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How is U.S. adults' health related to literacy, numeracy, technological problem-solving skills, and adult education? A PIAAC analysis

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Keywords: adult health, adult education, adult learning, literacy, numeracy, social determinants of health, technological problem-solving skills

Abstract: This paper uses U.S. data from the Program for the International Assessment of Adult Competencies (PIAAC) to analyze the relationship between self-reported health and (a) literacy, numeracy, and technological problem-solving skills, and (b) involvement in adult education, and to determine whether those relationships vary by race/ethnicity and educational attainment.

Higher educational attainment is strongly related to better health, but we know far less about how other social determinants—namely, literacy and numeracy proficiency, technological problem-solving skills, and continuing participation in formal and non-formal education—shape health outcomes. This paper uses U.S. respondent data from the Program for the International Assessment of Adult Competencies (PIAAC) to analyze the relationship between self-reported health and (a) literacy, numeracy, and ICT scores, and (b) participation in adult education, and to determine whether those relationships vary by race/ethnicity and levels of educational attainment. Our findings contribute to the burgeoning interest in health and adult education (e.g., Collins et al., 2014; English, 2012; Hill, 2011; Papen, 2009; Prins & Mooney, 2014).

Theoretical Framework

This paper is situated in the social determinants of health literature, which posits that economic and social opportunities and resources such as educational attainment are a fundamental cause of health and health disparities (e.g., Braveman et al., 2011; Hayward et al., 2014). Accordingly, we view capabilities in literacy, numeracy, and technological problem solving and participation in adult education as tools that can help adults access the economic and social opportunities and resources that are needed to maintain and improve health. These skills accumulate over time, and people who struggle with basic skills are also excluded from the very resources and opportunities that enable people to flourish.

Fifty percent of U.S. PIAAC respondents scored in the bottom two literacy levels, compared to 60% for numeracy (OECD, 2013). Adults who struggle with literacy, numeracy, and poor health are disproportionately people of color, the elderly, and those with limited education, income, and English proficiency (Kutner et al., 2006). Our paper integrates research on the influence of *literacy* (Berkman et al., 2011; Nielsen-Bohlman et al., 2004; Ronson & Rootman, 2009), *numeracy* (Lipkus & Peters, 2009; Rothman et al., 2008), and *technological problem-solving skills* (Baur, 2008; Norman & Skinner, 2006) on adult health. Previous studies indicate that even at the same education levels, literacy shapes health outcomes. However, the research on numeracy or technological problem-solving is less conclusive. Also, there is some evidence that adult education participation enhances health (Feinstein & Hammond, 2004).

The aforementioned proficiencies and adult learning activities may matter more or less depending on one's formal educational attainment or race/ethnicity. For instance, formal

education is strongly associated with better health, even after controlling for income (Hayward et al., 2014), and because of entrenched racial disparities, whites accrue more health advantages than blacks from higher levels of formal education, a pattern known as the “diminishing returns hypothesis” (Farmer & Ferraro, 2005; Monnat, 2014). Our study extends this research by examining whether people across different racial/ethnic groups and levels of formal schooling gain similar health benefits from developing basic skills and participating in adult education.

Method and Data Sources

The PIAAC is an international survey of adults (16-65) in 24 countries. This paper uses U.S. PIAAC data to answer the following questions: (1a) Are literacy, numeracy, and technological problem-solving skills associated with self-rated health (SRH), after controlling for race/ethnicity, socioeconomic status (SES), and other respondent characteristics? (1b) Does the relationship between skills in these areas and SRH vary across racial/ethnic groups? (1c) Does the relationship between skills in these areas and SRH vary across levels of formal educational attainment? (2a) Which types of adult education activities are most strongly associated with SRH? (2b) Which types of adult education matter most for the health statuses of different racial/ethnic groups? (2c) Which types of adult education matter most for the health statuses of people at different levels of formal educational attainment?

The dependent variable is self-rated health. The independent variables are literacy, numeracy, and PS-TRE scores and five dummy variable indicators of adult education during the previous 12 months: open/distance learning courses, workplace training, seminars/workshops, courses/private lessons, and formal education (beyond highest level of schooling). Five dummy variables were created to examine race/ethnicity: non-Hispanic white, non-Hispanic black, Hispanic/Latino, Asian, and other (American Indian/Alaska Native, Native Hawaiian/Pacific Islander). There were six educational attainment levels: less than high school diploma, high school graduate, certificate from trade school or other, associate degree, bachelor’s degree, and master’s degree or higher. Control variables included sex; age; employment status; household size; lived with a spouse or a partner; had children aged 12 or younger; nativity; mother’s and father’s educational attainment; vision problems, hearing problems, or a learning disability; health insurance status; and English proficiency.

After deletion of cases with missing information, our sample sizes ranged from 4,647 to 3,664 depending upon the outcome. T-tests were used to conduct descriptive analyses. Ordinal logistic regression was used to answer the research questions. For each independent variable we first present a model that includes only that variable, without controlling for anything else. This enables us to determine whether there is an association between that independent variable (e.g., literacy) and SRH before accounting for other respondent characteristics that may affect both that independent variable and their health. We then integrate all control variables into the second model. Finally, we separately examine interactions between each independent variable and race/ethnicity and educational attainment, again controlling for characteristics that may influence health. We weighted all analyses with the final sample weight provided with the data.

Results

Literacy, Numeracy, and Technological Problem-Solving Skills

Descriptive statistics show that literacy scores ranged from 103 to 424 (average = 272), and numeracy ranged from 45 to 427 (average = 255), which corresponds with Level 2 out of five levels. The PS-TRE score ranged from 114 to 425 (average = 278), or Level 1. Over half of

respondents (58%) rated their health as very good or excellent. The majority of the sample was non-Hispanic white, 11% were non-Hispanic black, 14% were Hispanic, 5% were Asian, and the remaining respondents were “other race.” The majority of the sample had at least a high school diploma, but less than half participated in formal education post-high school. Most respondents were employed (65%) and were living with a spouse or partner (71%). About half of the sample was female, less than a quarter had a child aged 12 or younger, and about 15% was foreign-born. The majority of respondents’ parents had obtained a high school diploma or better. Almost a quarter of respondents reported having vision or hearing problems or a diagnosed learning disability, and nearly 80% had health insurance. Less than 5% were unable to work due to a disability. Finally, respondents had an average English proficiency score of 4.87, indicating overall strong proficiency in the sample.

In unadjusted models, literacy, numeracy, and PS-TRE scores are positively associated with SRH. Ten-point increases on these scales are associated with 10.5%, 8.5%, and 7.6% greater odds, respectively, of being in a better health category. However, after controlling for respondent characteristics, numeracy and PS-TRE were no longer significant. The effect size for literacy was reduced, but it remained significant: a 10-point increase on the literacy scale was associated with 2.6% greater odds of being in a better health category. This suggests that U.S. adults may accrue greater health benefits from developing literacy than numeracy or technological problem-solving abilities, after accounting for other individual characteristics.

Regression analyses also showed that literacy is significant, yet it is not one of the strongest predictors of SRH. Several control variables had a much larger effect size, including inability to work due to disability (96% lower odds of being in a better health category), bachelor’s or graduate degree (92% and 212% greater odds, respectively), foreign-born (48% greater odds), vision/hearing problems or learning disability (42% lower odds), college-educated father (36% greater odds) or high school-educated mother (23% greater odds), better English proficiency (8% greater odds), and health insurance (5% greater odds). This suggests that to improve U.S. residents’ health, literacy instruction needs to be accompanied by efforts to increase college attainment, English proficiency, and access to health insurance.

Second, the relationships between SRH and literacy, numeracy, and PS-TRE scores did not differ across racial/ethnic groups. In other words, people of color and whites gain equal health advantages from strengthening their literacy proficiency (neither numeracy nor PS-TRE scores were significantly related to SRH after controlling for demographic variables). This indicates that the diminishing returns hypothesis, whereby racial/ethnic minorities accumulate fewer health rewards than whites from increasing levels of educational attainment, does not apply to literacy, numeracy, and technological problem-solving skills.

Third, of the three PIAAC scales, only the relationship between PS-TRE and self-rated health differed by formal educational attainment. Respondents who had at least a master’s degree gained more health benefits from technological problem-solving proficiency than people who had not completed high school. Thus, only the most highly educated U.S. adults experience improved health (although very modest) with better PS-TRE skills.

Adult Education

Descriptive statistics show that participation in workplace training was most common at 41%, followed by seminars/workshops (31%), formal education (21%), distance education (17%), and courses/private lessons (9%). For all types of adult education, a lower percentage of non-Hispanic whites participated compared to at least one of the other racial/ethnic groups.

Participation in courses/private lessons, workplace training, and seminars/workshops all increase with higher levels of formal educational attainment. Participation in distance education shows a similar pattern, but a slightly lower percentage of respondents with a bachelor's degree participate in distance education compared to those with an associate degree. Participating in formal education is most common among those with a high school diploma/some college and least common among those with a trade or other certificate.

In unadjusted models, respondents who participated in four types of adult education had greater odds of being in a better health category, compared to those who did not participate: workplace training (38% greater odds), formal education (46% greater odds), seminars/workshops (50% greater odds), and courses/private lessons (84% greater odds). Participation in open or distance education was not significantly associated with SRH. However, after accounting for sociodemographic characteristics, only courses/private lessons remained significantly associated with improved SRH (59% greater odds of better SRH).

Second, ordinal logistic regression results showed that the relationship between SRH and adult education did not differ across racial/ethnic groups. This means that no racial/ethnic group experiences greater health rewards than others from pursuing adult education. Specifically, participation in courses/private lessons is the only type of adult education activity to remain positively related to SRH, and the results indicate has the same positive association with SRH across all racial/ethnic groups.

Finally, we found no significant interactions between educational attainment and any of the adult education activities, except participation in formal education. In this model, the association between participating in formal education in the past 12 months was weaker for respondents with a high school diploma than for those with less than high school. This means that compared to high school graduates, people with less than a high school education derive more health rewards from pursuing formal education. We did not find significant interactions for any of the other models, which indicates that the associations between SRH and distance education, workplace training, seminars or workshops, and courses or private lessons were the same across all levels of educational attainment. In other words, respondents experience similar health benefits from these activities, regardless of how much or little prior schooling they have.

Discussion

Our study is the first to use PIAAC data to identify how literacy, numeracy, technological problem solving, and adult education are associated with health, and how those relationships vary (or do not) across racial/ethnic and educational attainment groups. The results show that literacy, numeracy, and PS-TRE scores are positively related to SRH, but only literacy is significant after controlling for sociodemographic variables. These relationships were driven almost entirely by differences in human capital resources, namely, education, employment, parents' education, and English proficiency. That is, the socioeconomic resources that can "buy" us good health are the same ones that help us gain better skills. Our findings suggests that people may experience greater health benefits from developing literacy than numeracy or technological problem-solving abilities. Further research is needed to determine precisely how literacy enhances health and why numeracy and PS-TRE are more weakly related to health.

A possible reason for the non-significant relationship between PS-TRE and health (net of control variables) is that we had to exclude respondents who did not answer the PS-TRE items. Also, the PS-TRE scale may not capture the technological problem-solving skills that people use to analyze Internet health information and navigate other technologically complex health tasks.

The findings show that literacy matters for health, yet its effect size (3%) is much smaller than that of several control variables. This finding may surprise readers who expected a stronger relationship between literacy and SRH. Unlike many previous studies, our analysis accounts for background characteristics, which allowed us to disentangle literacy from other characteristics that influence both literacy and health, especially educational attainment. Thus, our study elucidates whether higher literacy scores are related to better health *among adults with identical attributes*. Some of the attributes that significantly influence the odds of better health, such as age and disability, are beyond one's control, but others are promising areas for policy intervention. Specifically, literacy instruction should be coupled with policies to increase college completion, English proficiency, and access to health insurance, especially for low-SES groups.

Respondents who had at least a master's degree gained more health benefits (although very modest) from technological problem-solving proficiency than those who did not complete high school. Given their advantaged socioeconomic position, highly educated people have greater access to computers and the Internet, are more likely to use the Internet for health matters, and may be better positioned to act on digitally acquired information and resources, thus creating a "vicious cycle of digital exclusion" (Baum et al., 2014, p. 355).

Regarding the second set of research questions, only participation in courses/private lessons was related to better SRH, beyond health benefits derived from employment, educational attainment, or other control variables. More research is needed to understand what these activities entail and how they enhance health (e.g., through access to psychosocial or material resources). Since blacks and people with less schooling were the least likely to participate in these activities, increasing their involvement could yield health benefits for these groups.

We found no variation in the relationship between SRH and literacy, numeracy, and PS-TRE scores by race/ethnicity and little variation across educational attainment categories; the same held true for the relationship between SRH and adult education. This finding suggests that the racialized pattern of diminishing returns does not apply to basic skills or adult education; rather, racial/ethnic groups gain similar benefits from literacy capabilities and participating in courses/private lessons, the learning activity that most strongly predicted health. Comparing these results with other PIAAC countries could reveal whether our findings apply elsewhere.

Our findings should be considered in light of some limitations. The cross-sectional data cannot determine causality, we could not control for respondent income (this item was excluded for several reasons), some of the PIAAC items are subject to recall bias, and standardized tests do not capture the myriad ways people use literacy and numeracy in their daily lives.

In sum, our study highlights the need to couple literacy and ESL instruction with other policy interventions and to understand precisely how and why courses/private lessons contribute to health. In contrast to research on the racialized health returns of formal educational attainment, we found that all racial/ethnic groups can benefit equally from these skills and activities.

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