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Cohort study of early literacy and childbearing over the reproductive lifecourse

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ABSTRACT

Introduction: Literacy is linked to a range of health outcomes, but its association with reproductive health in high-income countries is not well understood. We assessed the relationship between early-life literacy and childbearing across the reproductive lifecourse in the USA.

Study design: A prospective cohort design was employed to assess early-life literacy and subsequent childbearing, using data from the National Longitudinal Survey of Youth 1979. The US youth aged 14–22 years in 1979, including 6283 women, were surveyed annually through 1994 and biannually thereafter. Literacy was assessed in 1980 using the Armed Services Vocational Aptitude Battery Reading Grade Level (RGL). Cumulative childbearing and grand multiparity (≥5 births) were assessed in 2010. Summary statistics, χ^2, Kruskal-Wallis, test for trend and logistic regression, were used.

Results: Of 6283 women enrolled, 4025 (64%) had complete data and were included in the analyses. In 1980, these women were on average 18 years old and in 2010 they were 45. Median cumulative parity decreased for each RGL and ranged from 3.0 (<5th grade) to 2.0 (>12th grade) (p=0.001). Adjusting for race/ethnicity, poverty status, whether a woman had had a child in 1980, and age in 1980, odds of grand multiparity were 1.9 (95% CI 1.1 to 3.5) and 1.8 (95% CI 1.0 to 3.3), greater among women with <5th or 5–6th grade literacy compared with those ≥12th literacy.

Discussion: In the USA, early-life literacy is associated with total parity over a woman's lifecourse. Literacy is a powerful social determinant of reproductive health in this high-income nation just as it has been shown to be in low-income nations.

Strengths and limitations of this study

- This is a longitudinal study of more than 4000 women from across race/ethnic and socioeconomic groups and through their full reproductive span, which allows a lifecourse perspective to be applied to the question of how literacy relates to health.
- This study extends the evidence that literacy is a powerful social determinant of health, including childbearing, a key reproductive health outcome, and this relationship holds true in a high-income country and independent of educational attainment and poverty.
- Unlike most studies assessing the linkage of literacy and health, literacy was assessed here using a robust and precise measure of reading skill rather than a simple and limited screening tool.
- While study non-respondents were somewhat different from those included in the analyses, it is unlikely that this difference affects results; non-respondents were less than a third of the full sample and were more likely to have higher literacy, making our estimates conservative.
- Additional research is needed to assess whether this relationship extends to other reproductive health outcomes.

INTRODUCTION

Literacy, the ability to use written text and numeracy, is primarily formed as a result of early-life educational inputs and is associated with poor health behaviours and outcomes at different life stages from adolescence to old age.[1–4] Despite these two important findings, little research has explored the impact of limited literacy prospectively on trajectories of health through the lifecourse; instead, nearly all research examining literacy and health has assessed the associations between the two at a single point in time or in a very narrow temporal window, which reduces the ability to assess a causal relationship between these variables.[1–4] A number of studies have examined the impact of literacy on health; however, these studies have focused on older adults whose past experiences, exposures and health behaviours may confound the associations.[1 4] Lifecourse epidemiology has made evident the importance of taking a longitudinal approach to understanding the magnitude of effect that social factors have on health and to inform interventions upstream (earlier in the life course) and downstream (later in the life course) to

moderate the impact these social factors have on health trajectories, including on the critical areas of maternal, child and reproductive health.[5–8]

Although historically much attention has been paid to the effect of educational attainment on health outcomes, there has been an increasing awareness of the independent role of literacy on health.[9 10] Literacy is an assessment of actual skill and is an independent risk factor for outcomes traditionally related to educational attainment.[1 11 12] Furthermore, modifiable social determinants of health are of interest to primary and community health policy because of their association with racial and economic disparities in health outcomes.[13 14] Because literacy is a modifiable skill, it opens the potential for novel interventions.[15 16] Despite this, most research on the relationship between health and literacy focuses on short-term risks and consequences, such as misreading medical directions. As a result, these studies fall short of addressing the larger cumulative risk to health that arises from chronic exposures to disadvantage secondary to low literacy through life and the greater role that literacy could play as a social determinant of health. In addition, nearly all research on this topic within high-income nations has used instruments with severely limited capacity to measure literacy, instead using rapid screening assessments of risk of low literacy, reducing the ability to attribute health outcomes to specific levels of literacy skills.[3 8] In order to inform public policy and interventions, there is a great need to carry out longitudinal studies, which assess the magnitude of effect of literacy on health outcomes independent of other established social determinants of health and within a lifecourse framework.

Childbearing plays a major role in women's health and is the most common reason for hospitalisation in the USA among adults under age 45.[17] While most childbirths do not affect the health of mothers, severe maternal morbidity affects more than 60 000 US women annually[18] and the maternal mortality ratio is higher in the USA than other high-income nations.[19] Furthermore, unintended pregnancy represents a very high percentage of births in high-income nations, particularly in vulnerable populations at risk for poor birth outcomes.[9 10] Girls in the USA with below-average reading skill at age 11 have increased risk of subsequent teenage childbearing compared with girls with average reading skill, even after adjusting for a range of social factors.[20] In the developing world, associations between low literacy and increased birth rates have been observed at the district, state and individual level.[21–23]

Despite these findings, there has been little research in high-income nations examining the influence of early-life literacy on subsequent reproductive health outcomes such as childbearing.[24] Increased parity, or number of total births, increases the cumulative risk of poor health outcomes for women; grand multiparity (delivering 5 or more children) is associated with poor health outcomes for women and their children, including obstetric complications, neonatal morbidity and perinatal mortality.[25] In 2011, 190 000 US women delivered a fifth, or higher order, child, making up 4.8% of all US births that year.[26 27] While higher parity is associated with low-socioeconomic status and low educational attainment[28] and may be associated with cultural norms the relationship between early-life low literacy and grand multiparity has not been explored. In this study, we sought to assess the association between early-life literacy and parity through women's full reproductive lifecourse. We hypothesised that women with lower early-life literacy levels would be at an increased risk of grand multiparity compared with those with higher early-life literacy levels.

METHODS

Data

Data from the National Longitudinal Survey of Youth 1979 (NLSY-79),[29] a representative probability sample of US men and women born between 1957 and 1964, were used to assess the relationship between early-life literacy and risk of grand multiparity across a woman's reproductive lifecourse. These data have been used to assess a range of social influences on birth and birth outcomes.[30 31] In 1979, the first survey year, 6283 women were enrolled. Participants were surveyed annually through 1994 and biannually thereafter. Survey data through 2010 were used in analyses. Retention in the survey through 2010 exceeded 80%.

The survey followed women from 1979 when they were 14–22 years old to 2010 when they were 45–53 years old. These data provided the novel opportunity to examine the full female reproductive lifecourse, commonly accepted as age 15–45.[32] Women missing data on early-life literacy or total parity, including those dropped from the NLSY prior to 2010, were excluded from the analysis.

Outcome measures

Parity was measured in each survey year. Total cumulative parity for each woman in 2010 was used to create the variable grand multiparity defined as five or more births. To decrease the effect of non-response bias, for those women missing parity data in 2010, total parity in 2008 or 2006 was used; <1% of women with parity data in 2010 had a child between 2006 and 2010.

Exposure measures

Department of Defense Reading Grade Level (RGL) in 1980 was used as the measure of early-life literacy. RGL categories were created from the Armed Services Vocational Aptitude Battery (ASVAB) using a previously validated conversion method.[33] The ASVAB is a text-based measure of a range of cognitive skills with rigorously assessed psychometric properties. Components of this well-validated instrument have been used in a range

of health studies.[34 35] This measure of early-life literacy was used to construct an ordinal variable for literacy based on commonly accepted RGL cut-points (<5th grade, 5–6th grade, 7–8th grade, 9–11th grade and ≥12th grade).

Covariates

Using an adaptation of the behavioural model described by Andersen, we identified maternal predisposing and enabling factors to predict grand multiparity.[36] This study focused on early-life factors and covariates that did not change over time (time invariant), as opposed to covariates that change with time. Predisposing factors included early-life literacy, as well as age at reading assessment, and race/ethnicity. Income was included as an enabling factor.

Participants self-reported their age in 1980 when the ASVAB was administered. Race/ethnicity was assigned in 1979 by NLSY interviewers and reported as Hispanic; Black; or non-Black, non-Hispanic. Poverty status was assessed for every participant in each of the survey years. Participants' family income was compared with the years' Poverty Income Guidelines created by the US. Department of Health and Human Services. The respondent's family size, whether or not they lived on a farm, and their state of residence were used in assessing poverty status. In following with a lifecourse approach, poverty status in 1979 was used in this study. Poverty status was dichotomised as in poverty or not in poverty. Whether or not a woman was parous prior to 1980 (ie, before the literacy assessment was administered) was dichotomised as parous or nulliparous.

Statistical analysis

Summary statistics, including frequencies, percentages, means and SDs, were used to describe the study population. To examine the relationship between presence or absence of grand multiparity (yes/no) and predisposing and enabling factors, the χ^2 and Kruskal-Wallis tests were used for categorical and continuous variables, respectively. To determine the independent association of RGL to grand multiparity, a logistic regression was employed, adjusting a priori for race/ethnicity and poverty status in 1979. Despite past evidence that without intervention adult literacy is for the most part, fixed,[37] bivariate analysis revealed variation in RGL by age at reading assessment. For this reason, age at the time of reading assessment in 1980 was also included in all models. Furthermore, having a child prior to age at reading assessment may confound the relationship between RGL and grand multiparity, and was also included in all models. A Cochran-Armitage test for trend was employed to test whether there was a decreasing trend in multiparity with increasing RGL. Analyses were performed using the Stata statistical software (Stata Statistical Software: Release 12 [computer program]. College Station, TX: StataCorp LP, 2011).

RESULTS

Women in the military and poor white women who had been oversampled and subsequently dropped from the NLSY prior to 2010 (n=1331), those who were missing ASVAB scores (n=268) and those without parity data in 2006, 2008 and 2010 (n=659) were excluded, resulting in an analytic sample of 4025 women (64% of women enrolled in NLSY). Those with parity data varied from those missing parity data on several variables of interest (table 1). Those missing parity data had higher RGL and lower parity than respondents. Similarly, the group missing RGL had higher proportions of Black and Hispanic women, without a high school degree in 1985, and in poverty at age 14 compared with respondents.

Among eligible participants, 49.5% were non-Black, non-Hispanic, 31.3% were Black and 19.2% were Hispanic. The majority of participants (69.4%) were not in poverty from 1978 to 1979. The average age at reading assessment in 1980 was 19.2 years of age, while the average RGL in that year was 9.7; 14.21% had an RGL of <5th, 14.0% 5–6th grade, 16.2% 7–8th grade, 33.2% 9–11th grade and 22.4% 12th grade or greater. By 1985, 80.8% of participants had a high school degree or GED. In 2010, on average woman had 2.1 children; 15.8% of women had no children, 16.5% one, 34.2% two, 20.8% three, 8.3% four, 2.7% five, 1.1% six, 0.4% seven and 0.4% (15) women had 8 or more children. One hundred and eighty-three women (4.6%) were grand multiparous. Participant characteristics differed between those who were grand multiparous and those who were not (table 2). Greater proportions of women who were grand multiparous were Hispanic, Black, in poverty 1980, did not have a high school degree in 1985 and were parous in 1980 compared with non-grand multiparous women.

Bivariate analyses demonstrated differences between women in varying RGL categories (table 3). Among participants, women with an RGL lower than fifth grade were likely to be Black or Hispanic (57.6% and 29.2%, respectively), in poverty in 1979 (55.8%), have a high average number of siblings (5.4) and a high average parity (3.0). Women in the highest RGL category were unlikely to be Black or Hispanic (9.2% and 10.2%, respectively), in poverty in 1979 (7.6%), have a lower median number of siblings (2.0) and had a lower median parity (2.0). Furthermore, 10.3% of women in the lowest RGL category were grand multiparous and 2.6% of those in highest RGL were grand multiparous. Forty-two per cent of those in the lowest RGL were parous before 1980, while only 13.9% of those in the highest RGL were parous in 1980.

After adjustment for age at reading assessment, race/ethnicity, poverty status and parous in 1980, the odds of grand multiparity was 1.94 times (95% CI 1.1 to 3.5) and 1.84 times higher (95% CI 1.0 to 3.3) in the lowest two RGL categories, respectively, compared to the highest RGL category (≥12th grade, table 4). Additionally, the adjusted odds of grand multiparity was

Table 1 Differences between those missing parity data and those with parity data

	Not missing parity (4025)		Missing parity (659)		Missing ASVAB (268)	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
RGL						
<5th grade	572	14.2	64	9.7	–	–
5–6th grade	562	14.0	86	13.1	–	–
7–8th grade	653	16.2	107	16.2	–	–
9–11th grade	1338	33.2	234	35.5	–	–
12th+ grade	900	22.4	168	25.5	–	–
Race/ethnicity						
Hispanic	774	19.2	132	20.0	74	27.6
Black	1258	31.3	167	25.3	52	19.4
Non-Black, non-Hispanic	1993	49.5	360	54.6	142	53.0
HS degree in 1985						
No	689	17.1	85	12.9	85	31.7
Yes	3251	80.8	482	73.1	60	22.3
Age in 1980 (years)						
15	345	8.6	54	8.2	5	1.9
16	531	13.2	104	15.8	15	5.6
17	573	14.2	82	12.4	17	6.3
18	543	13.5	98	14.9	18	6.7
19	544	13.5	72	10.9	20	7.5
20	497	12.4	81	12.3	19	7.1
21	416	10.3	83	12.6	19	7.1
22	442	11.0	69	10.5	22	8.2
23	78	1.9	7	1.1	10	3.7
Average (mean age)	18.0		16.7		19.3	
Poverty status at age 14						
In poverty	1021	25.4	129	19.6	76	61.6
Not in poverty	4025	69.4	473	71.8	165	28.4
Parous in 1980						
Parous	756	23.9			34	28.3
Nulliparous	2404	76.1			86	71.7

Note: percentages do not add to 100% in all cases.
ASVAB, Armed Services Vocational Aptitude Battery; RGL, Reading Grade Level.

2.99 times higher (95% CI 1.3 to 3.2) for women of Hispanic ethnicity compared to the odds of grand multiparity in non-Hispanic/non-Black women. Compared to those who were nulliparous in 1980, those who were had 2.86 times (95% CI 2.0 to 4.0) the odds of grand multiparity. A Cochran-Armitage test for trend showed a significant decreasing trend in grand multiparity as RGL increased ($p<0.001$). The final bivariate model was also run with only those not missing 2010 parity data and results did not vary from the model presented in table 4, except that the effect of Hispanic ethnicity was not as great (OR: 2.01, 95% CI 1.27 to 3.17).

DISCUSSION

This study of more than 4000 women followed over three decades demonstrated that early-life literacy is associated with parity in a stepwise manner. Low literacy is a predictor of grand multiparity among US women, even after controlling for identified confounders. Those with the lowest early-life literacy are at the highest risk for grand multiparity; those with less than a seventh or fifth grade reading level at the time of assessment were nearly two times more likely to be grand multiparous at the end of the reproductive lifecourse, respectively, compared to those with a 12th grade or greater RGL. These results provide important additions to the understanding of literacy as a distinct social determinant of health across the lifecourse in a high-income country and echo findings from low-income and middle income countries.[22 23]

We also found that, after controlling for early-life literacy status, Hispanic women are at an increased risk of grand multiparity compared with non-Black, non-Hispanic women. In contrast to previous work that found an interaction between these variables in the risk of teenage childbearing in a US sample, we did not find evidence for an interaction between race/ethnicity and literacy in this sample of women somewhat later in their lifecourse.[21] Additional research is needed to clarify the relationships between race/ethnicity, culture, reproductive outcomes and early-life literacy.

Increased appreciation of the influence of social determinants on health outcomes has led to new efforts

Table 2 Participant characteristics

	Non-grand multiparous (n=3852)		Grand multiparous (n=183)	
	Frequency	Per cent	Frequency	Per cent
Race/ethnicity				
Hispanic	717	18.7	57	31.2
Black	1182	30.8	76	41.5
Non-Black, non-Hispanic	1943	50.6	50	27.3
Poverty status at 14				
In poverty	942	24.5	79	43.2
Not in poverty	2697	70.2	98	53.6
Average age (mean)				
In 1980	18.25		18.15	
In 2010	45.03		45.48	
RGL				
<5th grade	513	13.4	59	32.2
5–6th grade	519	13.5	43	23.5
7–8th grade	628	16.4	25	13.7
9–11th grade	1305	34.0	33	18.0
12th+ grade	877	22.8	23	12.6
HS degree in 1985				
No	606	15.8	83	45.4
Yes	3155	82.0	96	52.5
Parous in 1980				
Parous	678	18.7	78	45.1
Nulliparous	2943	81.3	95	54.9

Note: Percentages do not add to 100% in all cases.
RGL, Reading Grade Level.

Table 4 RGL and risk of grand multiparity, adjusted for covariates

	OR	95% CI	p Value
RGL (reference: ≥12th)			
<5th	1.94	1.07 to 3.53	0.029
5–6th	1.84	1.02 to 3.32	0.044
7–8th	0.97	0.51 to 1.82	0.914
9–11th	0.76	0.43 to 1.34	0.350
Race/ethnicity (reference : non-Black, non-Hispanic)			
Hispanic	2.99	1.27 to 3.17	0.003
Black	1.37	0.87 to 2.15	0.178
Poverty status (reference: not in poverty)	1.21	0.85 to 1.73	0.300
Age in 1980	0.98	0.95 to 1.02	0.319
Parous in 1980 (reference: nulliparous)	2.86	2.03 to 4.01	<0.0001

RGL, Reading Grade Level.

to incorporate these forces into primary and community health.[13 14] Their contribution to health across the lifecourse raises the question of what novel interventions can be implemented to alter health trajectories. Literacy, because it is modifiable, has particular potential in this regard and some efficacious interventions have been implemented.[15 16] Additional work is needed to assess the benefits of these strategies on health outcomes, to determine the causal pathways through which literacy effects health and to explore additional opportunities to improve health and reduce health disparities through literacy, including assessment of timing of births across women's reproductive lifecourse.

Limitations

This study had several limitations. First, NLSY-79 participants self-reported total parity in 2010, which could be vulnerable to reporting error resulting in outcome misclassification. It is unlikely, however, that this would result in a systematic bias as reporting of such major life events has been found to be accurate.[38 39] Similarly, there is potential for bias due to outcome misclassification because we used 2008 and 2006 parity for those missing 2010 parity. However, when final model results were re-run, including only those respondents not missing 2010 parity, results were similar. For this reason, we are confident that using 2008 and 2006 parity did not introduce significant bias. Second, we made the assumption that early-life literacy measured in 1980 was

Table 3 Cohort by RGL

RGL	<5th N (%)	5–6th N (%)	7–8th N (%)	9–11th N (%)	≥12th N (%)	p Value*
Race/ethnicity						<0.0001*
Hispanic	161 (28.2)	159 (28.3)	151 (23.1)	211 (15.8)	211 (10.2)	
Black	329 (57.6)	287 (51.1)	279 (42.7)	280 (20.9)	83 (9.2)	
Non-Black/Hispanic	82 (14.3)	116 (20.6)	223 (34.2)	847 (63.3)	725 (80.6)	
In poverty 1979	319 (55.8)	233 (41.5)	186 (28.5)	215 (16.1)	68 (7.6)	<0.0001
Siblings (median)	5.0	4.0	4.0	3.0	2.0	0.001†
Parity (median)	3.0	2.0	2.0	2.0	2.0	0.001†
Parous in 1980	207 (42.0)	126 (27.4)	132 (25.6)	200 (19.3)	91 (13.9)	<0.0001*
Grand multiparous	59 (10.3)	43 (7.7)	25 (3.8)	33 (2.5)	23 (2.6)	<0.0001†

Note: Percentages do not add to 100% in all cases.
RGL, Reading Grade Level.
*p Values reported for Pearson's χ^2 test comparing all RGL.
†p Values reported for Kruskal-Wallis test comparing all RGL.

stable over the course of the study, which does not account for potential changes in RGL over a woman's life. This assumption is supported by a large body of educational research, indicating that few individuals experience dramatic changes in literacy over time.[40] We also controlled for possible effects of changes in literacy for women whose literacy was assessed at an early age by including age at assessment in the multivariate model. Furthermore, we made use of a true measure of literacy, the ASVAB, as opposed to limited proxy or brief screening measures most commonly employed in studies of the connection between literacy and health.[3 4] Third, there may have been unmeasured confounding. We were unable to control for cultural factors that may be related to childbearing. Such cultural factors, including religiosity, may account for the persistent increased risk of grand multiparity in Hispanic women as compared with non-Black, non-Hispanic women. The association between high fertility and low early-life literacy among Hispanic women may be confounded by cultural factors that lead to a preference for larger families. Similarly, we focused on time-invariant and early-life covariates. Potential time-varying confounders, including employment status, marital status, income and health status, were not controlled. Future work should further investigate the role of cultural factors on reproductive outcomes and time-varying covariates. Finally, non-respondents were different from study participants in total parity. However, we do not believe that their omission would result in a change in our fundamental findings since non-respondents had higher early-life literacy, and fewer children than respondents, which would result in a larger estimate of the association between early-life literacy and parity, if included.

CONCLUSIONS

Contributing to the growing literature demonstrating a relationship between literacy and health, we found that early-life literacy is associated with cumulative total births among women in the USA. Grand multiparity, which has associated health risks,[6–8] was elevated among the lowest literacy groups when compared to those with greater than high school literacy level. These findings represent strong evidence that literacy is a critical social determinant of health independent of other established factors known to influence health outcomes. The current study represents evidence for the influence of literacy on childbirth, the single greatest cause for hospitalisation among adults under age 45.[17] This study contributes to the field of research in literacy and health by: (1) focusing on childbearing, (2) providing evidence of cumulative effects through the lifecourse and (3) making use of true measures of literacy providing precise and comparable reading levels. These findings strengthen the call for additional attention to be paid to literacy in the development of interventions and policy that aims to influence health outcomes. Furthermore, this builds on the literature, indicating that literacy should be considered an additional risk factor when creating policy to reduce maternal risk. This work affirms the importance of attending to literacy needs of reproductive age women and developing and testing literacy interventions appropriate to this population.

Contributors JWS conceived of the study, executed analyses and was the primary manuscript writer. RF and IMB advised and contributed to study execution and to the writing. FSS advised and contributed to analyses and manuscript writing.

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