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Literacy and Childbearing Across OECD and Partner Nations

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Literacy and Childbearing Across OECD and Partner Nations

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Literacy and Childbearing Across OECD and Partner Nations

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Abstract

Literacy is associated with a range of health behaviors and outcomes, however, the relationship between literacy and reproductive health remains understudied. Literacy level is related to but distinct from educational attainment, a social determinant of health, which is strongly associated with health inequities. Given policy makers' interest in factors that influence childbearing and interventions that would impact them, further investigation of literacy skills and their relationship with reproduction and associated variables is warranted. We sought to address the following questions: 1) Are self-reported health and literacy related to childbearing in OECD and partner nations, and 2) If so, is there evidence that literacy acts as a mediator, moderator, or both in the relationship between self-reported health and childbearing across these developed countries? If literacy is a moderator, the association between self-reported health and childbearing would change based on literacy proficiency. If a mediator, literacy would account for some portion of the relationship between self-reported health status and childbearing.

Data from the Program for the International Assessment of Adult Competencies (PIAAC) Round 1 of the Survey of Adult Skills, a survey organized by the OECD, were used. We included all women without missing data on PIAAC literacy score, childbearing, and other covariates from 18 OECD and two partner countries. The final study population included 52,300 women.

Consistent with previous work, higher literacy skill was associated with lower childbearing and better self-reported health was associated with higher childbearing in all OECD countries, however these associations were not observed among partner countries. After controlling for education and age, we found evidence of moderation between self-reported health and childbearing in the excellent/very good and good self-reported health groups or in the

fair/poor and good self-reported health groups in three countries; however, the magnitude of these moderating effects were small and may not be meaningful. Controlling for education and age, we found some evidence that literacy operated as a mediator of the relationship between self-reported health and childbearing in nine countries, including the United States. These results extend our understanding of the role of literacy skills as a social determinant of health for a key reproductive health outcome, childbearing. The independence of literacy from the educational attainment is a basis for supporting the health benefits of interventions targeting literacy development in primary and adult education in high income nations.

Background

Social determinants of population health are a lens through which to view the health of communities and nations (Kindig & Stoddard, 2003; Norman, Kennedy & Kawachi, 1999). Social determinants provide an opportunity to understand disparities or inequities in health across communities and to identify interventions to reduce such disparities (Marmot, 2007). Health inequities are often most stark between low- and high-income regions and nations, however a health inequality lens is also relevant when examining disparities in health outcomes across high income nations (Braveman, 2006; Healthy People, n.d.; Solar & Irwin, 2007).

The complex set of processes, including social determinants of health, that influence birth rates at the population level are of interest to the demographic, public health, medical, economic, and education fields, as well as national and international policy makers (Grant et al., 2004). The effect of high birth rates differ at the population and individual levels; there are national economic benefits of maintaining replacement level birth rates, but high childbearing is associated with increased risk of obstetric complications for individual women in both high- and lower-income countries (Babinszki et al., 1999; Brunner et al., 1992; Roman et al., 2004; Shechter et al., 2010). The degree to which social determinants influence reproductive health outcomes is of interest to better understand the implications of policies for health equity across populations with differing rates of childbearing.

Education is a key social determinant of health with strong links to a range of health outcomes (Healthy People, n.d.). While the education domain includes both quality and quantity of schooling, most studies do not address this distinction and rely on educational attainment, or years of school completed, as a proxy for overall individual educational input. As with other health outcomes, educational attainment is associated with childbearing; women with higher

levels of education tend to have fewer children compared with their counterparts with lower levels of education (Barro & Lee, 2013; Cochrane et al., 1979; Martin, 1995; Singh & Casterline, 1985). Because educational attainment is not a direct proxy for educational quality, it may be a less precise measure of the risk or protective effects associated with the benefits of education than a metric that includes aspects of quality. For instance, individuals who complete a given level of poor quality education may have greater risk than those who achieve the same amount of high quality education. Literacy skill among individuals and populations reflects learning which has been achieved in the educational setting and so can be viewed as a metric of education that incorporates effectiveness or quality. In addition, literacy has the potential to be a more sensitive measure of one's ability to navigate the demands of a complex information-rich world than educational attainment because it accounts for variability quality that attainment alone cannot (Kutner et al., 2006; Freire, 1970).

The PIAAC defines literacy as "understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD, n.d., p. 20). While education and literacy are often seen as proxies for one another, higher educational attainment does not guarantee higher literacy skills and higher literacy does not rest solely on formal educational attainment. In a study using data from the 1994-1998 International Adult Literacy Survey to assess the relationship between level of education and literacy, Park and Kyei (2011) identified a significant variation in association between these variables.

Literacy skills are strongly associated with health and related health domains independent of educational attainment (Bennett et al., 2013; Bennett et al., 2009; Berkman et al., 2011; DeWalt et al., 2004). Across a range of health behaviors and outcomes, higher literacy skills are

associated with positive health behaviors and better health and social outcomes, while lower literacy skills are associated with poor health behaviors and outcomes (Berkman et al., 2011; DeWalt et al., 2004), including overall self-reported health (Baker et al., 1997).

An inverse relationship between literacy and childbearing has been observed in low and middle income countries; in this context associations between low literacy and increased birth rates at the population and individual levels have been observed (Murthi et al., 1995, Sarmad et al., 2007; Saurabh et al., 2013). The few studies in high income countries such as the United States have replicated these results (Bennett et al. 2013; Seymour et al., 2016).

While it is possible that literacy plays a direct role in influencing reproductive health outcomes, because literacy is sensitive to intervention, it is important to explore the role literacy plays in relation to other predictor variables and health outcomes. Interventions that increase literacy skills have been shown to improve a range of adult outcomes, including those in the health domain (Campbell et al., 2014; Heckman, 2006). There is support for the hypothesis that literacy mediates relationships between demographic individual factors and various health outcomes. For example, literacy mediates the relationship between racial/ethnic disparities in health status and receipt of influenza vaccination among older adults in the United States (Bennett et al., 2009). Bennett et al. (2013) also found that literacy acts as a moderator in the association between demographic factors and risk of teen childbearing.

The role of self-reported health in predicting outcomes is of particular interest because it is relatively easy to ascertain and can be readily compared across countries (Kuhn et al., 2006). Self-reported health status has been shown to be a predictor of mortality, which is in turn a reliable measure of health status (Idler & Benyamini, 1997). Self-reported health during pregnancy has shown to predict pregnancy-related health outcomes (Stepanikova et al., 2016.)

and there is a documented link between self-reported health and childbearing history (Kington et al., 1997).

The mechanism of action by which literacy impacts health behaviors and outcomes through factors such as self-reported health has implications for both policymaking and intervention development. If literacy is an effect modifier, or plays a moderating role between a given maternal characteristic (e.g. self-reported health) and a reproductive health outcome (in this case, childbearing), then targets for intervention to improve reproductive health outcomes should be tailored to the literacy levels of the women the intervention is designed to serve, and women with the lowest literacy may need additional intervention services. If literacy mediates the relationship between self-reported health and health outcomes, including childbearing, a pathway or channel between self-reported health and childbearing is suggested; in other words, some of the relationship observed between self-reported health and childbearing may be accounted for by literacy and interventions to improve literacy could directly impact the outcome of interest.

Despite increased focus on literacy and its mechanism in affecting health behaviors and outcomes, a major shortcoming of this literature is that most studies have relied upon imprecise screening tools to assess literacy (i.e. identify risk of low literacy), rather than measuring literacy skill across the full spectrum of literacy skills (Berkman et al., 2011; DeWalt et al., 2004). This limitation is largely a result of the burden of comprehensive literacy assessments and difficulty of including these in studies focused on health outcomes. The few investigations which have used robust and precise measures of literacy skill has consistently shown an association of literacy level with health measures including general health status, preventive health behaviors, and childbearing including risk of teen childbearing (Bennett et al., 2009; Bennett et al., 2013;

Kutner et al., 2006; Seymour et al., 2016). The use of measures capable of providing precise literacy skill level in these assessments of health is critical to making a substantial linkage across health and education policy which tend not to substantially inform each other. Such linkages are needed to inform interventions to impact the wellbeing of nations.

The PIAAC, which uses a robust and valid measure of literacy skill, offers such an opportunity to deepen understandings of the relationship between literacy and health outcomes across a range of nations. The PIAAC literacy assessment allows for determination of a linkage between literacy and health across a complete range of literacy proficiency, not only those with very low literacy. Additionally, PIAAC's measure of literacy is far superior to those used in most investigations of literacy and health (Berkman et al., 2011; Dewalt et al., 2004). The PIAAC measure provides a continuous, as opposed to categorical, measure of literacy, which allows more robust statistical analyses. For example, other screening tools have ceiling effects which limit the range over which associations with health outcomes can be assessed (Aguirre et al., 2005; Davis et al., 1993; Nurss et al., 1995; Weiss et al., 2005). The use of a highly valid and reliable measure of literacy, which can be compared across languages and nations, is by itself perhaps the greatest strength of the PIAAC data. It is crucial to the development of the study of literacy and health, along with the broader investigations of social factors influencing health that international and cross-nation comparisons are carried out. This is a unique opportunity to study the role of literacy on childbearing internationally and among high-income nations.

The importance of international comparisons of the relationship between literacy skill and health outcomes is often emphasized by researchers as well; Schleicher (2008) notes that this is vital, as "it is necessary to have high-quality comparative information regarding the fundamental skills of the adult population. Such information can help governments to evaluate

policies and design more effective interventions" (p. 1). PIAAC not only provides high quality literacy data, but also offers the opportunity to assess the nature of relationships between literacy and health outcomes in countries where there may be heterogeneity across populations as a result of population or policy differences, which may allow countries to "assess the comparative strengths and weaknesses of [different countries'] skill development policies" (Ibid, p. 3).

In the current study, literacy data from the PIAAC were used to identify relationships with the variables of interest among OECD countries and partner nations. We sought to better understand how literacy works to influence childbearing across these countries. We aimed to answer two questions: 1) Are self-reported health and literacy related to childbearing in OECD and partner nations, and; 2) If so, does literacy act as a mediator, moderator, or both in the relationship between self-reported health and childbearing across these developed countries?

Methods

Data from the 2012 PIAAC Round 1 of the Survey of Adult Skills, were used to assess whether literacy mediates or moderates the relationship between self-reported health and childbearing across the OECD and partner nations. Between 2011 and 2012, roughly 5,000 adults between the ages of 16 and 65 in each of 24 countries and sub-national regions were interviewed, for a total study population of roughly 166,000 adults. In addition to demographic variables including total number of children, the Survey of Adult skills assessed literacy and numeracy skills, as well as problem-solving skills in technology-rich environments. These data provided the novel opportunity to examine the relationship between literacy and childbearing across multiple developed nations and create cross-national comparisons. All men were excluded from the study. Additionally, countries missing self-reported health data and for which a complete childbearing variable was unavailable due to sensitivity of information and women

with missing data on literacy or childbearing were excluded from the analysis. Furthermore, those with missing data on covariates were excluded from analyses.

Outcome Measures

Women in all countries included in the analysis had valid data on self-reported total number of children including biological, adopted, and stepchildren. As the proportion of children who are biological (i.e. non-adopted or step-children) is greater than 90% in the U.S. (Kreider & Lofquist, 2010), we used this measure as a proxy for total cumulative childbearing for each woman.

Literacy Measures

The PIAAC literacy assessment includes continuous texts, non-continuous texts, and electronic texts and assesses literacy in the real-world by including tasks encountered in home, work, and community contexts (National Center for Education Statistics, n.d.). The PIAAC reports literacy as a continuous variable on a scale from 0 to 500 (standard deviation=approximately 50). This study used the continuous literacy score.

Covariates

We used an adaptation of the behavioral model described by Andersen (Andersen & Davidson, 2001). The model (Figure 1), originally called Andersen's Behavioral Model of Health Services Use, describes how predisposing, enabling, and need factors were related to access to care. Predisposing factors are biological, mental, social, and contextual factors that would predispose an individual to seek care; enabling factors are financing and organizational factors that would enable an individual to seek care; and need factors are an individual's perceived and evaluated needs for care. Since its original application, Andersen's model has also

been expanded for application to the relationships between predisposing, enabling, and need factors and health outcomes and is more generally called Andersen's Behavioral Model.

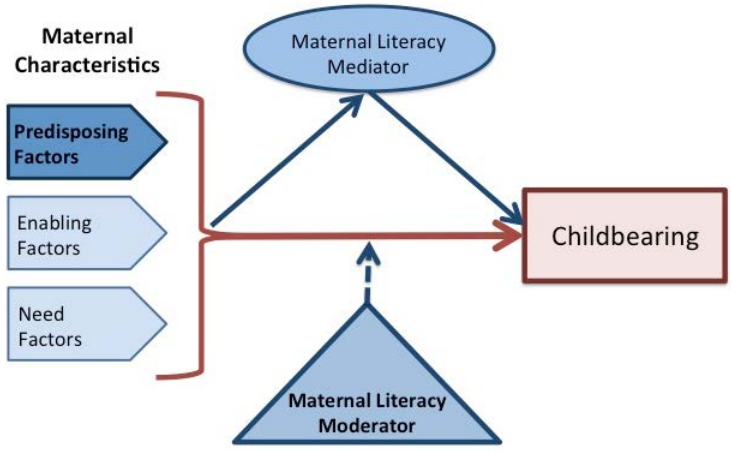

Figure 1. Modified Andersen (2001) model: potential mechanisms by which literacy impacts childbearing.

We identified maternal predisposing and enabling factors that could predict childbearing available in the PIAAC data. All variables were self-reported by participants.

Predisposing Factors

For the analyses in this report, we focus on self-reported health. Self-reported health was recorded as excellent, very good, good, fair, or poor. The self-reported health variable was collapsed into three categories (excellent/very good, good, and fair/poor) for use in mediation and moderation analyses and good served as the reference group.

Enabling Factor

Education, an enabling factor, was controlled for in final models in order to allow for an appreciation of how literacy mediated or moderated the relationship between self-reported health and childbearing, independent of education. Education was originally reported as a categorical variable with seven categories: lower secondary or less (ISCED 1, 2, 3C short or less), upper secondary (ISCED 3A-B, C long), post-secondary, non-tertiary (ISCED 4A-B-C), tertiary –

professional degree (ISCED 5B), tertiary – bachelor degree (ISCED 5A), tertiary – master/research degree (ISCED 5A/6), tertiary - bachelor/master/research degree (ISCED 5A/6). For this analysis categories were collapsed to three categories, less than a college degree, college degree, and advanced degree, and less than a college degree served as the reference group[1].

We also controlled for effect of age, another enabling factor and a potential confounder, which is reported in five-year bands from 16-65 years of age. Age is a potential confounder of the relationship between self-reported health and childbearing, as both self-reported health (Kuhn et al., 2006; National Research Council, 2006) and fertility decline as age increases. The seven categories of age (16-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-65) were treated as continuous.

Statistical Analyses

PIAAC data were used for all analyses. For the non-U.S. analyses, the international public-use files were examined, while the restricted-use file was used for U.S. analyses. The restricted-use file was used for the U.S. as this file included a continuous variable for number of children. Appropriate sampling and replicate weights were applied and summary statistics, including correlation, frequencies, percentages, means, and standard deviations were used to describe the study population across all countries and within each country.

To answer the first research question, we examined the relationships between self-reported health and childbearing, and literacy and childbearing using correlation analysis for each country individually. To answer the second research question, we examined the potential moderating and mediating effects of literacy. First, in all countries we examined whether

[1] The highest level of education attainment categories correspond to the following International Standard Classification of Education (ISCED:97) levels: ISCED:97 4a-b-c and lower (less than a college degree); ISCED:97 5a-b (college degree); ISCED:97 5a/6 (advanced degree).

literacy was a moderator of the relationship between self-reported health, and childbearing controlling for identified enabling factors in Andersen's model, age and education. To do so, we computed interaction terms by multiplying self-reported health status and literacy. Then, we conducted multiple regression analyses predicting childbearing with literacy, self-reported health, and an interaction term between literacy and self-reported health controlling for age and education. For self-reported health, the reference group was those with good self-reported health; therefore, two comparisons were made (good vs. excellent health and good vs. poor health). If the interaction term between self-reported health and literacy was significant, this was considered evidence of literacy acting as a moderator in the relationship between self-reported health and childbearing.

Next, we examined whether literacy was a mediator of the relationship between self-reported health and childbearing in all countries using the steps outlined by Baron and Kenny (1986). To do so, we again examined the bivariate relationships between 1) self-reported health and childbearing (A in Figure 2), 2) self-reported health and literacy (B in Figure 2), and 3) literacy and childbearing (C in Figure 2). We then created a multiple regression model predicting childbearing with literacy, and self-reported health controlling for age and education. For self-reported health, the reference group was again those with good self-reported health. If there were significant bivariate relationships between both self-reported health and childbearing (A in Figure 2) but such significant relationships become non-significant in the multiple regression model, this could be evidence of literacy acting as a mediator between self-reported health and childbearing. Also, the significance of indirect effect was tested using Sobel test (Sobel, 1982).

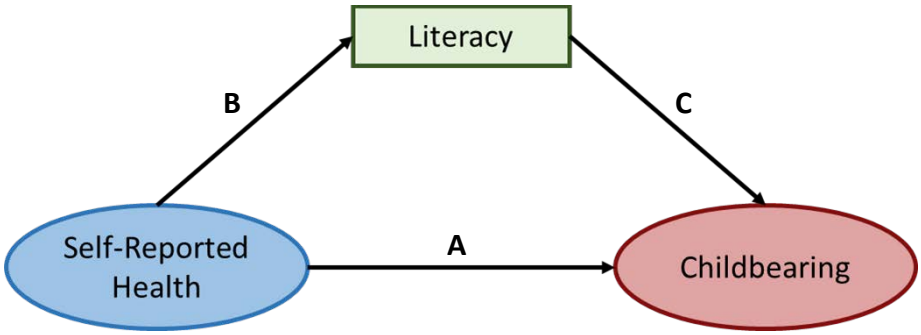

Figure 2. Mediation model tested in the study.

Results

Study Population

Six countries were excluded because of limitations in the data available for analysis: Canada was missing self-reported health data and Australia, Austria, Estonia, Germany, and Finland had top-coded the number of children born to a woman rather than including the full number. The total sample from the remaining 18 countries included 107,200 respondents. Among respondents, all men (47%) were excluded[2]. Of the remaining (i.e. all women), women with missing data on literacy score, number of children, self-reported health, education, age, and/or six other covariates related to childbearing (8%) were excluded. The final study sample included 52,300 women from Cyprus, the Czech Republic, Denmark, France, Ireland, Italy, Japan, Republic of Korea, Netherlands, Belgium, Norway, Poland, Russia, Slovakia, Spain, Sweden, the United Kingdom, and the United States.

The analytic sample is described in Tables 1a and b. Across the 18 countries studied, the average total childbearing per woman ranged from 1.2 in Russia to 1.8 in the United States (Table 1a). In each country, many women did not have children; the proportion of women with no children ranged from 27% in Russia to 37% in the Netherlands (Table 1a). The average

[2] Percentages were calculated using unweighted estimates.

PIAAC literacy score for our study population ranged from 250 in Spain to 295 in Japan (Table 1a). For self-reported health, the majority of women reported having good or very good/excellent self-reported health, except in Korea, where only 44% of women reported their self-reported health as good or very good/excellent. Otherwise, between 52% (Russia) and 88% (the Czech Republic and Ireland) of women had self-reported health of good or very good/excellent (Table 1a). The average age of women in the sample ranged from 38.5 in Ireland to 41.8 in Italy and Japan (Table 1b). In every country except for Russia (35%), the majority of women completed less than a college education; between 1% (Japan) and 30% (Russia) had more than a college education and between 5% (the Czech Republic and Slovakia) and 40% (Japan) had a college education (Table 1a).

We also assessed correlation between variables included in analyses (Table 2). The correlation coefficient between literacy and childbearing ranged from -0.045 in Russia to -0.359 in Korea, and for childbearing and self-reported health ranged from -0.088 in Belgium to 0.304 in Slovakia. The correlation between literacy and the three-level education variable was relatively low, ranging from 0.083 in Russia to 0.442 in Belgium. The correlation coefficient for childbearing and age was, as expected, high, ranging from 0.445 in the United States to 0.713 in Korea.

Research Question One – Relationship of Literacy and Self-Reported Health with Childbearing

We first sought to understand the relationships between literacy and self-reported health with childbearing (Table 3). There was a significant, negative relationship between literacy and childbearing across all OECD countries, but not partner countries. For example, in the United States, every one standard deviation increase in literacy score is associated with approximately

0.32 fewer children[3]. Literacy had the greatest unadjusted effect on childbearing in Korea where one standard deviation increase in literacy score is associated with 0.50 fewer children. Among these countries, literacy had the smallest effect in Belgium and Norway where one standard deviation increase in literacy is associated with 0.14 fewer children. In the partner countries, Cyprus and Russia, the relationship between literacy and childbearing was not significant.

Across all countries, those with excellent/very good self-reported health had, on average, more children than those with good self-reported health and those with fair/poor self-reported health, on average, had fewer children than those with good self-reported health. In the United States, those with excellent/very good self-reported health had an average of 0.23 more children than those with good self-reported health and those with fair/poor self-reported health had 0.49 fewer children than those with good self-reported health. In the Czech Republic and Slovakia, those with excellent/very good self-reported health had the greatest difference in number of children from those with good self-reported health; women in excellent or good self-reported health had an average of 0.67 more children than those with good self-reported health. In Ireland those with fair/poor self-reported health had the greatest difference in number of children from those with good self-reported health; women in fair/poor self-reported health had 0.79 fewer children on average than those with good self-reported health.

Research Question Two - Literacy's Mechanism

Next, we examined the role that literacy played in relationships between self-reported health and childbearing across all countries. We were interested in whether or not literacy acted as a mediator and/or moderator in the relationship between self-reported health and childbearing

[3] Estimates were derived by multiplying the country-specific standard deviation of literacy scores by the unstandardized coefficient for that country to enhance the interpretation as the unstandardized regression coefficient shows the effect of one scale score difference of the literacy assessment which ranges from 0-500.

controlling for education and age. Relationships between both self-reported health and childbearing and literacy and childbearing are necessary conditions for literacy to have either a mediating or moderating effect on the relationship between self-reported health and childbearing. As noted above (see Table 2), there was a significant relationship between both self-reported health and childbearing and literacy and childbearing in most countries.

Moderation

We first ran a regression model with interaction terms in order to determine if literacy moderated the relationship between self-reported health and childbearing. This model included self-reported health, literacy, education, age, and interaction terms between self-reported health and literacy (Table 4). Results showed that the difference between excellent and good self-reported health on childbearing was dependent on literacy in Slovakia and Spain (estimate=0.00466 and 0.00308, respectively) (Figure 4).

The difference between fair/poor and good self-reported health on childbearing was dependent on literacy in France (estimate= -0.00315) (Figure 4). In the United States, neither interaction term was significant. The size of all interaction effects was quite small.

Mediation

We then tested to see if literacy mediated the relationship between self-reported health and childbearing. For this model, total, direct, and indirect effects are reported. Figure 3a and b depicts mediation and the various effects measured in this model.

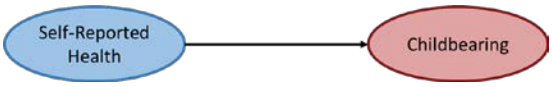

Figure 3a. Total effect of self-reported health on childbearing

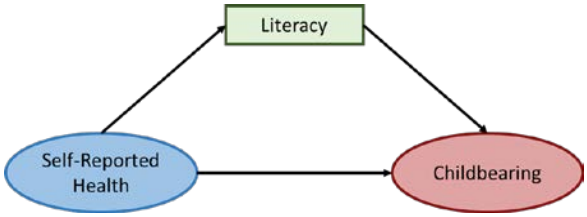

Figure 3b. Direct and indirect effects of self-reported health on childbearing

In Figure 3a, the total effect is the effect of self-reported health on childbearing. In Figure 3b, the direct effect is the effect of self-reported health on childbearing after assessing for mediation by literacy (a path from self-reported health to childbearing). Also shown in Figure 3b is the indirect effect, which is the total effect minus the direct effect, or the product of the effect of self-reported health on literacy and literacy on childbearing (a path from self-report health to childbearing through literacy).

In a mediation model that controlled for education and age (Table 5), the Netherlands, Sweden, United Kingdom, and United States had significant indirect effects for the difference between excellent/very good and good self-reported health on childbearing. In other words, there was evidence that the mean difference in number of children between the excellent/very good and good self-reported health groups was mediated through literacy. Additionally, the significance of the total effect was compared to the significance of the direct effect to examine whether literacy completely mediates the mean difference in number of children between the excellent/very good and good self-reported health groups. If the total effect was significant but the direct effect was not, complete mediation would be indicated; however, there was no difference in significance of total and direct self-reported health effects in the excellent/very good group in any country; thus, the mean difference in number of children between these two groups of self-reported health was partially mediated by literacy. For the fair/poor self-reported

health group, there was a significant indirect effect in France, Korea, Poland, Slovakia, Spain, Sweden, and the United States. Since no difference in significance between total and direct self-reported health effects was found, literacy was a partial mediator between fair/poor and good self-reported health groups in the mean difference in the number of children in these seven countries. The patterns of mediation effect of literacy between self-reported health status and childbearing for both comparisons of health status (i.e. excellent/very good vs. good and fair/poor vs. good) were not consistent for all countries, indicating inconclusive effect of literacy as a mediator between women's self-reported health status and childbearing.

Summary of Results

In Slovakia and Spain, there was evidence of a moderating relationship of literacy between self-reported health and childbearing in the excellent/very good and good self-reported health groups. In France there was a moderating relationship between self-reported health and childbearing in the fair/poor and good self-reported health groups. In Sweden and the United States, the mean difference in the number of children between both excellent/very good and good and fair/poor and good self-reported health groups was partially mediated by literacy. In another seven countries, the partial mediation is evident only for one self-reported health group (excellent/very good and good in the Netherlands and the United Kingdom and fair/poor and good in France, Korea, Poland, Slovakia, and Spain). Although the results show that literacy has some role as a mediator and a moderator between self-reported health and childbearing in France and Spain, the pattern of its effect was not consistent across countries.

Discussion

Implications

Because of the impact of population dynamics on nations, childbearing is important to the health, social, and economic policymaking of OECD nations (Grant et al., 2004). Investigators from many traditions including demography, public health, medicine, economics, and education are concerned with the processes that influence this outcome. However, when determining priorities, policymakers must also be aware of how social determinants of health are related to health inequities (Kindig & Stoddart, 2003; Norman et al., 2007). Because high childbearing is associated with poor health outcomes for individual women and social determinants, including socioeconomic influences (Penman-Aguilar et al., 2013), are linked to variability in rates of childbearing (i.e. higher social advantage is associated with lower childbearing), it is important that public policy be informed by these potential levers.

In this study of 52,300 women from 18 OECD and two partner nations, we examined the role that literacy plays in the relationship between self-reported health and childbearing. As has been observed in low income countries (Murthi et al., 1995, Sarmad et al., 2007; Saurabh et al., 2013), we found a consistent negative association between literacy and childbearing across these high income nations. Across nine countries there was evidence that literacy acted as a mediator in the relationship between the self-reported health status (a predisposing factor in our conceptual model) and childbearing, even when controlling for educational attainment and age.

Although we found some moderating effect of literacy on the relationship between self-reported health and childbearing in the excellent/very good and good self-reported health groups (Slovakia and Spain) and in the fair/poor and good self-reported health groups (France), the magnitude of such effect sizes were so small that they may not have meaningful effects.

In Sweden and the United States, findings suggest that literacy partially mediates the relationship between self-reported health and childbearing. In another seven countries, partial

mediation was only evident in one of the two comparison across self-reported health groups (excellent/very good vs. good and fair/poor vs. good), calling into question the partial mediation effect of literacy on the relationship between health status and childbearing. At the very least, these findings suggest non-uniform mediation effect of literacy across the self-reported health status groups; however, further investigation of the role that literacy plays in the relationship between health status and childbearing is warranted as both mediation and moderation analysis results do not seem to support findings.

Few previous investigations of the impact of literacy on health have focused on reproductive health outcomes, particularly in high income countries. Despite the fact that reproduction is a key measure of societal health on a large scale, there have been limited efforts to delineate the influence of literacy on childbearing. Over the last two decades, investigations of the linkages of literacy with health behaviors and outcomes have built an impressive body of research supporting literacy as an independent factor influencing health and one that has a unique role to play connecting the fields of public health and education (Berkman et al., 2011; Bennett et al., 2013; Bennett et al., 2009; DeWalt et al., 2004).

In a series of studies examining the benefits of educational interventions on health, international funding agencies showed significant influences on health from improving the literacy of the population (Benjamin, 2010; Kelly et al., 2007; Research Triangle Institute, 2011; Sheridan et al., 2011). Our finding that education and literacy are not highly correlated supports the understanding that literacy is independent of and perhaps a more precise measure of education than years of schooling (educational attainment) alone for defining relationships between maternal characteristics and reproductive health outcomes in high-income countries.

This is consistent with existing evidence and provides an opportunity to frame literacy within the population health framework (Kindig & Stoddart, 2003).

Strengths and Limitations

PIAAC data offers a valid, precise, and continuous measure of literacy. In these analyses, we were able to control for education and age. By doing so, we were able to identify the distinct role that literacy plays in the studied relationships. The independence of literacy from educational attainment provides a basis for framing the health value of interventions which aim to build literacy skills both in primary and adult education.

While the PIAAC is an extremely valuable and unique resource for the study of literacy in relation to childbearing and health measures, there are several limitations to this study. Importantly, the PIAAC is a cross-sectional study which limits our ability to make claims of directionality or causality despite our use of mediation and moderation analyses. Some of the influences of literacy on health will most likely come from its influences on processes of health best measured in a lifecourse framework (Sørensen et al., 2012), which requires longitudinal assessment. The cross-sectional design also means that women are at different stages of their reproductive lifespan and thus limits the accuracy of the measures of childbearing we identified. To control for this potential bias, models adjusted for age. Furthermore, although the sample analyzed for this study was representative of each country, approximately 8% of women were excluded from the full sample because of missing data. Therefore, the findings should be interpreted with caution.

Additionally, these analyses assume that the outcome, number of children, is normally distributed. Because the number of children is non-normally distributed, results may be biased (Preacher & Hayes, 2008). A replication using other statistical models such as zero-inflated

Poisson regression model is needed to accommodate the unique distribution characteristics of the outcome variable of this study. Similarly, the Sobel test conducted to test the significance of mediation effects assumes the normal distribution of indirect effects; thus, results of these mediation analyses should be interpreted with caution (Preacher & Hayes, 2008). Furthermore, only few studies have employed mediation analysis with categorical independent variables with more than two categories (Hayes & Preacher, 2014), so caution should be taken in interpreting how effects are interpreted.

PIAAC participants self-reported total number of children, which could be vulnerable to reporting error. It is unlikely however that this would result in a systematic bias as reporting of such major, or salient, life events have been found to be accurate (Casey et al., 1967; Glickman et al., 1990). In addition, the countries examined have no known laws or social norms to bias the reporting of the number of children. Similarly, although we were interested in biological childbearing, as it directly related to a woman's health, because a count of only biological children was unavailable, we used total number of children, including step- and adopted children as a proxy for total number of biological children. Doing so may exaggerate the number of births for some women. By including step- and adopted children in our childbearing count, we may have introduced a systematic bias if numbers of step- and adopted children varied by literacy status. However, since biological children represent more than 90% of household children in the United States, this is unlikely to have significantly influenced our results (Kreider & Lofquist, 2010). There may also be misclassification of exposure due to poor or differential reporting of self-reported health.

We also were not able to account for some enabling and need factors. Importantly, we were unable to control for income because the PIAAC only collects data on individual income,

so women who were not working did not have a reported income. Limiting our analysis to working women would not have accurately described the relationship between literacy and childbearing across all women. Additional variables that we were unable to control for across all countries included race/ethnicity and the duration of her partnership if she had a partner, and religious and policy-level factors, which may be related to childbearing as well as literacy and so confound our associations. Despite these limitations this study provides critical findings supporting the need to further investigate the relationships between literacy and childbearing.

Conclusions

The implications of this research are diverse and relevant to investigators, policy makers, and practitioners in a range of fields including education, economics, demography, and health. This work adds evidence from high-income countries to a strong and growing body of research indicating a link between literacy skills and health and extends it to childbearing. The influence of literacy on health outcomes represent an opportunity to frame literacy development, a product of high quality education, as a public health intervention to reduce morbidity and mortality of the adult population as well as health disparities and inequities in populations (Braveman, 2006; Healthy People, n.d.; Solar & Irwin, 2007).

We found some evidence that literacy played a mediating role in the relationship between self-reported health and childbearing in the OECD and partner nations. Future work should contextualize these findings to each of the studied countries to ensure they are appropriately acted upon across this heterogeneous group of countries. The PIAAC study is a starting point for additional work that is needed to extend these findings. Studies should be done to assess whether literacy acts as a mediator between other maternal factors, such as income and employment status, and childbearing. Furthermore, this work could be extended to examine

these relationships among men and their contribution to associated health outcomes for families and children.

As evidence gathers around the role that literacy plays in relationships between maternal characteristics and reproductive health outcomes, we should seek out additional data sources to understand if interventions to improve literacy at the population level (including both child and adult education interventions) have impacted reproductive health outcomes. Seeking out these natural experiments would be a logical next step as we gather evidence in order to make policy recommendations. If we continue to see evidence that literacy acts as a mediator between maternal characteristics and health outcomes, we would expect that reproductive health outcomes would improve with the implementation of effective literacy improvement interventions.

Understanding the mechanisms by which social determinants of health, such as literacy, a measure of education, act on outcomes is challenging, but beneficial. By better understanding how these factors influence health, we are able to make better recommendations about how to tailor and point interventions to improve health outcomes.

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Country	Average Literacy Score		Average Childbearing		No Children		Educational Attainment						Self-Reported Health					
							Less than College		College		More than College		Poor/Fair		Good		Very Good/ Excellent	
	Mean	S.E.	Mean	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
OECD																		
Belgium	272.77	1.14	1.48	0.03	30.14	0.79	62.84	0.91	26.76	1.03	10.40	0.65	15.30	0.71	40.19	1.03	44.51	0.93
Czech Republic	272.27	1.29	1.50	0.03	27.56	0.85	82.24	0.42	4.97	0.50	12.79	0.46	11.85	0.94	44.24	1.62	43.91	1.24
Denmark	271.17	0.80	1.48	0.02	32.37	0.66	61.33	0.76	29.70	0.66	8.97	0.42	17.97	0.72	20.44	0.84	61.59	0.86
France	262.22	0.71	1.55	0.02	31.75	0.65	70.70	0.49	20.98	0.53	8.32	0.42	20.31	0.60	35.45	0.69	44.24	0.74
Ireland	265.18	1.14	1.63	0.03	36.63	0.89	65.37	0.43	26.80	0.59	7.83	0.39	11.94	0.61	24.56	1.04	63.51	1.14
Italy	250.28	1.36	1.22	0.03	36.61	1.12	86.70	0.57	11.62	0.59	1.68	0.24	22.71	1.21	35.98	1.52	41.31	1.62
Japan	295.06	1.05	1.39	0.02	33.16	0.92	59.19	0.69	39.64	0.67	1.18	0.22	26.60	0.94	44.16	0.94	29.24	0.88
Korea	269.94	0.86	1.38	0.02	32.60	0.80	67.34	0.68	30.96	0.66	1.71	0.25	55.53	0.82	30.97	0.87	13.49	0.62
Netherlands	281.89	0.99	1.41	0.02	37.08	0.71	70.07	0.84	22.60	0.74	7.32	0.54	20.24	0.85	37.66	1.08	42.11	1.07
Norway	276.67	0.91	1.58	0.02	30.39	0.68	62.02	0.80	26.32	0.69	11.66	0.56	18.35	0.73	29.60	1.01	52.05	1.00
Poland	269.50	0.89	1.32	0.02	31.63	0.69	71.78	0.83	6.12	0.38	22.10	0.84	20.02	0.85	46.75	0.89	33.23	0.82
Slovakia	274.22	0.84	1.55	0.02	29.26	0.68	80.71	0.87	4.99	0.48	14.30	0.83	21.58	0.78	35.28	0.95	43.14	0.97
Spain	249.50	1.06	1.36	0.03	33.77	0.76	69.30	0.58	18.89	0.72	11.81	0.65	24.26	0.98	38.46	1.01	37.28	0.92
Sweden	277.78	1.12	1.52	0.02	32.79	0.69	67.77	0.58	21.15	0.70	11.09	0.66	18.78	0.94	26.54	1.03	54.68	1.02
United Kingdom	271.61	1.33	1.51	0.02	33.29	0.79	63.28	0.95	13.45	0.81	23.27	0.60	14.99	0.73	26.11	0.86	58.89	0.95
United States	269.60	1.30	1.79	0.04	29.95	1.14	62.67	0.69	26.71	0.82	10.63	0.53	15.78	0.88	28.83	1.00	55.39	1.34
Partner																		
Cyprus	269.86	0.97	1.57	0.03	34.25	0.80	66.07	0.49	27.10	0.65	6.82	0.57	15.25	0.72	27.22	0.97	57.53	1.05
Russia	277.99	3.11	1.21	0.04	27.00	1.19	35.34	1.07	34.47	1.18	30.19	0.54	47.61	2.19	35.52	2.14	16.86	1.68

Table 1a. Characteristics of study population.

Country	Average Age		Age													
			16-19		20-24		25-29		30-34		35-39		40-44		45-65	
	Mean	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
OECD																
Belgium	41.68	0.11	8.25	0.33	8.12	0.30	8.38	0.38	10.28	0.38	8.28	0.43	10.04	0.36	46.64	0.47
Czech Republic	40.88	0.13	7.30	0.22	9.72	0.57	8.13	0.56	12.09	0.60	11.55	0.86	9.69	0.68	41.54	0.66
Denmark	41.1	0.1	9.05	0.35	8.30	0.40	8.48	0.38	9.06	0.41	9.74	0.44	11.65	0.45	43.71	0.26
France	40.58	0.1	8.41	0.37	9.13	0.37	9.77	0.45	9.45	0.43	9.79	0.44	10.77	0.36	42.69	0.29
Ireland	38.45	0.2	8.38	0.53	9.59	0.56	10.53	0.55	14.44	0.67	12.43	0.59	11.25	0.58	33.38	0.66
Italy	41.81	0.28	7.63	0.66	5.73	0.54	8.50	0.78	10.00	0.80	11.45	0.72	12.33	0.73	44.35	1.04
Japan	41.83	0.2	5.67	0.36	8.01	0.52	7.74	0.55	10.94	0.61	12.69	0.71	12.14	0.64	42.81	0.79
Korea	39.76	0.19	8.15	0.32	9.97	0.45	8.17	0.39	10.34	0.39	11.04	0.54	13.29	0.52	39.04	0.64
Netherlands	40.77	0.09	8.16	0.43	9.08	0.52	9.66	0.64	9.20	0.48	9.42	0.54	11.06	0.44	43.42	0.44
Norway	40.17	0.08	9.30	0.37	8.92	0.40	9.35	0.58	10.26	0.50	10.31	0.61	11.28	0.47	40.59	0.28
Poland	40.05	0.08	7.70	0.13	10.58	0.18	12.16	0.54	10.48	0.57	9.74	0.53	7.95	0.50	41.39	0.38
Slovakia	39.97	0.08	8.54	0.35	9.42	0.38	11.04	0.50	10.76	0.50	11.01	0.52	8.56	0.46	40.67	0.37
Spain	41.31	0.09	5.72	0.36	6.20	0.35	10.06	0.51	11.29	0.57	12.44	0.62	11.60	0.51	42.70	0.45
Sweden	40.71	0.1	7.61	0.44	10.57	0.48	9.56	0.56	9.24	0.46	10.26	0.66	10.12	0.59	42.64	0.48
United Kingdom	40.03	0.09	7.65	0.07	10.37	0.18	10.48	0.20	9.95	0.13	9.82	0.19	11.17	0.18	40.55	0.32
United States	40.3	0.2	6.80	0.53	10.09	0.72	11.08	0.76	10.22	0.52	9.51	0.53	10.44	0.58	41.86	0.87
Partner																
Cyprus	38.6	0.17	11.22	0.63	8.94	0.65	11.88	0.74	10.91	0.59	10.09	0.55	9.69	0.51	37.26	0.63
Russia	40.74	0.11	5.61	0.11	10.94	0.19	10.66	0.33	11.27	0.32	9.40	0.29	8.69	0.33	43.43	0.33

Table 1b. Average age and age distribution of study population.

Country	***Literacy***				***Childbearing***			***Self-Reported Health***		***Education***
	Education	**Age**	**Self-Reported Health**	**Childbearing**	**Education**	**Age**	**Self-Reported Health**	**Age**	**Education**	**Age**
OECD										
Belgium	0.442*	-0.249*	0.212*	-0.104*	0.031	0.531*	-0.088*	-0.211	0.177*	0.029*
Czech Republic	0.353*	-0.198*	0.251*	-0.223*	-0.089*	0.614*	-0.268*	-0.420	0.162*	-0.017*
Denmark	0.339*	-0.179*	0.253*	-0.149*	0.025	0.592*	-0.112*	-0.145*	0.182*	0.126*
France	0.393*	-0.257*	0.250*	-0.256*	-0.117*	0.550*	-0.202*	-0.326	0.159*	-0.021*
Ireland	0.385*	-0.142*	0.213*	-0.173*	-0.177*	0.569*	-0.143*	-0.201	0.144*	-0.010*
Italy	0.232*	-0.216*	0.162*	-0.215*	-0.130*	0.528*	-0.231*	-0.381*	0.105*	-0.043*
Japan	0.382*	-0.184*	0.131*	-0.173*	-0.096*	0.522*	-0.121*	-0.247	0.081*	0.004*
Republic of Korea	0.337*	-0.430*	0.217*	-0.359*	-0.122*	0.713*	-0.210*	-0.298*	0.104*	-0.071*
Netherlands	0.377*	-0.260*	0.269*	-0.226*	-0.065*	0.581*	-0.112*	-0.206*	0.151*	0.054*
Norway	0.370*	-0.105*	0.221*	-0.097*	0.030	0.593*	-0.097*	-0.144*	0.203*	0.128*
Poland	0.342*	-0.239*	0.261*	-0.279*	-0.141*	0.510*	-0.273*	-0.493	0.192*	-0.016*
Slovakia	0.244*	-0.092*	0.185*	-0.263*	-0.109*	0.590*	-0.304*	-0.479	0.174*	0.020*
Spain	0.411*	-0.229*	0.270*	-0.223*	-0.136*	0.528*	-0.220*	-0.366	0.175*	-0.021*
Sweden	0.312*	-0.142*	0.267*	-0.178*	0.034	0.585*	-0.092*	-0.129*	0.125*	0.120*
United Kingdom	0.369*	-0.014	0.217*	-0.119*	-0.134*	0.508*	-0.121*	-0.128*	0.142*	0.030*
United States	0.424*	-0.091*	0.325*	-0.181*	-0.110*	0.445*	-0.149*	-0.150*	0.264*	0.108*
Partner										
Cyprus	0.273	-0.077*	0.207*	-0.056*	-0.192*	0.662*	-0.251*	-0.396*	0.200*	-0.072*
Russia	0.083	-0.027	0.121*	-0.045	0.004	0.532*	-0.267*	-0.453*	0.031*	0.129*

Table 2. Correlation between study variables in OECD and partner nations. Estimates significant at the 0.05 level are indicated with an asterix.

Country	***Literacy***	***Health***	
		Very Good/ Excellent	***Fair/Poor***
OECD			
Belgium	-0.0029*	0.17*	-0.13
Czech Republic	-0.0068*	0.67*	-0.17
Denmark	-0.0043*	0.08	-0.34*
France	-0.0075*	0.39*	-0.36*
Ireland	-0.0065*	0.08	-0.79*
Italy	-0.0058*	0.42*	-0.25*
Japan	-0.0057*	0.28*	-0.13*
Korea	-0.0099*	0.37*	-0.31*
Netherlands	-0.0063*	0.17*	-0.23*
Norway	-0.0029*	0.11	-0.26*
Poland	-0.0075*	0.57*	-0.33*
Slovakia	-0.0091*	0.67*	-0.36*
Spain	-0.0064*	0.33*	-0.42*
Sweden	-0.0048*	0.04	-0.33*
United Kingdom	-0.0035*	0.14	-0.37*
United States	-0.0063*	0.23*	-0.49*
Partner			
Cyprus	-0.002	0.29*	-0.35*
Russia	-0.000	0.38*	-0.24*

Table 3. Regression analysis results predicting childbearing with literacy and self-reported health in separate analyses. All reported coefficients are unstandardized. For self-reported health, "good" is reference. The PIAAC literacy score ranges from 0-500. Estimates significant at the 0.05 level are indicated with an asterix.

Country	Health		Literacy	Literacy*Health		Education		Age
	Excellent	Poor		Excellent	Poor	More than college	College	
OECD								
Belgium	0.11	-0.03	0.00077	-0.00024	0.00005	-0.04	0.05	0.33*
Czech Republic	-0.17	0.34	-0.00265	0.00056	-0.00172	-0.16	-0.30*	0.36*
Denmark	0.18	0.76	0.00005	-0.00053	-0.00253	-0.24*	0.00	0.37*
France	-0.03	0.77*	-0.00188*	0.00015	-0.00315*	-0.30*	-0.23*	0.36*
Ireland	0.48	0.33	-0.00010	-0.00135	-0.00172	-0.76*	-0.49*	0.46*
Italy	0.04	0.56	-0.00151	-0.00028	-0.00220	-0.34*	-0.31*	0.29*
Japan	0.67	0.06	-0.00103	-0.00201	-0.00018	-0.85*	-0.16*	0.34*
Korea	-0.17	-0.21	-0.00174	0.00078	0.00075	-0.38*	-0.12*	0.38*
Netherlands	-0.32	0.16	-0.00185	0.00137	-0.00078	-0.43*	-0.12	0.37*
Norway	0.32	0.14	-0.00003	-0.00111	-0.00043	-0.21*	0.01	0.38*
Poland	-0.10	-0.13	-0.00384*	0.00034	0.00018	-0.27*	-0.15*	0.28*
Slovakia	-1.29*	-0.52	-0.00888*	0.00466*	0.00152	-0.28*	-0.34*	0.38*
Spain	-0.73*	-0.48	-0.00336*	0.00308*	0.00222*	-0.33*	-0.24*	0.34*
Sweden	-0.40	0.34	-0.00305*	0.00178	-0.00098	0.06	-0.17*	0.37*
United Kingdom	-0.06	-0.21	-0.00206	0.00004	0.00104	-0.41*	-0.20*	0.34*
United States	-0.37	-0.48	-0.00395*	0.00131	0.00232	-0.52*	-0.36*	0.36*
Partner								
Cyprus	0.50	-0.44	0.00171	-0.00151	0.00144	-0.64*	-0.46*	0.45*
Russia	-0.27	-0.06	-0.00070	0.00053	0.00010	-0.15*	-0.04	0.25*

Table 4. Moderation analysis controlling for education and age. All reported coefficients are unstandardized. For self-reported health, "good" is reference. The PIAAC literacy score ranges from 0-500. For education, "less than college" is reference. Estimates significant at the 0.05 level are indicated with an asterix.

Country	***Health Excellent***			***Health Poor***		
	Total effect	***Direct effect***	***Indirect effect***	***Total effect***	***Direct effect***	***Indirect effect***
OECD						
Belgium	0.052	0.049	0.004	-0.021	-0.018	-0.004
Czech Republic	-0.046	-0.012	-0.034	-0.102	-0.107	0.004
Denmark	0.038	0.046	-0.008	0.128*	0.121	0.007
France	0.009	0.017	-0.008	0.04	0.003	0.038*
Ireland	0.118	0.127*	-0.009	0.225	0.213	0.012
Italy	-0.032	-0.025	-0.007	0.038	0.028	0.01
Japan	0.059	0.064	-0.005	0.005	0	0.005
Korea	0.049	0.047	0.002	0.005	-0.004	0.009*
Netherlands	0.057	0.072	-0.015	-0.022	-0.039	0.017
Norway	0.006	0.013	-0.007	0.02	0.017	0.003
Poland	-0.024	-0.008	-0.016	-0.046	-0.085	0.039*
Slovakia	-0.023	0.005	-0.028	-0.029	-0.093	0.064*
Spain	0.061	0.065	-0.004	0.097	0.069	0.028*
Sweden	0.079	0.109*	-0.03*	0.14	0.105	0.035*
United Kingdom	-0.064	-0.046	-0.018*	0.072	0.05	0.022
United States	-0.055	-0.021	-0.034*	0.14*	0.099*	0.041*
Partner						
Cyprus	0.096	0.086	0.01	-0.087	-0.077	-0.01
Russia	-0.131	-0.123	-0.008	-0.033	-0.035	0.001

Table 5. Mediation analysis controlling for education and age. For self-reported health, "good" is reference. The PIAAC literacy score ranges from 0-500. Estimates significant at the 0.05 level are indicated with an asterix.