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Pre-teen literacy and subsequent teenage childbearing in a US population

Ian M. Bennett^{1,2,*}, Rosemary Frasso^{2,4}, Scarlett Bellamy³, Stanton Wortham⁵, and Kennen Gross⁵

¹Department of Family Medicine and Community Health, University of Pennsylvania

²Center for Public Health Initiatives, University of Pennsylvania

³Center for Clinical Epidemiology and Biostatistics, Perelman School of Medicine; University of Pennsylvania

⁴School of Nursing; University of Pennsylvania

⁵Graduate School of Education, University of Pennsylvania

Abstract

Background—While literacy is a key factor in health across the life course, the association of literacy and teenage childbearing has not been assessed in the US.

Study design—Prospective cohort study using standardized reading data from 12,339 girls in the 7th grade in the 1996-97 or 1997-98 academic years of the Philadelphia Public School System linked to birth records from the city of Philadelphia (1996-2002).

Results—Less than average reading skill was independently associated with two and a half times the risk of teen childbearing than average reading skill (aHR 2.51, 95% CI: 1.67-3.77). Above average reading skill was associated with less risk (aHR 0.27, 95% CI 0.17-0.44). A significant interaction ($p < 0.05$) between reading skill and race/ethnicity indicated that Hispanic and African American girls had greater risk of teen-childbearing by literacy.

Conclusions—Literacy strongly predicts risk of teenage childbearing independent of confounders. The effects of literacy were stronger among girls with Hispanic or African American race/ethnicity.

Keywords

Pregnancy in Adolescence; Education; Schools

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*Corresponding author: Ian Bennett, MD, PhD, 2nd Floor Gates Pavilion, 3400 Spruce Street, Philadelphia, PA 19104-4283, Tel: 215 614-0849, Fax: 215 662-3591, ibennett@mail.med.upenn.edu.

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1. Introduction

The reduction of teenage childbearing in the United States, where rates are higher than any comparably developed nation, is the focus of significant public health effort [1-3]. Public policy interest in reducing this outcome stems from the association of teenage childbearing with negative and persistent health, education, and economic outcomes for mothers and their children even after adjustment for other risk factors for these outcomes [4-6]. Substantial race/ethnic disparities exist in the rates of teenage childbearing [7-10]. The rate of births for White women age 15-19 years in 2009 was 25.6 per 1000 women while African American and Hispanic/Latina women had rates of 59.1 and 70.1, respectively [9]. Despite substantial decreases in the rate of teen childbearing in the United States over the last decade, teenage births remain disproportionately concentrated among women from race/ethnic minority groups and those with lower socioeconomic status and may contribute to continued socioeconomic differences in the well-being of these women and their children [10].

Literacy, most often measured by reading skill, contributes to a number of well known predisposing factors for teenage childbearing including school success and likelihood of high school graduation [11-13]. Poor reading skill in early years of formal education is difficult to overcome and is predictive of subsequent decisions to drop out of formal education and adult literacy [13]. Reading skill in pre-teens also has the same pattern of race/ethnic disparities seen in teenage parenting [14]. Despite these associations and the fact that adult literacy is strongly linked to health related outcomes throughout the life course there have been no studies that we are aware of that assess the association of literacy among pre-teen girls and the risk of subsequent teenage childbearing in a US population [15]. Using linked school, birth certificate, census, and other administrative databases, we wished to directly assess the contribution of reading skill among pre-teens with the risk of subsequent teenage childbearing. We also wished to better understand the degree to which race/ethnic disparities in literacy contribute to differences in teenage childbearing through formal assessment of interactions between pre-teen reading skill, race, and teenage childbearing while controlling for other sociodemographic and neighborhood level variables associated with teen parenting.

2. Materials and methods

Approval for the current study was provided by the University of Pennsylvania Institutional Review Board.

2.1 Data

Administrative data for this study were obtained from the Philadelphia Public School System, the Pennsylvania Department of Health, Philadelphia Utilities, and the US Census. The study sample includes all girls, who completed the Stanford Achievement Test Version 9 (SAT-9; Pearson Education, Inc.), a widely used assessment of individual student academic achievement in a range of domains including reading while enrolled in the 7th grade in the Philadelphia Public School system during the 1996-97 (n=6737) or 1997-98 (n=6,683) academic years. Girls in the sample were enrolled in 92 separate schools at the time of the assessment. Fig. 1 summarizes participant inclusion for the final analytic sample. After elimination of duplicate records (n=120), the sample size was 13,300. Additional observations were excluded based on age (0.02%), missing reading assessment scores (3.4%), and missing addresses (4.2%). The final sample size was 12,339 girls (93% of the original pool). Observations were then linked to records of live births in the years 1996-2002 provided by the Pennsylvania State Department of Health. Individual deterministic linking was carried out using name and date of birth on the each participant's school district file and the vital statistics birth record [16].

2.2 Variables

Our main independent variables were pre-teen reading skill and race. However, we also examined other sociodemographic and neighborhood level variables in these analyses. Reading skill of individual students was determined by national percentile rank of “composite reading” performance on the SAT-9, a Norm Referenced test which compares each student's performance on the test to the performance of a nationally representative sample of public school students of the same age and grade. Three ordinal reading skill categories are derived from this test: 1) above average (76th percentile), 2) average (24th-75th percentile), and 3) below average (23rd percentile). Gifted students, a subset of special education services, were removed from the special education category. English for speakers of other languages (ESOL) services was included to account for potential confounding by low English proficiency. Race/ethnicity was self-identified using the categories: White, African American, Hispanic, and other. This variable was included because of its well established association with both literacy and teenage childbearing [9, 10, 15, 17]. School neighborhood characteristics were included based on the addresses reported at the time of the assessment using the 2000 US census of Population and Housing Summary Tape File 3A [18]. Poverty concentration was defined as a continuous variable of percent of families at or below 100% of poverty level and by three exclusive categories: 1) non-poverty area (0-19.9% families at 100% of poverty level), 2) poverty area (20-39.9% families at 100% poverty level), and 3) severe poverty area (40% of families at 100% poverty level) [19].

Additional census block group variables were split into quartiles to facilitate analyses and interpretation: unemployment among females >25 years of age, <9th grade education among females >25 years of age, percent white non-Hispanic residents (as a measure of relative segregation), and percent foreign born adults >25 years of age. The percent imminently dangerous buildings and the percent vacant homes per block group listed in this database in 2001 were used as proxies for overall neighborhood quality.

2.2.1 Outcome variables—High school graduation was coded as the receipt of a diploma in the period 2000-2005 (1 or 2 years prior to 2 or 3 years after expected graduation depending on the year of reading assessment). Teen childbearing was defined as the presence of an individually matched certificate of live birth from the Pennsylvania Department of Public health before the age of 20. Live births for women age 20 years or older were removed.

2.3. Statistical analysis

Univariate associations between basic demographic variables, education status, census block group measures and teenage childbearing with 7th grade reading skill level were assessed by the chi-square statistic. In the Cox regression model, reading level was the only covariate included to obtain an initial, unadjusted hazard ratio (HR) with average reading skill level as the reference group. School attended was included in all fitted models as a frailty (random effects) term to account for unobserved heterogeneity not captured in the measured covariates. Frailty is an unobserved random proportionality factor that modifies the hazard function of an individual, or of related individuals to address the distinct error estimates related to similarities in these groups. In this particular case the attendance of girls in a specific school could reflect common characteristics of the girls which invalidate assumptions of independence and so change estimates of error. The inclusion of the frailty term while running the hazards models addresses this possibility and corrects the error estimate related to this clustering of girls in schools. Statistical significance of association was $p < 0.05$ for all analyses. Statistical analysis was carried out using STATA, version 9 software (Stata Corporation, 2005).

3. Results

The characteristics of the study sample and associations with reading skill level are shown in Table 1 for: 1) teen childbearing, 2) individual demographic and education variables and 3) school neighborhood block group variables. Among the 12,339 girls included in the sample, a total of 1,817 live births were identified over the six-year period of the analysis with 1,616 single births (13%), and 201 second or third births (2%; total period incidence of 147 births/1,000 girls). The mean age of these girls at the time of reading assessment was just under 12 years of age (11.9 years, SD 0.7).

The distribution of reading skill for the sample along nationally normed categories is shown across the top row of Table 1. Of the 12,339 girls assessed, approximately one quarter of the sample scored below average, two thirds scored within the average reading skill category and 14% were in the above average skill category. Teenage childbearing was significantly associated with pre-teen reading skill such that 21% and 3% of girls with below average pre-teen reading skill had either one or two-three births in the six years following the reading assessment, respectively, while 12% and 1% of girls with average reading and only 5% and 0.4% of those with above average reading skill had such births ($p < 0.001$). Reading skill also varied by Race/ethnicity, with African American and Latina girls over represented in the below average reading skill group. All of the neighborhood distress measures for school block groups were also significantly associated with reading skill.

Table 2 illustrates the final adjusted hazard ratios for reading skill level by race/ethnicity as compared to average reading skill among White girls. The final fitted model indicates that higher reading skill for girls in the 7th grade is protective for subsequent teenage pregnancy. Specifically, the HR for below average readers is two and a half times higher than for average readers, while girls with above average reading skill had approximately a quarter of the hazard.. The model also shows differential risk of teenage pregnancy by race/ethnicity. For girls with average reading skill, Asian/other race was protective, compared to Whites while African Americans and Hispanics had increased risk of teenage pregnancy. The combination of race and 7th grade reading skill on teenage pregnancy was also differentially expressed in our study sample and a statistically significant interaction was present (< 0.05). Latinas persistently had significantly increased risk of teenage pregnancy, compared to White teens who were average readers, regardless of reading skill, although the risk decreased as reading skill increased. African Americans were at increased risk in the below average and average reading levels but there was a suggested protective effect of being an above average reader although this result was not statistically significant. White teens with below average reading skill had two and a half times the hazard of teenage childbearing while above average reading skill was protective. Fig. 2 illustrates the strong effect of pre-teen reading skill on teenage childbearing and the early divergence of the hazard curves for these reading skill categories. This figure also illustrates the differential effect of reading skill on teenage childbearing by race/ethnicity through the greater deflection of the hazard curves for African American and particularly Hispanic/Latina girls than is seen for White girls as the time from the 7th grade reading assessment increases.

4. Discussion

In this analysis of a longitudinal cohort of pre-teen girls linked to birth records over a seven-year period, we found that low literacy in the 7th grade was independently associated with increased likelihood of childbearing through the teen years. The hazard curves of childbearing for different reading skill categories diverge soon after the reading assessment with clear distinctions apparent within a year. We identified a significant interaction between pre-teen reading skill measured in the 7th grade and race/ethnicity so that the risk of

childbearing for girls with average and below average reading level was greater among African American and Hispanic/Latina girls than it was for White girls. This is the first study of which we are aware that quantifies the magnitude of risk for teenage childbearing associated with different levels of literacy in pre-adolescents and distinguishes it from other established risk factors in a US sample.

This study has several limitations. First, administrative data are subject to errors of collection and coding. However, the scrutiny associated with assessments of school achievement tests are high and the stability of these measures for individuals has been shown to be robust. To reduce errors in the data linking, we utilized an individualistic deterministic linkage protocol which has been shown to minimize matching errors [16]. We also used an area level measure of poverty, percent of families in block groups at 100% poverty level, rather than individual level data which do not necessarily reflect the same level of risk as individual measures. However, this measure has been found to consistently predict expected outcomes related to the consequences of poverty.

These findings provide important evidence for the role of literacy in the reproductive health of US populations and they contribute to the growing literature linking literacy to health through the life course. While the role of literacy as an important and independent social risk factor for health outcomes has been increasingly studied there has been little research to understand the relationship of literacy to reproductive health outcomes. Given the strength of our findings additional research is warranted to inform health and education policy. Health care providers working with pre-teens and adolescents should consider literacy when delivering contraceptive and other reproductive health services to this population.

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More than one exclusion criteria was met by 2 individual participants leading to the apparent discrepancy between those removed and remaining.

Fig. 1. Schematic representation of participant selection

Frailty and covariate adjusted survival (Time to childbirth)
by 7th grade reading level

Frailty and covariate adjusted survival (Time to childbirth)
by 7th grade reading level (Whites only)

Frailty and covariate adjusted survival (Time to childbirth)
by 7th grade reading level (Blacks only)

Frailty and covariate adjusted survival (Time to childbirth)
by 7th grade reading level (Hispanics only)

Figure 2. Survival Curves Showing Overall Survival and Race/Ethnicity Stratified Association of Reading Score and Teenage Childbearing

Table 1

Characteristics of the study population of 12,339 girls and associations with levels of reading skill in 7th grade

	Reading skill level (7 th grade)				p value
	Total N=12339	Below average N=3166	Average N=7437	Above average N=1736	
Teen childbearing, # (%)					
1 birth	1616 (13)	651 (21)	886 (12)	79 (5)	<0.001
2 or 3 births	201 (2)	98 (3)	96 (1)	7 (0.4)	
Demographics*					
Mean age in years (SD)	11.9 (0.7)	12.0 (0.7)	11.9 (0.7)	11.9 (0.6)	0.229
Race/ethnicity -- # (%)					
African American (non-Hispanic)	7861 (64)	2362 (75)	4817 (65)	682 (39)	<0.001
White (non-Hispanic) and other	2379 (19)	232 (7)	1405 (19)	742 (43)	
Latina/Hispanic	1358 (11)	478 (15)	776 (10)	104 (6)	
Asian/other	738 (6)	93 (3)	437 (6)	208 (12)	
Education -- # (%)					
Special education (not gifted)	253 (2)	154 (5)	93 (1)	6 (0.3)	<0.001
Receiving ESOL services**	288 (2)	141 (5)	132 (2)	15 (1)	<0.001
Did not graduate***	5746 (47)	1913 (60)	3314 (45)	519 (30)	<0.001
School block group measures					
Girls in poverty area # (%)†					
Poverty area	4719 (38)	1284 (41)	2920 (39)	515 (30)	<0.001
Severe poverty area	2973 (24)	1133 (36)	1634 (22)	206 (12)	
Distress measures - top quartile, # (%)					
Female unemployment†	2802 (23)	894 (28)	1670 (23)	238 (14)	<0.001
12% female < 9 th grade education†	3072 (25)	915 (29)	1829 (25)	328 (19)	<0.001
45% White non-Hispanic†	3093 (25)	382 (12)	1863 (25)	848 (49)	<0.001
11% Foreign born†	3275 (27)	643 (20)	1969 (27)	663 (38)	<0.001
5% Imminently dangerous buildings†	3106 (25)	1128 (36)	1770 (24)	208 (12)	<0.001
9% Vacant buildings†	3090 (25)	1151 (36)	1745 (24)	194 (11)	<0.001

* At the time of reading assessment (7th grade).

** ESOL = English for Speakers of Other Languages

*** High school diploma within expected window of -1 year to plus 3 years of expected graduation date.

* Poverty area = 20-39% of families at 100% of poverty level; Severe poverty area = >40% of families living at 100% of poverty level.

* Highest quartile.

Percent may not add to 100 because of rounding.

Table 2

Estimated hazard ratios for first teenage childbirth in frailty model

HR (95% CI)	7 th Grade Reading Level		
	Below average	Average	Above average
White	2.51 (1.67,3.77)	<i>reference</i>	0.27 (0.17, 0.44)
African American	2.76 (2.14,3.56)	1.61 (1.25,2.08)	0.81 (0.55,1.20)
Hispanic	3.75 (2.75,5.10)	2.25 (1.68,3.02)	1.71 (1.06,2.78)
Asian/other	1.06 (0.53,2.11)	0.78 (0.52,1.18)	0.38 (0.19,0.74)

Estimated HRs and corresponding 95% CIs from final Cox model with frailty adjustment for school, controlling for the following census block group measures: poverty area status, proportion of female unemployment, proportion of female education <9th grade, proportion of block group white non-Hispanic, proportion of residents that are foreign born, and proportion of houses that are vacant. Reference group is average, white readers.