A Chapter a Day – Association of Book Reading with Longevity

Avni Bavishi[1], **Martin D. Slade**[1], and **Becca R. Levy**[1]

[1]Yale University School of Public Health, Laboratory of Epidemiology and Public Health, 60 College Street, New Haven, CT 06510. Masters in Chronic Disease Epidemiology

Abstract

Although books can expose people to new people and places, whether books also have health benefits beyond other types of reading materials is not known. This study examined whether those who read books have a survival advantage over those who do not read books and over those who read other types of materials, and if so, whether cognition mediates this book reading effect. The cohort consisted of 3635 participants in the nationally representative Health and Retirement Study who provided information about their reading patterns at baseline. Cox proportional hazards models were based on survival information up to 12 years after baseline. A dose-response survival advantage was found for book reading by tertile ($HR_{T2} = 0.83$, p<.0001, $HR_{T3} = 0.77$, p<.0001), after adjusting for relevant covariates including age, sex, race, education, comorbidities, self-rated health, wealth, marital status, and depression. Book reading contributed to a survival advantage that was significantly greater than that observed for reading newspapers or magazines ($t_{T2} = 90.6$, p<.0001; $t_{T3} = 67.9$, p<.0001). Compared to non-book readers, book readers had a 4-month survival advantage at the point of 80% survival. Book readers also experienced a 20% reduction in risk of mortality over the 12 years of follow up compared to non-book readers. Cognitive score was a complete mediator of the book reading survival advantage (p=.04). These findings suggest that the benefits of reading books include a longer life in which to read them.

Keywords

reading; longevity; aging; mortality; cognition

While most sedentary behaviors are well-established risk factors for mortality in older individuals (Wullems et al., 2016; de Rezenade et al., 2014, Katzmaryk & Lee, 2012; Muennig, Rosen, & Johnson, 2013), previous studies of a behavior which is often sedentary, reading, have had mixed outcomes. That is, some found that reading reduces the risk of mortality (Agahi & Parker, 2008; Jacobs, Hammerman-Rozenberg, Cohen, & Stessman, 2008), whereas others found that it has no effect (Bygren, Konlaan & Johansson, 1996; Menec, 2003). However, previous studies often combined different types of reading material and have not compared the health benefits of reading-material type; also, the mechanism for

Correspondence to: fax: 203-785-6980, phone; 203-785-2869, becca.levy@yale.edu.

the possible protective effect was not identified. We speculated that books engage readers' minds more than newspapers and magazines, leading to cognitive benefits that drive the effect of reading on longevity. In the following study, we were able to build on previous studies by examining the potential survival advantage of books. We predicted that the survival advantage for reading books would be greater than the survival advantage of reading newspapers and magazines.

Reading books tends to involve two cognitive processes that could create a survival advantage. First, it promotes "deep reading," which is a slow, immersive process; this cognitive engagement occurs as the reader draws connections to other parts of the material, finds applications to the outside world, and asks questions about the content presented (Wolf, Barzillai, & Dunne, 2009). Cognitive engagement may explain why vocabulary, reasoning, concentration, and critical thinking skills are improved by exposure to books (Stanovich, West, & Harrison, 1995; Stanovich & Cunningham, 1998; Wolf, Barzillai, & Dunne, 2009). Second, books can promote empathy, social perception, and emotional intelligence, which are cognitive processes that can lead to greater survival (Bassuk, Wypij, & Berkmann, 2000; Djikic, Oatley, & Moldoveanu 2013; Kidd & Castano 2013; Shipley, Der, Taylor, & Deary 2008; Olsen, Olsen, Gunner-Svensson, & Waldstrom, 1991). Better health behaviors and reduced stress may explain this process (Bassuk, Wypij, & Berkmann, 2000).

The current study hypothesized that book reading provides a survival advantage, and that this advantage is mediated by cognitive engagement. To determine if the advantage is specific to the immersive nature of book reading, we also examined whether there is a survival advantage to reading periodicals (i.e., newspapers and magazines). Cognitive engagement might also occur while reading thought-provoking periodicals, however this engagement is more likely to occur when reading books due to the tendency of book authors to present themes, characters and topics in greater length and depth (Stanovich, 1992). Accordingly, we hypothesized that the survival advantage would be stronger when reading books compared to periodicals.

METHODS

Participants

The study cohort was drawn from the Health and Retirement Study (HRS), collected by the University of Michigan's Institute of Social Research and supported by the National Institute on Aging. The HRS has conducted national telephone surveys biennially since 1992 among adults over age 50. In 2001, the off-year Consumption and Activities Mail Survey (CAMS) was added, which contained questions about reading habits. All individuals completed identical telephone questionnaires and had identical follow-up procedures. This dataset follows individuals from the first year they answered the CAMS to December 31, 2012. Respondent level weights from the HRS were used in all survival analyses in order to correct for the oversampling design and for differential non-response. This weighting design makes the sample representative of the United States population (Health and Retirement Study, 2014).

The final sample consisted of 3635 individuals that were followed over 34,496 person-years, with 27.4% of the sample dying during an average 9.49 years of follow-up. Consistent with the older population, the sample was predominantly (62%) female.

Chi-square tests revealed that book readers differed from non-book readers in that a higher proportion was female, college educated, and in the higher-wealth group (all p < .001); These variables were included as covariates in all models. No significant differences existed in age, race, health, job status, or marriage status between groups at the .05 level. To be conservative, models were also adjusted for all of these covariates. (See Table 1.)

Measures

Predictor: Reading—Time spent reading books and time spent reading periodicals were assessed by the CAMS questions: "How many hours did you actually spend last week reading books?" and "How many hours did you actually spend last week reading newspapers or magazines?" These were assessed in the first year that participants responded to the CAMS, which was used as their baseline year. Following the model of previous studies, reading was split into three levels (Agahi & Parker, 2008; Bygren, Konlaan, & Johansson, 1996); the first tertile was the reference group. The tertiles constructed for: books were: 0, 0.01 – 3.49, 3.5 or more hours per week. The tertiles constructed for periodicals were: 0 – 2, 2.01 – 6.99, 7 or more hours per week. Total reading scores were calculated as a sum of the tertiles of book and periodical reading, with scores ranging from 2 to 6. The average time spent reading per week was 3.92 hours for books and 6.10 hours for periodicals. The two types of reading were not strongly correlated (weighted Pearson and polychoric r=.23), and 38% of the sample (n=1390) read only books or only periodicals; this allowed them to be treated as separate constructs.

Survival—Vital status was determined by matching participants to the National Death Index (National Death Index, 2015). Follow-up time was calculated from the first CAMS survey until either death or December 31, 2012.

Mediator: Cognitive Engagement—Cognitive engagement was assessed with total cognitive score (available in the supplemental Imputation of Cognitive Function Measures) which is a summary variable based on 8 items, including immediate recall, delayed recall, serial 7s, backwards count from 20, object naming, President naming, Vice President naming, and date naming. These items covered recall and mental status; reading has been found to be positively associated with both components (Wolf, Barzillai, & Dunne, 2009; Stanovich, West, Harrison, & 1995; Stanovich & Cunningham, 1998). This HRS cognitive measure has been validated for use in population surveys (Herzog & Wallace, 1997). During each wave of the survey, response rates exceeded 80% (Ofstedal, Fisher, & Herzog, 2005). Total cognitive score in 2004 was used for a mediation analysis after adjusting for cognitive score in 2000; the change in cognitive score ranged from a twenty point drop to a thirteen point gain (standard deviation = 4.31). On average, the cognitive score dropped 1.47 points over these 4 years.

Covariates—Covariates were included that could influence reading or survival. They included individual comorbidities (cancer, lung disease, heart disease, stroke, arthritis, diabetes, and hypertension), visual acuity, wealth, marriage status, job status, depression, age, sex, race, self-rated health, and education. Self-rated health was reported on a five-point scale from poor to *excellent*. Visual acuity was self-reported on a six-point scale from *blind* to *excellent*. Wealth was calculated by the Rand HRS dataset as the sum of l relevant financial components (e.g., real estate, stocks, bank accounts, bonds) minus the sum of debts (RAND HRS Data, 2014), and was included as a continuous variable. Marriage and job status were dichotomized (married vs. not; employed vs. not). Depression was quantified using a yes-or-no question: "Much of the time during the past week, you felt depressed." Race was categorized as Black, White, or other. Education level was used as continuous, quantified by the number of school years. These covariates were used in all multivariate models.

Statistical Analyses

Chi-square tests were completed in order to determine baseline comparability between groups. Unadjusted-Kaplan-Meir curves were plotted to differentiate between book readers and non-book readers and a log-rank test was conducted. The proportional hazards assumption was checked by assessing the parallelism of the log(−log(survival)) plots. Adjusted Cox proportional hazards models were constructed, using book reading and periodical reading as predictors of survival. These analyses all included respondent weights. To examine the robustness of the findings, sensitivity analyses for differential right censoring were also conducted by following participants through 2006, 2008, and 2010 instead of through 2012.

Following the mediation steps suggested by Hayes (2013), the total association effect (c) was calculated by a logistic regression of book reading on mortality, and the mediation effect of cognitive score was calculated using the product of the coefficient method. The association between book reading and cognitive score (a) was calculated by using a linear-regression model; the association between cognitive score and mortality (b) was calculated with a logistic model. This model also yielded the indirect effect of book reading on mortality, after adjustment for cognitive score (c'). The product of a and b was used to estimate the strength of the mediation. To calculate the significance of the mediation 95% confidence intervals for the model were generated using bootstrapping with 10,000 samples (Hayes, 2013). This method allows for greater power in the analysis and more robust confidence intervals.

The mediation effect was assessed using the SAS macro provided by Hayes (2013). Mortality status (dead or alive) as of December 31, 2012 was used as the outcome variable. In these analyses, book reading in 2001 was used as the predictor, the cognitive score in 2004 was used as the mediator and survival was examined from 2004 to 2012. The models adjusted for all covariates as well as baseline cognitive score.

All analyses were completed in SAS 9.4 (Cary, NC). These analyses had a significance threshold of $p < .05$.

RESULTS

In support of the prediction, book reading was associated with significantly greater survival for both the second and third tertiles, with adjustment for all covariates (HR_{T2}=0.83, p<0.0001; HR_{T3}=0.77, p<0.0001). During follow-up 33% of non-book readers, died, compared to 27% of book readers. Hazard ratios for reading periodicals were also obtained (HR_{T2}=1.01, p<0.0001; HR_{T3}=0.89, p<.0001), with a protective effect seen only for the third tertile. The HRs for reading books were significantly more protective than those obtained for reading periodicals when compared by tertile using t-tests (t_{T3}= 90.6, p<.0001; t_{T3}= 67.9, p<.0001). The total reading effect (summation of books and periodicals tertile) was also advantageous per total reading point (HR=.92, p <0.0001)). As described above, this overall protective effect appears to be driven by books.

The second and third tertiles of book reading were combined to further explore the book effect. This was simplified to any-book reading vs. no-book reading. Figure 1 presents unadjusted survival curves for book readers compared to non-book readers (HR = 0.76, p<.0001). When readers were compared to nonreaders at 80% mortality (the time it takes 20% of a group to die), nonbook readers lived 85 months (7.08 years), whereas book readers lived 108 months (9.00 years) after baseline. Thus, reading books provided a 23-month survival advantage. After adjustment for all covariates, the survival advantage persisted (HR=0.80, p<.0001), with reading books providing a 4-month survival advantage.

As an indication of the robustness of the effect, the survival advantage remained for book readers when stratified by sex (males, HR = 0.81, p < .0001; females, HR = 0.80, p<.0001); health status (less than 4 comorbidities, HR = 0.84, p <.0001; four or more comorbidities, HR = 0.68, p<.0001); wealth ($133,000, HR = 0.84, p<.0001; >$133,000, HR = 0.75, p<. 0001); and education level (high-school degree or less, HR = 0.81, p<.0001; at least some college, HR = 0.79, p<.0001). Medians of the health, wealth, and education variables were used as the stratification cut points. Models were adjusted for all covariates other than the stratification variable.

Sensitivity analyses supported the robustness of the results. Various exposure categorizations were tested, with adjustment for covariates. A significant survival advantage was still found for reading books with quartiles of reading time, rather than tertiles; this survival advantage was also greater than for reading periodicals. Additionally, both books and periodicals were categorized using the total reading tertile cut-points, such that all three types had 0 – 4.49, 4.49 – 10.49, and 10.5 or more hours of reading. With this categorization, the same pattern of effects was found. The results were consistent regardless of the degree of right censoring: the same pattern of findings was observed when survival was shortened to 2006, 2008, or 2010.

Additionally, a sensitivity analysis was conducted to confirm that the survival advantage of reading books is not due to higher baseline cognition of book readers. Baseline cognition in 2000 was included as a covariate in the main model. This pattern of findings replicated the earlier reported patterns. A protective effect was still found from reading books (HR_{T2}=0.90,

p<0.0001; HR_{T3}=0.80, p<0.0001) and an attenuated effect was found from reading periodicals (HR_{T2}=1.02, p=<.0001; HR_{T3}=0.89, p<.0001).

Figure 2 shows the results of the mediation analysis, following the mediation steps suggested by Hayes (2013), which are outlined in the statistical analysis section. After adjustment for all covariates, including baseline cognition, the effect of reading in 2001 on cognitive score in 2004 was significant (a: β=.48, p=.01), as was the total effect of book reading on survival (c: β=.25, p=.04). The effect of cognitive score on survival (b: β=.07, p<.0001) and the indirect effect of reading on survival after adjustment for cognition (c': β= .21, p=.10) were obtained from the same logistic model. The mediation effect of cognition equals ab =.03(p=.04; 95% CI: .01, .10), indicating that there was a significant complete mediation effect of cognitive score on the relationship between book reading and survival. Another mediation analysis was conducted to test the direction of the effect, using cognitive score in 2000 as the predictor and book reading in 2003 as the mediator. The indirect effect ab =.00 was non-significant (p=.99, 95% CI: −.003, .001), indicating that reverse causality mediation was not present.

DISCUSSION

A 20% reduction in mortality was observed for those who read books, compared to those who did not read books. Further, our analyses demonstrated that any level of book reading gave a significantly stronger survival advantage than reading periodicals. This is a novel finding, as previous studies did not compare types of reading material; it indicates that book reading rather than reading in general is driving a survival advantage.

The mediation analyses showed for the first time that the survival advantage was due to the effect that book reading had on cognition. The adjustment for baseline cognition makes it unlikely that higher cognitive level causing increased reading was driving the mediation. We found that book reading did not mediate the relationship between cognition and survival, so there was not a reverse causality effect. That is, as predicted, cognition mediated the relationship between reading and survival but reading books did not mediate the relationship between cognition and survival. This finding suggests that reading books provide a survival advantage due to the immersive nature that helps maintain cognitive status.

The protective effect of book reading appears to have wide applicability, as indicated by the covariates that were included in the models and the stratified analyses. Older individuals, regardless of gender, health, wealth, or education, showed the survival advantage of reading books. Others have found a protective effect for book reading only in women or only among men (Agahi & Parker, 2008; Jacobs, 2008); The contrast between those findings and our finding regarding the advantage for both male and female readers may be due to our study having a larger sample with more recent data and a more detailed measure of reading that assessed hours, which the other studies were unable to do because of survey design.

In addition, the stratified analyses demonstrated that the effect is not driven by education, as the protective effect of reading was observed independently in the low- and high-education

groups, as well as the high- and low-wealth groups. Further, the survival advantage persisted after adjustment for baseline cognition. These findings make the results more robust.

Individuals over age 65 spend an average of 4.4 hours per day watching television (Bureau of Labor Statistics, 2014). Efforts to redirect leisure time into reading books could prove to be beneficial in terms of survival for this population. Also, participants in the study spent considerably more time reading periodicals than reading books; since the survival advantage is significantly stronger for book reading, switching from reading periodicals to books, or adding book reading to daily activities, might be worthwhile.

There are several areas that would be interesting for future research to explore, including: whether there are additional health benefits from book reading, other than extended survival; whether there are similar effects reading e-books and audiobooks, which may be more likely to be read in a non-sedentary manner; and whether nonfiction vs. fiction, as well as various genres, have differential effects, Considering that 87% of book readers read fiction (National Endowment for the Arts, 2014), it is likely that most of the book readers in our study were reading fiction.

This study found that those who read books for an average of 30 minutes per day – say, a chapter a day – showed a survival advantage, compared to those who did not read books. The robustness of our findings suggest that reading books may not only introduce some interesting ideas and characters, it may also give more years of reading.

Acknowledgments

REFERENCES

Agahi N, Parker MG. Leisure Activities and Mortality Does Gender Matter? Journal of Aging and Health. 2008; 20(7):855–871. [PubMed: 18815413]

Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of personality and social psychology. 1986; 51(6):1173. [PubMed: 3806354]

Bassuk SS, Wypij D, Berkmann LF. Cognitive impairment and mortality in the community-dwelling elderly. American journal of epidemiology. 2000; 151(7):676–688. [PubMed: 10752795]

Bureau of Labor Statistics. American Time Use Survey - Charts by Topic: Older Americans. 2014

Bygren LO, Konlaan BB, Johansson SE. Attendance at cultural events, reading books or periodicals, and making music or singing in a choir as determinants for survival: Swedish interview survey of living conditions. BMJ: British Medical Journal. 1996; 313(7072):1577. [PubMed: 8990990]

de Rezende LFM, Rey-López JP, Matsudo VKR, do Carmo Luiz O. Sedentary behavior and health outcomes among older adults: a systematic review. BMC Public Health. 2014; 14(1):1. [PubMed: 24383435]

Djikic M, Oatley K, Moldoveanu MC. Reading other minds: Effects of literature on empathy. Scientific Study of Literature. 2013; 3(1):28–47.

Hayes, AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford Press; 2013.

"Health and Retirement Study, public use dataset. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG09740). Ann Arbor, MI, (2014)."

Herzog AR, Wallace RB. Measures of cognitive functioning in the AHEAD Study. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 1997; 52:37–48. Special Issue.

Jacobs JM, Hammerman-Rozenberg R, Cohen A, Stessman J. Reading daily predicts reduced mortality among men from a cohort of community-dwelling 70-yearolds. The Journals of Gerontology Series B. Psychological Sciences and Social Sciences. 2008; 63(2):S73–S80.

Katzmarzyk PT, Lee IM. Sedentary behaviour and life expectancy in the USA: a cause-deleted life table analysis. BMJ open. 2012; 2(4):e000828.

Kidd DC, Castano E. Reading literary fiction improves theory of mind. Science. 2013; 342(6156):377–380. [PubMed: 24091705]

Menec VH. The relation between everyday activities and successful aging: A 6 year longitudinal study. The Journals of Gerontology Series B. Psychological Sciences and Social Sciences. 2003; 58(2):S74–S82.

Muennig P, Rosen Z, Johnson G. Do the psychosocial risks associated with television viewing increase mortality? Evidence from the 2008 General Social Survey–National Death Index dataset. Annals of epidemiology. 2013; 23(6):355–360. [PubMed: 23683712]

National Death Index. 2015. Retrieved from http://www.cdc.gov/nchs/ndi.htm

National Endowment for the Arts. Reading on the rise a new chapter in American literacy. 2009

Ofstedal, MB.; Fisher, GG.; Herzog, AR. MI: University of Michigan; 2005. Documentation of Cognitive Functioning Measures in the Health and Retirement Study.(HRS/AHEAD Documentation Report DR-006.) Ann Arbor: University of Michigan.

Olsen RB, Olsen J, Gunner-Svensson F, Waldstrøm B. Social networks and longevity. A 14 year follow-up study among elderly in Denmark. Social science & medicine. 1991; 33(10):1189–1195. [PubMed: 1767289]

Santa Monica, CA: 2014 Sep. RAND HRS Data, Version O. Produced by the RAND Center for the Study of Aging, with funding from the National Institute on Aging and the Social Security Administration.

Shipley BA, Der G, Taylor MD, Deary IJ. Cognition and mortality from the major causes of death: the Health and Lifestyle Survey. Journal of psychosomatic research. 2008; 65(2):143–152. [PubMed: 18655859]

Sobel ME. Asymptotic confidence intervals for indirect effects in structural equation models. Sociological methodology. 1982; 13(1982):290–312.

Stanovich KE, West RF, Harrison MR. Knowledge growth and maintenance across the life span: The role of print exposure. Developmental Psychology. 1995; 31(5):811.

Stanovich KE, Cunningham AE. What reading does for the mind. American Education Journal. 1998

Wolf M, Barzillai M, Dunne J. The importance of deep reading. Challenging the Whole Child: Reflections on Best Practices in Learning, Teaching, and Leadership. 2009; 130

Wullems JA, Verschueren SM, Degens H, Morse CI, Onambélé GL. A review of the assessment and prevalence of sedentarism in older adults, its physiology/health impact and non-exercise mobility counter-measures. Biogerontology. 2016; 1:19.

Highlights

- Book reading provides a survival advantage among the elderly (HR = .80, p<.0001)

- Books are more advantageous for survival than newspapers/magazines

- The survival advantage of reading books works through a cognitive mediator

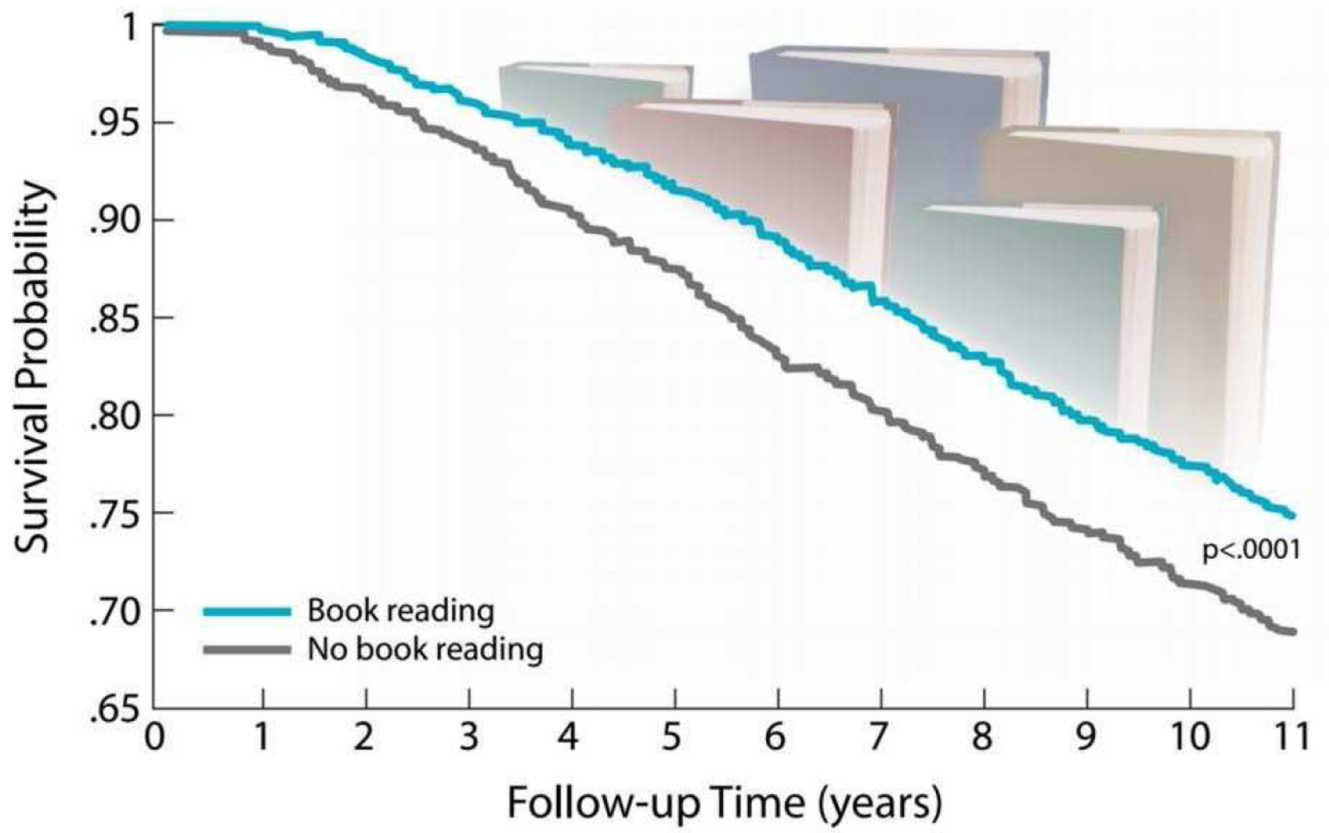- Books are protective regardless of gender, wealth, education, or health

Fig. 1. Survival Advantage Associated with Book Reading
Unadjusted survival curves comparing book readers to non-readers (HR=.77, p<.0001). At
80% mortality, a 19-month survival advantage is found.
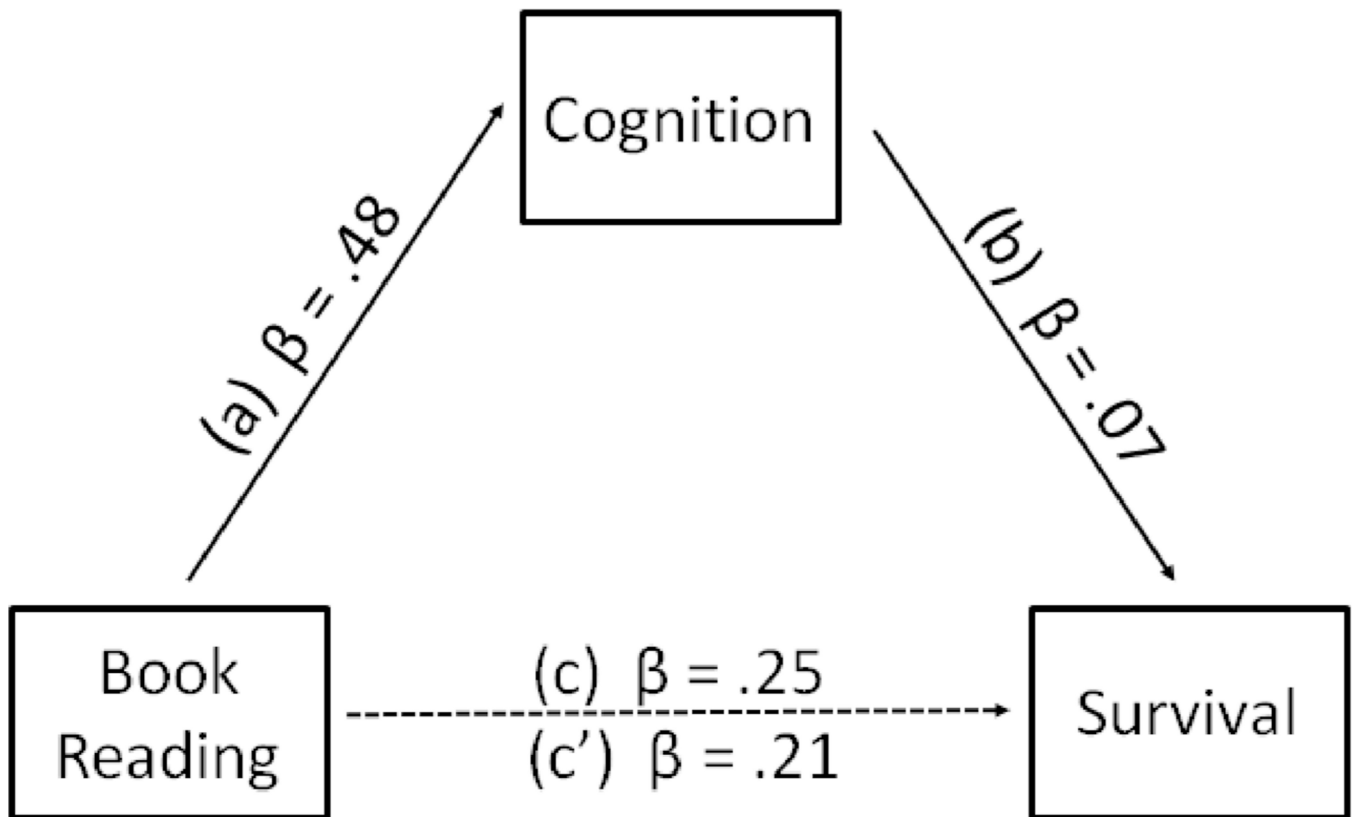
Fig. 2. Mediation analysis of book reading by cognitive score

This model exhibits complete mediation by cognitive score. The indirect effect *ab=.03* was statistically significant (95% CI: .01, .10). *a) p = .01; b) p<.0001; c) p=.04; d) p=.10*

Table 1

Cohort Demographics

Cohort demographics, by covariate.

		Total N = 3635	Zero Books N = 1490 (41%)	Book Readers N = 2145 (59%)	p-value
Baseline Age	50–59	30.48%	29.15%	31.40%	0.43
	60–69	33.23%	34.88%	32.09%	
	70–79	24.50%	24.04%	24.83%	
	80–89	10.80%	10.88%	10.75%	
	90+	0.98%	1.04%	0.94%	
Sex [*]	Male	37.93%	45.72 %	32.55%	<.0001
	Female	62.07%	54.28%	67.45%	
Race	White	88.70%	88.66%	88.72%	0.59
	Black	8.30%	8.01%	8.47%	
	Other	3.02%	3.33%	2.80%	
Wealth [*]	< 40,000	23.65%	25.63%	22.28%	<.0001
	40,000–133,000	24.51%	27.61%	22.37%	
	133,000–361,500	25.78%	24.30%	26.79%	
	> 361,500	26.06%	22.46%	28.55%	
Comorbidities	0–1	51.75%	49.90%	53.03%	0.29
	2–3	40.19%	41.97%	38.97%	
	4–5	7.78%	7.82%	7.75%	
	6–7	0.28%	0.32%	0.25%	
Vision [*]	Blind	10.69%	9.07%	11.81%	<.0001
	Poor	27.18%	26.30%	27.79%	
	Fair	42.93%	41.67%	43.80%	
	Good	14.65%	16.76%	13.19%	
	Very Good	4.17%	5.60%	3.18%	
	Excellent	0.38%	0.60%	0.22%	

		Total N = 3635	Zero Books N = 1490 (41%)	Book Readers N = 2145 (59%)	p-value
Education *	High School or less	57.92%	68.58%	50.56%	<.0001
	Some College +	42.08%	31.42%	49.44%	
Job Status	Unemployed	62.34%	63.86%	61.28%	0.11
	Employed	37.66%	36.14%	38.72%	
Marriage Status	Unmarried	50.63%	51.46%	50.05%	0.40
	Married	49.37%	48.54%	49.95%	
Depression *	No	84.22%	80.65%	86.69%	<.0001
	Yes	15.78%	19.35%	13.31%	

(*: p < .05).

Book readers and non-book readers differed significantly by sex, wealth, vision, education, and depression.