudinal study of the adult offspring of women who enrolled in a study of pregnancy and developmental outcomes. Using a discrepancy model of reading disability (RD), this study addressed the following research questions and hypotheses:

Research Question 1: Does having RD at age 7 predict educational attainment as an adult?

Hypothesis 1: Individuals who have RD at age 7 will be less likely to attain high levels of education than their peers with average or above reading ability at age 7.

Research Question 2: Does having RD at age 7 predict attained income as an adult?

Hypothesis 2: Individuals who have RD at age 7 will be less likely to attain high levels of income than their peers with average or above reading ability at age 7.

Research Question 3: Does attained education as an adult mediate the relationship between having RD at age 7 and attained income as an adult?

Hypothesis 3: Attained education as an adult will mediate the relationship between having RD at age 7 and attained income as an adult.

Method

Description of the Database

Participants were adult offspring of pregnant women enrolled in the Collaborative Perinatal Project (CPP) between 1959 and 1966 (Broman, Nichols, & Kennedy, 1975; Niswander & Gordon, 1972). The original aims of the CPP were to identify developmental consequences of pregnancy and delivery complications. Expecting mothers were enrolled during pregnancy, and their offspring were followed periodically through age 7. Building on the CPP, the Transdisciplinary Tobacco Use Research Center–New England Family Study (TTURC-NEFS) was established in 1999 as a follow-up study to examine nicotine dependence and related health conditions across the life span and across generations among adult offspring of women enrolled in the CPP. In 2000, the TTURC-NEFS follow-up study located and interviewed 1,625 adult offspring of women who were enrolled in the Providence, Rhode Island, and Boston, Massachusetts, sites of the CPP.

Identification Criteria for Participants Studied

Participants for the TTURC-NEFS were selected through a multistage sampling procedure that oversampled families in which multiple siblings participated. The sample included (a) all Rhode Island offspring with one or more siblings enrolled in the CPP, (b) a sample of all remaining Rhode Island offspring, and (c) a sample of Massachusetts offspring with one or more siblings enrolled in the CPP. Screening questionnaires were mailed to 4,579 of the 15,721 Massachusetts and Rhode Island CPP offspring who survived until age 7. Of the 3,121 questionnaires returned, 2,271 (67.6%) were eligible for participation in the TTURC-NEFS. Eligibility criteria included having a history of smoking, whether potential respondents had any children between 12 and 17 years of age, and whether potential respondents had any siblings. Of 2,271 eligible individuals, 1,674 CPP offspring agreed to participate and were enrolled in the study (Graham et al., 2008; Kahler et al., 2008). Data from 49 individuals were excluded because they received a pilot version of the survey (n = 11) or because of problems with interview administration (n = 38). This yielded a sample of 1,625 completed adult interviews. Comparisons were conducted to determine the generalizability of the final interviewed sample to the surviving CPP cohort. Those who were not interviewed (n = 14,047) were similar to those in the interviewed sample (n = 1,674) on maternal age at time of birth and race. However, women who completed the follow-up interview were from lower socioeconomic backgrounds and had mothers with lower levels of education than those who did not participate in the follow-up interview (Graham et al., 2008).

Data Selection and Treatment

Independent variable. We defined RD based on a discrepancy model. That is, we selected children based on their Full-Scale Intelligence Quotient (FSIQ) and reading achievement at age 7. FSIQ was assessed using the *Wechsler Intelligence Scales for Children* (WISC-R; Wechsler, 1974). Reading achievement was assessed using the Reading subtest of the *Wide Range Achievement Test* (WRAT-3; Wilkinson, 1993). Both the WISC-R and the WRAT-3 are nationally normed instruments with means of 100 and standard deviations of 15. Using participants' scores on these assessments, we identified children using a two-step process. First, we identified those children in the sample with FSIQ scores of 90 or greater. Second, we examined these children's scores on the Reading subscale of the WRAT-3. Participants who scored 1 or more standard deviations below the national mean (i.e., 85 or lower) were identified as having RD. Participants who scored within 1 standard deviation below the mean or above (i.e., greater than 85) were considered to have average or above reading achievement and classified as non-RD participants

Dependent variables. Participants' level of education in adulthood was assessed by a series of five questions during the TTURC-NEFS follow-up interview: "Do you have a GED or high school diploma?" "What is the last grade in school that you completed and got credit for?" "Besides

classes for your high school diploma or GED, have you had any other schooling?" "What kind of schooling did you have?" and "What degrees/certificates do you have?" Responses to these questions were grouped into three categories: (a) high school degree or less (baseline category), (b) some college or a professional degree (i.e., a technical, trade, or certificate degree), and (c) a college degree or more. Each category was parameterized with an indicator variable.

Annual income attained in adulthood was also assessed during the follow-up interview. Respondents were shown a card with 25 categories of income (range: $0–$60,000 or greater) and asked, "Considering all your sources of income, which letter on this card best represents your (current) average total income, before taxes?" We grouped responses into five categories representing the distribution of attained income among our sample: (a) less than $14,400 (baseline category), (b) $14,400–$28,799, (c) $28,800–$40,799, (d) $40,800–$59,999, and (e) $60,000 and greater. Each quintile was modeled with an indicator variable.

Covariates. Seven covariates were entered into each model: childhood socioeconomic index (SEI), mother's educational attainment at the time of the participant's birth, participant's race, participant's marital status, participant's gender, participant's age at the time of the follow-up interview, and participant's number of children at the time of the follow-up interview.

Childhood SEI was calculated based on methods developed by the U.S. Census Bureau reflecting the education and occupation of the head of the household and household income. Participants' SEI scores were compared to national census data from 1960, the year the measure was created, and given a percentile rank on each of these three factors. The SEI is an average of these percentiles, with higher percentiles indicating higher relative standing for the United States in 1960 (range: 0.3–9.3, *Mdn* = 5.0; see Myrianthopoulos & French, 1968, for greater detail about how the index was coded). We used a composite measure of socioeconomic status because a single item measure may ignore some of the complexity of this construct. For example, income can vary greatly among individuals with the same level of education (Braveman et al., 2005). SEI was coded with dummy variables parameterizing quartiles based on the distribution of SEI in our sample: (a) 0.3–3.7 (lowest quartile), (b) 3.8–5.3 (low medium quartile), (c) 5.4–6.7 (high medium quartile), and (d) 6.8–9.3 (highest quartile).

Mother's educational attainment at the time of the participant's birth was dummy coded into four categories: (a) 0–9 years (baseline category), (b) 10–11 years, (c) 12 years, and (d) 13 or more years. Race was dichotomized as non-White (baseline category) or White. Participants' marital status at the time of the follow-up interview was dummy coded into three categories: (a) married (baseline category), (b) divorced, widowed, or separated, or (c) never married. Gender was included as a dichotomous variable with male as the baseline category. Participants' age at the time of the follow-up interview was dummy coded into three categories: (a) 34–37 (baseline category), (b) 38–40, or (c) 41–44 years old based on the distribution of our sample. Participants' number of children at the time of the follow-up interview was dummy coded into quartiles based on the distribution of our sample: (a) no children (baseline category), (b) one child, (c) two children, and (d) three or more children. All covariates were modeled with dummy variables.

Data Analysis

To address our first two research questions, we fit two separate ordinal logistic regression models because our outcome variables (education and income) were ordinal-level variables with more than two levels (Stokes, Davis, & Koch, 2000). The first model examined the association of reading achievement at age 7 with educational attainment during adulthood. The second model examined the association of reading achievement at age 7 with earned income during adulthood. Both models were proportional odds models.

To address our third research question, we fit a model to evaluate participants' educational attainment as a mediator of the association between reading achievement at age 7 and attained income as an adult.

Mediators are distinguished from covariates in their assumed causal role (Shenassa, Daskalakis, Liebhaber, Braubach, & Brown, 2007). Covariates and the independent variable are correlated because the former is a causal consequence of the latter or because the two variables share a common cause. For example, in this study, mother's educational attainment could be considered a covariate. This is because mother's educational attainment at the time of the participant's birth was both a determinant of her child's risk for RD at age 7 and her child's income as an adult. A reduction of the effect of risk for RD at age 7 on attained income as an adult because of an adjustment for mother's educational attainment is interpreted as eliminating bias.

The mediator and the independent variable are also correlated, but the mediator is in the causal pathway from the independent to the dependent variable (i.e., direction of causation is from independent variable to mediator to dependent variable). For example, a child's risk for RD at age 7 can affect his or her educational attainment as an adult, which in turn will affect his or her attained income as an adult. A reduction in the effect of risk for RD at age 7 on attained income as an adult because of an adjustment for educational attainment as an adult is interpreted as the indirect risk for RD effect. If, after adjustment, a risk for RD effect still remains, it can be interpreted as an independent (direct) effect that does not involve that specific mediator. To examine the mediating effect of educational attainment, we entered educational attainment in a model that included

risk for RD and all of the covariates. A significant change in the coefficient for risk for RD indicated that its association with attained income was mediated by educational attainment.

To examine the mediating effect of educational attainment, we assessed the three conditions that Baron and Kenny (1986) recommend are necessary for establishing mediation: (a) the independent variable is statistically significantly related to the mediator, (b) the independent variable is statistically significantly related to the dependent variable, and (c) the mediator is statistically significantly related to the dependent variable when the independent variable is controlled for. To test for these conditions, we estimated three regression equations: (a) to test the first condition, we regressed the mediator on the independent variable; (b) to test the second condition, we regressed the dependent variable on the independent variable; and (c) to test the third condition, we regressed the dependent variable on the independent variable and the mediator. All analyses were conducted using SAS Version 9.1.

Results

Sample Characteristics

In the sample of TTURC-NEFS respondents with FSIQ scores of at least 90 ($N = 1,344$), 14% of respondents had RD at age 7 and 86% had average or above reading achievement at age 7. Respondents' ages at the follow-up interview ranged from 34 to 44, with a mean age of 39 years.Eighty-eight percent of the sample was white and 12% was non-white. Sixty-five percent of the sample was married, 20% had never married and the remaining 15% were divorced, widowed, or separated. Forty-seven percent of the sample had completed some college work but had not graduated from college, 33% of the sample had a college degree and 20% of the sample had a high school degree or less education. Fifty-four percent of the sample had an attained income below $40,800 (see Table 1).

Data from two different but overlapping samples were analyzed to predict the two dependent variables: educational attainment and attained income. Both analytic samples consisted of respondents with FSIQ scores of at least 90 ($N = 1,344$). For the model predicting educational attainment, 321 observations were excluded because of missing values on at least one of the following variables: WRAT-3 Reading scores ($n = 260$), mother's SEI ($n = 68$), mother's years of education ($n = 55$), race ($n = 5$), and participants' number of children ($n = 8$), yielding an analytic sample of 1,023. Additional missing data on attained income ($n = 69$) yielded an analytic sample of 980 for the model predicting attained income (see Table 1).

We determined how the samples used to predict educational attainment and attained income differed from the overall TTURC-NEFS sample. Both analytic samples differed from the overall TTURC-NEFS sample on maternal education, participants' educational attainment in midlife, and participants' marital status; however, these differences were within two percentage points (see Table 1).

Bivariate Analyses

Chi-square analyses were performed to test the association between all independent variables and the two dependent variables: educational attainment and attained income. Reading achievement at age 7 and all covariates were associated with the two dependent variables ($p < .01$). In addition, two relatively simple models were fit to determine (a) the relationship between reading achievement at age 7 and educational attainment as an adult and (b) reading achievement at age 7 and attained income as an adult. These models indicate that relative to non-RD participants, participants with RD at age 7 were less likely to attain a high level of education or income as an adult. These initial results provide justification for our multivariate analyses.

Multivariate Analyses

Our multivariate models yielded odds ratios and confidence intervals. Odds ratios indicate magnitude and direction. Whether an odds ratio is greater or smaller than 1 determines direction of association between the independent and dependent variables. For example, when predicting attained education, an odds ratio that is less than 1 indicates that participants with RD are *less* likely than non-RD participants to have attained a higher level of education. An odds ratio greater than 1 indicates that participants with RD are *more* likely than non-RD participants to have attained a higher level of education. Odds ratios can be subtracted from 1 to determine magnitude. For example, in our model predicting attained education, an odds ratio of 0.20 indicates that participants with RD are 80% less likely to have attained a high level of education than non-RD participants. Similarly, an odds ratio of 1.20 indicates that participants with RD are 20% more likely to have attained a high level of education than non-RD participants. Confidence intervals can be used to determine the statistical significance of a test statistic. A confidence interval that includes 1 (e.g., 0.03, 1.94) indicates that the test statistic is not statistically significant.

Educational attainment. We found support for our first hypothesis; participants with RD at age 7 were 74% (95% CI: 0.18, 0.37) less likely to attain a high level of education as an adult than participants with average or above reading achievement at age 7 controlling for family SEI, mother's years of education, age, race, gender, marital status, and number of children (see Table 2, column 1).

We conducted separate analyses by RD status to investigate associations between the covariates and attained education for RD participants and non-RD participants separately (see

Table 1. Descriptive Statistics for Participant Demographics of the TTURC-NEFS Sample, the Educational Attainment Analytic Sample, and the Attained Income Analytic Sample.

	TTURC-NEFS Sample			Educational Attainment Sample			Attained Income Sample		
Variables	Overall (*N* = 1,344)	Boston (*n* = 724)	Providence (*n* = 620)	Overall (*n* = 1,023)	Non-RD (*n* = 875)	RD (*n* = 148)	Overall (*n* = 980)	Non-RD (*n* = 840)	RD (*n* = 140)
Independent variable									
Reading achievement at age 7									
RD (%)	14.30	9.09	20.36	14.47	0	100	85.71	0	100
Non-RD (%)	85.70	90.91	79.64	85.53	100	0	14.29	100	0
Covariates									
Mother's characteristics at time of participant's birth									
Socioeconomic index									
Lowest quartile (%)	19.29	9.32	31.29	20.23	17.94	33.78	20.00	17.74	33.57
Low middle quartile (%)	26.31	21.33	32.31	27.17	26.86	29.05	27.35	27.14	28.57
High middle quartile (%)	23.84	30.51	15.82	24.54	24.23	26.35	24.80	24.40	27.14
Highest quartile (%)	30.56	38.84	20.58	28.05	30.97	10.81	27.86	30.17	10.71
Mother's years of education									
2–9 years (%)	20.66	12.22	30.60	21.21	18.40	37.84	21.63	18.69	39.29
10–11 years (%)	19.97	14.63	26.25	21.21	20.11	27.70	21.43	20.36	27.86
12 years (%)	44.70	55.97	31.44	45.16	47.89	29.05	44.69	47.50	27.86
13 or more years (%)	14.67	17.19	11.71	12.41	13.60	5.41	12.24	13.45	5.00
Participant characteristics									
Race/ethnicity									
Non-White (%)	12.25	6.22	19.32	12.22	10.40	22.97	12.55	10.71	23.57
White (%)	87.75	93.78	80.68	87.78	89.60	77.03	87.45	89.29	76.43
Gender									
Female (%)	58.63	58.43	58.87	59.53	59.31	60.81	58.37	58.10	60.00
Male (%)	41.37	41.57	41.13	40.47	40.69	39.19	41.63	41.90	40.00
Age at follow-up									
M	39.15	39.72	38.49	39.09	39.14	38.82	39.09	39.14	38.79
SD	1.90	1.88	1.70	1.91	1.92	1.85	1.90	1.91	1.87
Marital status									
Married (%)	65.10	70.58	58.71	63.34	64.91	54.05	62.14	63.81	52.14
Divorced, widowed, separated (%)	14.73	11.19	18.87	15.64	15.66	15.54	16.22	16.19	16.43
Never married (%)	20.16	18.23	22.42	21.02	19.43	30.41	21.63	20.00	31.43
Number of children									
0 (%)	29.45	26.66	32.74	28.74	29.14	26.35	29.69	30.12	27.14
1 (%)	18.01	15.75	20.68	17.89	17.37	20.95	18.37	17.74	22.14
2 (%)	32.81	35.22	29.97	32.55	32.23	34.46	32.86	32.50	35.00
3 or more (%)	19.73	22.38	16.61	20.82	21.26	18.24	19.08	19.64	15.71
Dependent variables									
Educational attainment									
High school or less (%)	20.31	12.15	29.84	21.99	17.14	50.68	22.24	17.26	52.14
Some college (%)	46.50	46.96	45.97	48.09	49.26	41.22	48.27	49.64	40.00
College degree or more (%)	33.18	40.88	24.19	29.91	33.60	8.11	29.49	33.10	7.86
Attained income									
Less than $14,400 (%)	16.52	14.74	18.56	16.43	14.88	25.71	16.43	14.88	25.71
$14,400–$28,799 (%)	18.86	15.33	22.91	19.29	17.14	32.14	19.29	17.14	32.14
$28,000–$40,799 (%)	18.71	14.61	23.91	18.37	18.33	18.57	18.37	18.33	18.57
$40,800–$59,999 (%)	21.12	24.09	17.73	21.43	22.74	13.57	21.43	22.74	13.57
$60,000 or more (%)	24.79	31.68	16.89	24.49	26.90	10.00	24.49	26.90	10.00

Note: Participants with an IQ of 90 or less were excluded from the sample. RD = reading disability; TTURC-NEFS = Transdisciplinary Tobacco Use Research Center–New England Family Study.

Table 2. Results of Ordinal Logistic Regression Model Predicting Attained Education During Adulthood.

	Educational Attainment (n = 1,023)					
	Complete Sample (n = 1,023)		Non-RD Sample (n = 875)		RD Sample (n = 148)	
	OR	CI	*OR*	CI	*OR*	CI
Reading achievement at age 7						
Non-RD	reference					
RD	0.26	0.18, 0.37				
Family socioeconomic status at birth						
Lowest quartile	reference		reference		reference	
Low middle quartile	1.06	0.73, 1.54	0.94	0.62, 1.44	1.39	0.55, 3.54
High middle quartile	1.21	0.82, 1.79	1.13	0.73, 1.76	1.59	0.60, 4.22
Highest quartile	2.57	1.68, 3.95	2.33	1.46, 3.72	6.05	1.55, 23.54
Mother's years of education						
2–9 years	reference		reference		reference	
10–11 years	0.94	0.65, 1.38	0.89	0.58, 1.37	1.43	0.56, 3.67
12 years	1.39	0.98, 1.97	1.38	0.94, 2.03	1.69	0.62, 4.56
13 years or more	4.02	2.44, 6.61	4.11	2.40, 7.04	3.10	0.64, 14.91
Race						
Non-White	reference		reference		reference	
White	0.75	0.51, 1.09	0.69	0.44, 1.06	1.03	0.41, 2.58
Gender						
Male	reference		reference		reference	
Female	1.37	1.07, 1.77	1.17	0.89, 1.53	3.73	1.57, 8.86
Participant's marital status in middle adulthood						
Married	reference		reference		reference	
Divorced, widowed, separated	0.50	0.35, 0.71	0.49	0.34, 0.70	0.78	0.26, 2.30
Never married	0.67	0.47, 0.95	0.60	0.40, 0.89	1.12	0.43, 2.88
Number of children in middle adulthood						
No children	reference		reference		reference	
1 child	0.78	0.54, 1.13	0.78	0.52, 1.17	0.73	0.23, 2.33
2 children	0.91	0.66, 1.25	0.81	0.57, 1.15	1.56	0.60, 4.09
3 children or more	0.90	0.62, 1.32	0.93	0.62, 1.40	0.72	0.21, 2.48
Age at follow-up						
34–37	reference		reference		reference	
38–40	0.89	0.65, 1.21	0.75	0.53, 1.06	2.22	0.93, 5.31
41–44	1.12	0.77, 1.64	0.81	0.54, 1.22	6.87	2.30, 20.52

Note: This model predicts the odds of attaining a higher level of education. This model includes a variable indicating if the participant was recruited in Boston or Providence. RD = reading disability.

Table 2, columns 2 and 3). Non-RD participants from the highest SEI quartile were 133% (95% CI: 1.46, 3.72) more likely than those from the lowest quartile to attain high levels of education, whereas RD participants from the highest SEI quartile were 505% (95% CI: 1.55, 23.54) more likely to attain high levels of education than those from the lowest SEI quartile. Non-RD participants whose mothers had 13 or more years of education were 311% (95% CI: 2.40, 7.04) more likely to have higher levels of education as adults than their counterparts whose mothers had 2 to 9 years of education. The relationship between mother's years of education and participant's educational attainment in adulthood was not significant for participants with RD. Female participants with RD were 273% (95% CI: 1.57, 8.86) more likely than male participants with RD to attain a high level of education. There was not a statistically significant relationship between gender and attained education for the non-RD participants. Non-RD participants who were divorced, widowed, or separated or never married were less likely to attain a high level of education as an adult than non-RD participants who were married (*OR* = 0.49, 95% CI: 0.34, 0.70 and *OR* = 0.60, 95% CI: 0.40, 0.89, respectively).

Finally, RD participants who were 41 to 44 years old were 587% (95% CI: 2.30, 20.52) more likely to attain a high level of education than RD participants who were 34 to 37 years old (see Table 2, columns 2 and 3).

Attained income. We found support for our second hypothesis; participants with RD at age 7 were 56% (95% CI: 0.32, 0.61) less likely to attain a higher level of income than non-RD participants controlling for family socioeconomic status, mother's years of education, age, race, gender, marital status, and number of children (see Table 3, column 1).

We conducted separate analyses by RD status to investigate associations between the covariates and attained income for RD participants and non-RD participants separately (see Table 3, columns 2 and 3). RD participants from the high middle SEI quartile were 66% (95% CI: 0.14, 0.81) less likely than those from the lowest quartile to attain high levels of income. There were no significant relationships between SEI and income as an adult for the non-RD sample. Non-RD participants whose mothers had 13 or more years of education were 89% (95% CI: 1.12, 3.20) more likely than non-RD participants whose mothers had 2 to 9 years of education to achieve a high level of income as an adult. Gender was associated with income for both the RD and non-RD sample with women from both samples being less likely than men to achieve a higher level of income as an adult (OR = 0.15, 95% CI: 0.07, 0.31 and OR = 0.17, 95% CI: 0.13, 0.22, respectively). Finally, non-RD participants who were never married were 40% (95% CI: 0.42, 0.86) less likely to attain a high level of education as an adult than non-RD participants who were married.

Educational attainment as a mediator. We found support for our third hypothesis: Participants' educational attainment as an adult was found to mediate the relationship between RD at age 7 and attained income as an adult. The three conditions specified by Baron and Kenny (1986) to establish mediation were met. RD was statistically significantly associated with education (*OR* = 0.20, 95% CI: 0.15, 0.28). RD was also significantly associated with attained income (*OR* = 0.37, 95% CI: 0.28, 0.50). Level of education was significantly associated with attained income when controlling for RD (some college or a professional degree: *OR* = 1.54, 95% CI: 0.49, 0.86; and college degree or more: *OR* = 4.12, 95% CI: 0.17, 0.34).

Using the complete sample, we fit a model predicting attained income that included participants' educational attainment (see Table 4, column 1). In this model, participants who had RD at age 7 were 40% (95% CI: 0.43, 0.84) less likely to attain a high level of income as an adult than participants who demonstrated average or above reading achievement at age 7 (see Table 4, column 1). Participants with some college education were 84% (95% CI: 1.37, 2.49) more likely to report a higher income and participants who earned a college degree or more were 426% (95% CI: 3.65, 7.58) more likely to report a higher income than participants who earned a high school degree or less.

We also examined the relationship between adult education and income for RD and non-RD participants separately (see Table 4, columns 2 and 3). These results show that RD and non-RD participants with some college or a professional degree or a college degree or more were more likely to attain a higher level of income as an adult than their counterparts with a high school degree or less.

Discussion

In this study we analyzed the relationships between RD at age 7 and two important adult outcomes: level of education and income. Although our study was exploratory in nature, our findings confirm previous research that has demonstrated the impact of RD on high school graduation, college enrollment, and earnings as an adult. Descriptive results suggest the impact of low reading inasmuch as very few (8%) of the participants in the RD sample earned a college degree or more whereas more than a third of the non-RD participants had college degrees. Similarly, only 10% of the RD sample reported incomes of $60,000 or greater, compared to 27% of the non-RD participants. Multivariate results show that participants with RD were 74% less likely to have attained a high level of education by their late 30s and early 40s and 56% less likely to have attained a high level of income by midlife than non-RD participants when controlling for family educational and economic background and demographic variables. Furthermore, our results extend the research suggesting that RD in early childhood affects educational attainment and earnings in adolescence and early adulthood by suggesting that the impact of low reading ability as a child continues to be felt in midlife.

In addition to demonstrating a link between early reading achievement and later educational attainment and income, our results suggest several covariates that might be important for understanding the relationship between RD in childhood and later educational attainment and income. Family socioeconomic status at birth was an important predictor of later educational attainment and income. This association between family socioeconomic status and later outcomes is not surprising as the impact of poverty on child development has been extensively documented (e.g., Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Shonkoff & Phillips, 2000). In addition, socioeconomic status has been shown to be directly linked to the educational and occupational outcomes of children with reading and learning disabilities (Levine & Nourse, 1998; O'Connor & Spreen, 1998; Wagner, Newman, Cameto, Garza, & Levine, 2005). Our analyses indicated that family socioeconomic status was more important for children with RD than for children without RD.

In our sample, children from the highest SEI quartile with RD were 500% more likely to achieve a high level of education than children from the lowest SEI quartile with RD, whereas non-RD children from the highest SEI quartile

Table 3. Results of Ordinal Logistic Regression Model Predicting Attained Income During Adulthood.

	Complete Sample (n = 980)		Non-RD Sample (n = 840)		RD Sample (n = 140)	
	OR	CI	*OR*	CI	*OR*	CI
Reading achievement at age 7						
Non-RD	reference					
RD	0.44	0.32, 0.61				
Family socioeconomic status at birth						
Lowest quartile	reference		reference		reference	
Low middle quartile	0.82	0.58, 1.15	0.83	0.57, 1.22	0.83	0.37, 1.86
High middle quartile	0.85	0.58, 1.24	0.99	0.64, 1.53	0.34	0.14, 0.81
Highest quartile	1.06	0.72, 1.56	1.11	0.73, 1.70	1.09	0.37, 3.24
Mother's years of education						
2–9 years	reference		reference		reference	
10–11 years	1.08	0.76, 1.53	1.15	0.77, 1.72	0.86	0.39, 1.91
12 years	1.21	0.86, 1.70	1.18	0.81, 1.72	2.20	0.84, 5.80
13 years or more	1.80	1.11, 2.92	1.89	1.12, 3.20	0.74	0.15, 3.70
Race						
Non-White	reference		reference		reference	
White	1.31	0.90, 1.91	1.26	0.82, 1.93	1.58	0.70, 3.56
Gender						
Male	reference		reference		reference	
Female	0.18	0.14, 0.23	0.17	0.13, 0.22	0.15	0.07, 0.31
Participant's marital status in middle adulthood						
Married	reference		reference		reference	
Divorced, widowed, separated	0.97	0.70, 1.34	0.95	0.68, 1.34	1.20	0.43, 3.34
Never married	0.60	0.44, 0.85	0.60	0.42, 0.86	0.73	0.29, 1.83
Number of children in middle adulthood						
No children	reference		reference		reference	
1 child	1.11	0.79, 1.55	1.06	0.73, 1.53	1.42	0.52, 3.88
2 children	1.08	0.80, 1.45	0.99	0.72, 1.36	2.25	0.87, 5.82
3 children or more	0.83	0.56, 1.24	0.80	0.52, 1.22	1.28	0.41, 3.97
Age at follow-up						
34–37	reference		reference		reference	
38–40	1.15	0.86, 1.53	1.10	0.80, 1.50	1.39	0.63, 3.08
41–44	1.34	0.95, 1.91	1.28	0.87, 1.87	1.35	0.51, 3.57

This model predicts the odds of attaining a higher income level. This model includes a variable indicating if the participant was recruited in Boston or Providence. RD = reading disability.

were only 133% more likely to achieve a high level of education than non-RD children from the lowest SEI quartile. This suggests that the combination of low family socioeconomic status and RD may be especially detrimental and the importance of controlling for family SEI (Savolainen, Ahonen, Aro, Tolvanen, & Holopainen, 2008). However, the small cell sizes in our sample (e.g., there are only 15 individuals who had RD as a child and were in the highest SEI quartile) mean that these findings should be interpreted with much caution.

Level of maternal education was associated with level of attained education and income, but only for the non-RD participants. In general, research has not found a consistent link between maternal education and young adult outcomes. Shonkoff and Phillips (2000) report several studies showing mixed effects, and Tenenbaum, Porche, Snow, Tabors, and Ross (2007) found no relationship between maternal education and high school completion or college enrollment in a sample of low-income children. Carneiro, Meghir, and Parey (2007) found that mother's education increased the child's performance in both math and reading at ages 7–8, but these effects were not seen at ages 12–14.

Our findings also suggest that gender plays an interesting role in the relationship between childhood RD and later

Table 4. Results of Ordinal Logistic Regression Model Predicting Attained Income During Adulthood With Adult Education as a Mediator.

	Complete Sample (n = 980)		Non-RD Sample (n = 852)		RD Sample (n = 141)	
	OR	CI	*OR*	CI	*OR*	CI
Reading achievement at age 7						
Non-RD	reference					
RD	0.60	0.43, 0.84				
Family socioeconomic status at birth						
Lowest quartile	reference		reference		reference	
Low middle quartile	0.80	0.57, 1.13	0.84	0.57, 1.22	0.83	0.35, 1.94
High middle quartile	0.80	0.55, 1.17	0.98	0.64, 1.50	0.23	0.09, 0.61
Highest quartile	0.83	0.56, 1.21	0.91	0.60, 1.37	0.42	0.12, 1.43
Mother's years of education						
2–9 years	reference		reference		reference	
10–11 years	1.21	0.79, 1.59	1.19	0.80, 1.78	0.86	0.38, 1.96
12 years	1.14	0.81, 1.60	1.11	0.76, 1.61	2.06	0.75, 5.69
13 years or more	1.30	0.80, 2.12	1.37	0.81, 2.31	0.73	0.15, 3.57
Race						
Non-White	reference		reference		reference	
White	1.38	0.94, 2.00	1.34	0.87, 2.06	1.46	0.63, 3.36
Gender						
Male	reference		reference		reference	
Female	0.15	0.12, 0.19	0.14	0.12, 0.20	0.10	0.05, 0.20
Participant's marital status in middle adulthood						
Married	reference		reference		reference	
Divorced, widowed, separated	1.15	0.83, 1.58	1.13	0.80, 1.58	1.39	0.46, 4.18
Never married	0.63	0.45, 0.87	0.62	0.43, 0.90	0.73	0.28, 1.88
Number of children in middle adulthood						
No children	reference		reference		reference	
1 child	1.20	0.86, 1.68	1.15	0.80, 1.66	1.45	0.56, 3.75
2 children	1.12	0.83, 1.51	1.05	0.76, 1.45	2.04	0.77, 5.46
3 children or more	0.86	0.58, 1.29	0.82	0.53, 1.27	1.24	0.40, 3.84
Age at follow-up						
34–37	reference		reference		reference	
38–40	1.19	0.89, 1.59	1.17	0.86, 1.60	1.10	0.48, 2.51
41–44	1.29	0.91, 1.83	1.34	0.91, 1.96	0.51	0.18, 1.38
Education						
High school degree or less	reference		reference		reference	
Some college or a professional degree	1.84	1.37, 2.49	1.79	1.27, 2.50	2.40	1.10, 5.25
College degree or more	5.26	3.65, 7.58	4.74	3.21, 7.00	38.71	8.28, 180.88

This model predicts the odds of attaining a higher income level. This model includes a variable indicating if the participant was recruited in Boston or Providence. RD = reading disability.

adult outcomes. As expected, women from both the RD and non-RD groups were less likely than men to achieve a higher level of income as an adult. This is expected because, in general, women earned less than men in 2000 when the data were collected (Bureau of Labor Statistics, 2001), and this income gap persists, although less so, to the present day (Bureau of Labor Statistics, 2011).

There seems to be a more complex relationship among gender, RD status, and educational attainment. Females with RD were almost 300% more likely to attain a higher level of education than males with RD. However, gender was not related to educational attainment for the non-RD participants. Females were about 15% less likely to attain a high level of income as an adult than males in both the RD

and non-RD samples. One possible explanation for the higher educational attainment among females with RD might be related to differences in employment opportunities. Males with RD may have been able to find jobs in manufacturing or construction that required little formal education but provided adequate income. Females, lacking access to these jobs, may have decided to pursue higher education after high school. Gender effects on educational or occupational outcomes of individuals with low reading achievement have not been thoroughly explored (Kern & Friedman, 2008; Savolainen et al., 2008). Yet some studies (e.g., Levine & Nourse, 1998; Murray, Goldstein, Nourse, & Edgar, 2000) have reported that males with learning disabilities are more likely than their female counterparts to participate in postsecondary education and to be fully employed after graduation. Savolainen et al. (2008) found that among a sample of 1,700 secondary students, the effect of reading and spelling skills on secondary education choice was much stronger and more direct for males. Clearly, these gender differences need to be considered in the context of the larger cultural and employment situation at the time of the study and in the two cities where the data were collected.

In 2000, Boston and Providence differed from each other and from the nation as a whole in terms of the educational attainment and employment status of their citizens. In Massachusetts in 2000, 85% of the population 25 years old and older had a high school diploma or more education and 20% had a bachelor's degree or more (U.S. Department of Education, 2004). In Boston 85% of the population 25 years old and older had a high school degree and 34% had completed a bachelor's degree or more education in 2000 (U.S. Department of Education, 2001). In Rhode Island, 78% of the population 25 years old and older had at least a high school degree and 16% had at least a bachelor's degree in 2000 (U.S. Department of Education, 2004). In Providence in 2000, 66% of the population had a high school degree or higher and 24% had a bachelor's degree or higher (Rhode Island Department of Labor and Training, n.d.) As a point of comparison, in the entire United States 80% of the population 25 years old and older had a high school diploma or higher and 16% had a bachelor's degree or higher in 2000. In addition, Massachusetts had a relatively low unemployment rate in 2000, whereas the unemployment rate in Rhode Island was higher. The annual average unemployment rate in 2000 was 4.0 for the entire United States, 2.7 for Massachusetts, 3.1 for Suffolk County, where Boston is located, 4.2 for Rhode Island, and 4.5 for Providence County, where Providence is located (Bureau of Labor Statistics, 2009; Bureau of Labor Statistics, n.d.).

We were also interested in examining the structural relationship among early reading status, attained education, and adult income. Specifically, we were interested in exploring whether RD leads to poorer educational outcomes, which in turn lead to lower income as an adult. In this way RD would provide a cumulative structural disadvantage (Elman & O'Rand, 2004). To explore the role of educational attainment, we fit a model that tested educational attainment as a mediator of the relationship between RD and income as an adult. It is not surprising that the model suggests that educational attainment acted as a mediator. Higher levels of education were important for both RD and non-RD children since the odds of attaining a higher level of income as an adult were higher for individuals with higher levels of education. However, the number of individuals in the RD sample who attained a college degree or more was particularly small ($n = 11$), suggesting these coefficients may not be reliable. However, we do know that students with low reading achievement are less likely to obtain a postsecondary degree or graduate with lower qualifications (Horn, Berktold, & Bobbitt, 1999; Kern & Friedman, 2008; Murray et al., 2000; Newman, Wagner, Cameto, & Knokey, 2009). Given that our results suggest that higher education may make a greater difference in adult income for students with RD than those with average or above reading abilities, it seems important to attempt to replicate this finding using a sample with a larger proportion of RD participants.

Limitations

There are limitations to the present study that need to be acknowledged. Among these are the criteria used to select the sample for the TTURC-NEFS follow-up study. The follow-up study was designed to answer questions pertaining to progression of smoking and nicotine addiction. Consequently, rather than selecting a random sample of surviving CPP members, TTURC-NEFS follow-up participants were selected based on their smoking history and family demographics. Therefore, the study sample of 1,625 is not representative of the U.S. or New England population. However, this sample does provide a unique opportunity to explore the longitudinal impact of RD in early childhood on educational attainment and income during middle adulthood in two large metropolitan areas. Furthermore, the TTURC-NEFS does not provide a record of the specific school experiences or achievement of participants beyond age 7, nor do we have any indication of what support, if any, was provided to the poor readers.

We also recognize that the validity of identifying RD using a discrepancy model, as we have done, has been questioned (Francis et al., 1996; Hoskyn & Swanson, 2000; Vellutino, Fletcher, Snowling, & Scanlon, 2004). Research has demonstrated the failure of this model to discriminate between low achievers and those who may be identified with a specific learning disability (Hoskyn & Swanson, 2000; Vellutino et al., 2004). We further acknowledge that the lack of precision inherent in the model is particularly problematic when the intent is to classify students for intervention or treatment. However, we believe that our variable

provides a reasonable estimate of RD for examining the trajectory of the sample over a 30-year span of time.

Another potential limitation is the measure of reading achievement that was used, the Reading subtest of the WRAT-3. This subtest assesses skill in letter recognition, letter naming, and pronunciation of words in isolation. The subtest does not include a measure of comprehension or oral reading, as the test was designed to measure the "codes which are needed to learn the basic skills of reading" (Wilkinson, 1993, p. 10). Although this is a relatively small sample of reading skills, the link between word identification and reading comprehension is strong (Bruck, 1990; Samuels, 1988; Stanovich, 1991). Furthermore, the WRAT-3 is well standardized, has adequate reliability, and was widely used as a screening test to provide a global indication of reading skill during the period when the original data were collected (Salvia, Ysseldyke, & Bolt, 2007).

Finally, we acknowledge that our model did not address all of the possible factors that might interact with RD and either educational attainment or adult income. For instance, we have not accounted for important factors such as motivation (Baker & Wigfield, 2011) or behavioral or emotional disorders, such as generalized anxiety disorder (GAD; Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006; Willcutt & Pennington, 2000). In particular, Martin et al. (2007) found that individuals in the TTURC-NEFS sample who were identified as having a learning disability at age 7 were twice as likely to be identified as having GAD, which may affect attained income and educational attainment as an adult. However, our intent was not to explain variation in outcomes; rather, we wanted to capitalize on the unusual longitudinal aspects of the TTURC-NEFS to contribute to our understanding of the association between RD in early childhood and attained income and education as an adult.

To conclude, this study points to the need for further research examining the long-term impact of RD in early childhood on important adult outcomes. Findings also suggest the need to better understand both the impact of higher education and the factors that promote completion of higher education among children with RD and related disabilities.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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