OECD Education Working Papers No. 165

Association between literacy and self-rated poor health in 33 high-and upper-middle-income countries

Sujay Kakarmath,
Vanessa Denis,
Marta Encinas-Martín,
Francesca Borgonovi,
S. V. Subramanian

https://dx.doi.org/10.1787/7aaeac27-en

OECD

Organisation for Economic Co-operation and Development

EDU/WKP(2018)1

Unclassified **English text only**

8 January 2018

DIRECTORATE FOR EDUCATION AND SKILLS

ASSOCIATION BETWEEN LITERACY AND SELF-RATED POOR HEALTH IN 33 HIGH- AND UPPER-MIDDLE-INCOME COUNTRIES

OECD Education Working Paper No. 165

By Sujay Kakarmath (Harvard T. H. Chan School of Public Health, sujay.kakarmath@mail.harvard.edu); Vanessa Denis (OECD, vanessa.denis@oecd.org); Marta Encinas-Martin (OECD, marta.encinas-martin@oecd.org); Francesca Borgonovi (OECD, francesca.borgonovi@oecd.org); S V Subramanian (Harvard T.H. Chan School of Public Health, svsubram@hsph.harvard.edu).

This working paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

An earlier version of this paper was originally written for and presented at the 3rd PIAAC International Conference in Madrid, in November 2016. The paper was published by the International Journal of Public Health. This version of the paper is largely based on that journal article (Kakarmath, S. et al. (2017), "Association between literacy and self-rated poor health in 33 high- and upper-middle-income countries", *International Journal of Public Health*, Springer International Publishing, https://doi.org/10.1007/s00038-017-1037-7).

Contact: Ms. Marta Encinas-Martin, OECD, Marta.Encinas-Martin@oecd.org

JT03425198

This document, as well as any data and map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

OECD education working papers series

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed herein are those of the author(s).

Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works. Comments on Working Papers are welcome, and may be sent to the Directorate for Education and Skills, OECD, 2 rue André-Pascal, 75775 Paris Cedex 16, France.

This document, as well as any data and map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgement of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org.

Comment on the series is welcome, and should be sent to edu.contact@oecd.org.

This working paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

---

www.oecd.org/edu/workingpapers

Copyright © OECD 2018

Acknowledgements

We would like to acknowledge the contributions of all participants of the ALL and PIAAC surveys, researchers from OECD involved in the planning, design and implementation of the surveys and field staff in participant countries without whom this study would not have been possible. We would also like to acknowledge the thoughtful feedback from participants of the 3rd PIAAC International Conference held in Madrid, Spain. Finally, we would like to acknowledge the contributions of the reviewing team involved in proof-reading, formatting and publishing this paper.

Abstract

We assess the relationship between general literacy skills and health status by analysing data from the Programme for the International Assessment of Adult Competencies (PIAAC), an international survey of about 250 000 adults aged 16-65 years conducted by the Organisation for Economic Co-operation and Development (OECD) from 2011-15 in 33 countries/national sub-regions. Across countries, there seems to be a strong and consistent association between general literacy proficiency and self-rated poor health, independent of prior socio-economic status and income. General literacy proficiency also appears to be a mediator of the association between self-education and self-rated poor health. While the literacy-health association is robust over time, it varies in magnitude across countries. It is strongest for those with a tertiary or higher degree and does not appear to exist among young adults (ages 25 to 34 years). Future studies are required to understand the contextual factors that modify the general literacy proficiency-health association.

Résumé

Nous étudions la corrélation entre les compétences générales en littératie des adultes et leur état de santé en analysant les données du Programme pour l'évaluation internationale des adules (PIAAC), une étude internationale portant sur 250 000 adultes âgés de 16 à 65 ans, menée par l'Organisation de coopération et de développement économiques (OCDE) de 2011 à 2015 dans 33 pays et régions. Il semble exister une corrélation étroite et cohérente parmi les pays entre les compétences générales en littératie et l'état de santé auto-déclaré mauvais, indépendamment du statut socio-économique et du revenu. Les compétences générales en littératie semblent également jouer un rôle d'intermédiaire dans la corrélation entre l'auto-éducation et l'état de santé auto-déclaré mauvais. Bien que la corrélation entre la littératie et la santé persiste dans le temps, son intensité varie selon les pays. Elle est plus forte parmi les adultes diplômés de l'enseignement supérieur et elle semble ne pas exister parmi les jeunes adultes (âgés de 25 à 34 ans). De nouvelles recherches sont nécessaires pour comprendre les facteurs contextuels qui modifient la corrélation entre les compétences générales en littératie et l'état de santé.

Table of contents

Acknowledgements **3**

Abstract **4**

Résumé **4**

Introduction **8**

Methods **9**

Data sources 9
Study population and sample size 10
Measurements 11
Covariates 12
Statistical analysis 12

Results **14**

General literacy proficiency and self-rated poor health 15
Attenuation analysis 15
Heterogeneity in the general literacy proficiency-self-rated poor health association by age and self-education 15
Heterogeneity in the general literacy proficiency – self-rated poor health association by time and country 16

Discussion **19**

Conclusion 21
References 22

Annex A. Review of literature **23**

References 38

Annex B. Supplementary tables and figures **40**

Tables

Table 1. Distribution of adults (25-65 year olds) across levels of general literacy proficiency, parental education and self-education in the Programme for the International Assessment of Adult Competencies survey data from 33 high- and upper-middle-income countries and national sub-regions (2011-2015) 13
Table 2. Odds ratios for self-rated poor health in data pooled from 33 high- and upper- middle-income countries and national sub-regions from the Programme for the International Assessment of Adult Competencies survey (2011-2015) 14

Table A A.1. Literature review on general literacy skills and health 26

Table A B.1. Interpretation of general literacy proficiency levels in the Programme for the International Assessment of Adult Competencies (2011-2015) assessment 40
Table A B.2. Mean general literacy proficiency in 33 high- and upper-middle-income countries from the Programme for the International Assessment of Adult Competencies survey (2011-2015), by country and self-education..... 41
Table A B.3. Proportion of self-rated poor health, by socio-demographic characteristics in the Programme for the International Assessment of Adult Competencies Survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015)..... 42
Table A B.4. Proportion of self-rated poor health, by parental education, self-education and general literacy proficiency categories in the Programme for the International Assessment of Adult Competencies Survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015) 43
Table A B.5. Attenuation of self-education- self-rated poor health association by general literacy proficiency in pooled data from 33 high- and upper-middle-income countries and national sub-regions in the Programme for the International Assessment of Adult Competencies Survey (2011-2015)..... 44
Table A B.6. Confounding of general literacy proficiency-self-rated poor health association by parental education and self-education in pooled data from 33 high- and upper-middle-income countries and national sub-regions in the Programme for the International Assessment of Adult Competencies Survey (2011-2015) 44
Table A B.7. Comparison of adjusted odds ratios for self-rated poor health by age group, for seven upper-middle-income countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies (2011-2015) survey..... 45
Table A B.8. Comparison of adjusted odds ratios for self-rated poor health by level of self-education, for seven upper-middle-income-countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies (2011-2015) survey..... 46

Figures

Figure 1. Participant selection in the Programme for the International Assessment of Adult Competencies survey of 33 high- and upper-middle-income countries and national sub-regions 10
Figure 2. Proportion of participants with self-rated poor health by levels of parental education, self-education and general literacy proficiency in the Programme for the International Assessment of Adult Competencies survey data from 33 high- and upper- middle-income countries and national sub-regions (2011-2015) 17
Figure 3. Comparison of adjusted odds ratios for self-rated poor health for lowest level of parental education, self-education and general literacy proficiency in six high-income countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies survey (2011-2015) 18
Figure 4. Adjusted odds ratio for self-rated poor health in 33 high- and upper-middle-income countries and national sub-regions from the Programme for the International Assessment of Adult Competencies survey (2011-15)..... 19

Figure A B.1. Proportion of respondents across levels of parental education, self-education and general literacy proficiency in the Programme for the International Assessment of Adult Competencies survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015) 47

Boxes

Box A A.1. Search strategy 23

Introduction

Health disparities are closely associated with disparities in educational attainment. (Conti et al., 2010). Less educated individuals are less likely to engage in health promoting behaviours, are disadvantaged in the timeliness of diagnosis for a chronic disease, are less effective in managing the illness, have worse health outcomes and ultimately a lower life expectancy (Cutler and Lleras-Muney, 2006). This association is consistent across a variety of contexts and health outcomes although causality is challenging to conclusively establish. A lively scientific debate exists around the plausibility of reverse causation, and the potential for unmeasured confounding by factors such as income, individual ability, genetic potential or parental socio-economic status (SES) (Chatterji, 2014). Besides, even if we make an assumption of causality, it is difficult to argue that the health gap can be closed by simply focusing on greater equity in total years of schooling completed or degrees achieved, with disregard to the role of quality of education, skill domains, subsequent life experiences and social context that may cause individuals to differentially accrue and retain the health benefits of equivalent education. A deeper understanding of the factors driving the education-health association will enable the design of pragmatic and efficient policy solutions to reduce education-related disparities in health.

Scientific literature emerging from the 1990s onwards has shown low levels of general literacy proficiency to be associated with poorer health outcomes, including health-related knowledge, intermediate disease markers, morbidity, general health status, and use of health resources (Dewalt et al., 2004). Simultaneously, a relatively broader concept of 'health literacy' has been linked to the use of emergency health services, hospitalisation, interpretation of health communication, appropriate taking of medications and mortality in the elderly (Berkman et al., 2011). It is increasingly expected that individuals will become partners in the management of their own health and bear a major responsibility for adopting health promoting behaviours has increased in parallel with the growth in life expectancy and associated chronic health conditions (Bauer et al., 2014). Treatment of a chronic condition often requires that individuals communicate with health care providers and understand complex probabilistic concepts such as risk factors, learn to self-monitor parameters such as blood pressure, comply meticulously with long-term courses of drug regimens for multiple morbidities, navigate digital texts, interpret information on food and drug labels, and connect with support networks of friends and peer patients through social media. With rapidly evolving health-promoting technology products, individuals need to adapt to become perennial learners. As such, strong general literacy and numeracy proficiency have become pre-conditions for the development of health literacy. We therefore consider it to be plausible that general literacy proficiency may be causally associated with health, either independently or as a mediator of the education-health association, even after accounting for confounding by parental and self-educational attainment (hereafter referred to as 'education').

To evaluate what is already known about the literacy-health association, we conducted a literature review (Annex A) and found the following gaps in knowledge. First, there seems to no consensus around what constitutes general literacy proficiency or a gold

standard to measure it, and most scientific studies measure only the ability to read with different tools. Second, studies differ in variables used to adjust for bias as well as outcomes, making it difficult to compare estimates across regions and times. Third, only about a quarter of the studies come from nationally representative study populations and most are conducted in select groups such as patient populations, minorities and the elderly, thus restricting generalisability of the findings. Fourth, a majority of the studies come from the United States and may not be generalisable to countries that differ in social or macroeconomic context.

To address these gaps in knowledge, we analysed data from an international survey of adults in 33 high- and upper-middle-income countries/national sub-regions to assess the relationship between general literacy proficiency and health status.

Methods

Data sources

We analysed data from the Programme for the International Assessment of Adult Competencies (PIAAC), (Schleicher, 2008) an international survey of about 250 000 adults (16-65 years) conducted by the Organisation for Economic Co-operation and Development (OECD) from 2011-15 in the following 33 high- and upper-middle-income countries/national sub-regions: Australia, Austria, Belgium (Flanders), Canada, Chile, the Czech Republic, Cyprus,[1] Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Lithuania, the Netherlands, New Zealand, Norway, Poland, the Russian Federation,[2] Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Turkey, the United Kingdom (England and Northern Ireland), and the United States. Details about the design and implementation of the survey have been published elsewhere (OECD, 2013).

[1] Note by Turkey:

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

[2] The sample for the Russian Federation does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65 in the Russian Federation but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area. More detailed information regarding the data from the Russian Federation as well as that of other countries can be found in the *Technical Report of the Survey of Adult Skills, Second Edition* (OECD, forthcoming).

For comparison across time, we also analysed data on Australia, Canada, Italy, Norway, the Netherlands, New Zealand and the United States from the Adult Literacy and Lifeskills (ALL) survey, (Satherley et al., 2008) an international survey of about 30 000 adults (16-65 years) conducted between 2003 and 2008.

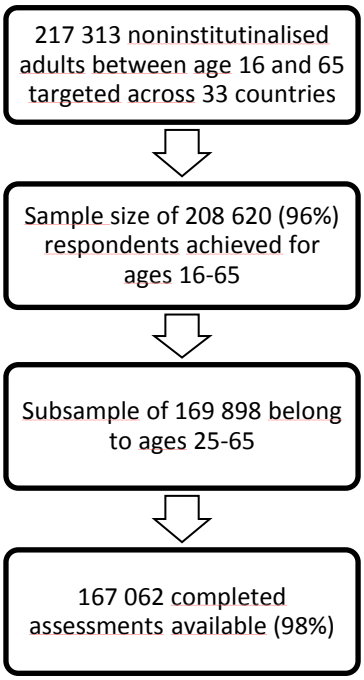
Study population and sample size

The survey population was representative of the civilian, non-institutionalised population aged 16-65 years residing in each country at the time of data collection irrespective of nationality, citizenship or language status. Sample sizes were determined primarily based on the number of cognitive domains assessed and the number of languages in which the survey was administered. For our analysis, we excluded participants whose age was less than 25 years at the time of taking the survey (Figure 1).

Data collection

The PIAAC survey was conducted in the official language/s of each participating country. It was administered under the supervision of trained interviewers in the respondent's home, or at a mutually agreed upon location. A background questionnaire was administered in computer-aided personal interview format (CAPI) by the interviewer. This was followed by the general literacy, numeracy and problem-solving skills assessment which was administered either on a laptop computer or as a pencil and paper test, depending on the computer skills of the respondent.[3]

Figure 1. Participant selection in the Programme for the International Assessment of Adult Competencies survey of 33 high- and upper-middle-income countries and national sub-regions



[3] Informed consent was obtained from all survey participants.

Measurements

Outcome: Self-rated poor health

Self-rated health was measured in PIAAC through the following question: "In general, you say your health is:" to which respondents could answer using a five-point scale ranging from "excellent", "very good", "good", "fair" to "poor". We recoded the self-rated health variable and in all our models we use a dichotomous indicator taking value 1 when individuals reported being in fair or poor health and 0 otherwise. Self-rated health is an important predictor of mortality, (Idler and Benyamini, 1997) and of the onset of disability and stress levels (Farmer and Ferraro, 1997). Self-rated health measures have high levels of validity and consistency, and the relationship between self-rated health and mortality does not vary by socio-economic group. Small differences can be observed, however, by gender and ethnic group (Franks et al., 2003; van Doorslaer and Gerdtham, 2003).

Primary independent variable: General literacy proficiency

General literacy is defined in PIAAC 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, 2013). The general literacy assessment was designed to assess three broad cognitive strategies considered necessary to achieving a full understanding of text: a) accessing and identifying information in a text; b) integrating and relating parts of one or more texts to each other; and c) drawing upon knowledge, ideas or values external to the text to evaluate aspects such as accuracy, reliability and timeliness of the text. In this regard, the construct of general literacy was broader than what would fall within the scope of 'reading ability', which can be narrowly understood as 'decoding' written text. One unique feature of the assessment of general literacy in PIAAC is that it assessed adults' ability to read digital texts (e.g. texts containing hypertext and navigation features such as scrolling or clicking on links) as well as traditional print-based texts. Secondly, given that the context in which reading takes place may influence the motivation to read and the manner of interpretation, materials for the general literacy assessment were drawn from a wide range of contexts. The tasks varied in difficulty based on: a) the transparency of information in the text as it related to the presented question; b) degree of complexity required in making inferences; c) semantic and syntactic complexity; d) amount of information needed to complete the task; e) amount of competing but potentially relevant information that the reader has to sift through to access information needed to complete the task; and f) degree to which the reader has to independently construct relationships among different parts of the text to make the required conclusion. Respondents with very low general literacy skills bypassed the full general literacy assessment and went directly to a test of reading component skills instead. Reading components represent the basic set of decoding skills which provide necessary pre-conditions for gaining meaning from written text – knowledge of vocabulary, ability to process meaning at the level of the sentence, and fluency in the reading of passages of text. The assessment had no time limit.

The test design for PIAAC was based on a variant of matrix sampling (using different sets of items, multistage adaptive testing, and different assessment modes) where each respondent was administered a subset of items from the total item pool (OECD, 2013). This was because the study aims to represent at the population level, and not individual level, level of proficiency and the relationship between proficiency and a set of outcomes. General literacy proficiency scores are considered to be on a continuum of ability

representing the mastery of tasks of increased complexity. The scores are represented on a 500-point scale, and were calculated based on Item Response Theory (IRT) models: individuals' response patterns to specific questions in their assessment were used to impute plausible value scores of achievement in the complete assessment. At each point on the continuous general literacy proficiency scale, an individual has 67% chance of completing items located at that point. The continuous scale was then divided by PIAAC into six levels of proficiency (Table A B.1). We recoded these general literacy proficiency levels into a categorical variable taking values 1, 2, 3 and 4, respectively, for general literacy proficiency level 1 and below, level 2, level 3 and levels 4 and 5 (referred to as "level 4/5" hereon).

Considerable effort was expended to make the content of the assessment equivalent in difficulty in each of the 27 language versions and to standardise implementation procedures across countries. Scoring systems were rigorously evaluated for within and cross-country reliability.

Secondary independent variables

The PIAAC background questionnaire collected information on respondents' (self) and their parent/guardian's (both father and mother) highest level of completed educational attainment (referred to as "parental education" hereon) (OECD, 2013). In order to derive a cross-country comparable measure of education, PIAAC mapped individual responses on national qualifications onto the International Standard Classification of Education (ISCED) system (UNESCO, 2013). For the purpose of this analysis, parental education was recoded into a dichotomous variable taking value 1 for parental education level of tertiary or higher degree, and 0 otherwise. Self-education was recoded into a categorical variable taking values 1, 2 and 3 for lower secondary degree at most, upper secondary degree, and tertiary or higher degree, respectively.

Covariates

Detailed information on covariates (age, gender, foreign-born or not, employment status and absolute income) was also collected through the PIAAC background questionnaire. For the purpose of this analysis, employment status (employed at the time of survey: yes/no) and country of birth (born in country where survey was administered: yes/no) were additionally considered.

Statistical analysis

Descriptive statistics for the outcome (self-rated poor health) and key independent variables (general literacy proficiency categories: Levels 1, 2, 3 and 4/5; self-education categories: lower secondary degree at most, upper secondary degree, and tertiary or higher degree; parental education categories: upper secondary degree at most, and tertiary or higher degree) were calculated as percentages, by country. The variation of self-rated poor health across levels of the independent variables and co-variation of the independent variables was assessed by preparing a contingency table (Table 1).

We used logistic regression to model parental education, self-education and general literacy proficiency as predictors of self-rated poor health. All models controlled for age, gender, employment status, income and country of birth. To establish a baseline, we initially modelled each of these independent variables separately, without adjusting for the others, and report the minimally adjusted odds ratio (OR) with 95% confidence

intervals (CI) as Models 1, 2 and 3 (Table 2). We then modelled self-education and general literacy proficiency, respectively, in Models 4 and 5, while adjusting for confounding by parental education. Finally, we modelled general literacy proficiency as a predictor of self-rated poor health while adjusting for both parental education and self-education (Model 6) to assess the relative importance of general literacy proficiency with regard to the latter. We also tested for interaction between self-education and general literacy proficiency in the adjusted model but these were not significant and hence were not included in the results.

We first conducted the above analysis on the PIAAC data (2012 to 2015), and then repeated the same on ALL data (2003 to 2008) to assess the robustness of the adjusted associations over time (Model 6). This analysis was restricted to the subset of seven countries that took part in both surveys. We also repeated these analyses by age and self-education categories to assess the relative importance of each predictor across age groups, across time and across self-education categories.

To assess the extent to which the association between self-education and self-rated poor health is explained by general literacy proficiency, we first calculated the absolute probabilities of self-rated poor health from the logistic regression coefficients. We then estimated the confounding of the general literacy proficiency-self-rated poor health association by parental education and self-education, and the attenuation of the self-education--self-rated poor health association by general literacy proficiency, as the relative percentage change in the absolute probability from the respective baseline model to the adjusted model.

Table 1. Distribution of adults (25-65 year olds) across levels of general literacy proficiency, parental education and self-education in the Programme for the International Assessment of Adult Competencies survey data from 33 high- and upper-middle-income countries and national sub-regions (2011-2015)

		General literacy proficiency % (standard error)				Father's education % (standard error)		Mother's education % (standard error)	
		Level 1 and below	Level 2	Level 3	Level 4/5	Upper secondary at most	Tertiary degree	Upper secondary at most	Tertiary degree
Father's education	Upper secondary at most	17.0 (0.3)	28.0 (0.4)	25.9 (0.4)	6.6 (0.2)				
	Tertiary degree	1.3 (0.1)	4.2 (0.2)	7.9 (0.2)	4.2 (0.2)				
Mother's education	Upper secondary at most	17.8 (0.3)	29.6 (0.4)	27.9 (0.3)	7.6 (0.2)				
	Tertiary degree	1.0 (0.1)	3.2 (0.2)	6.3 (0.2)	3.4 (0.1)				
Self-education	Lower secondary at most	9.8 (0.1)	7.6 (0.1)	2.6 (0.1)	0.2 (0.03)	17.8 (0.2)	0.6 (0.1)	18.3 (0.2)	0.5 (0.04)
	Upper secondary	7.5 (0.2)	16.5 (0.3)	14.3 (0.2)	2.7 (0.1)	33.5 (0.2)	4.6 (0.1)	35.5 (0.2)	3.5 (0.1)
	Tertiary degree	2.5 (0.1)	9.8 (0.2)	18.1 (0.2)	8.2 (0.2)	24.8 (0.2)	12.2 (0.2)	27.7 (0.2)	9.7 (0.2)

Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Table 2. Odds ratios for self-rated poor health in data pooled from 33 high- and upper-middle-income countries and national sub-regions from the Programme for the International Assessment of Adult Competencies survey (2011-2015)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Father's education						
Tertiary degree	Ref			Ref	Ref	Ref
Upper secondary at most	1.3 (1.2, 1.4)			1.1 (1.0, 1.2)	1.2 (1.1, 1.3)	1.1 (1.0, 1.2)
Mother's education						
Tertiary degree	Ref			Ref	Ref	Ref
Upper secondary at most	1.2 (1.1, 1.3)			1.1 (1.0, 1.2)	1.1 (1.0, 1.3)	1.1 (1.0, 1.2)
Self-education						
Tertiary degree		Ref		Ref		Ref
Upper secondary degree		1.5 (1.4, 1.7)		1.5 (1.4, 1.6)		1.4 (1.3, 1.5)
Lower secondary at most		2.4 (2.2, 2.7)		2.3 (2.1, 2.5)		1.9 (1.8, 2.1)
General literacy proficiency (categorical)						
Level 0/1, lowest			2.5(2.2, 3.0)		2.4 (2.0, 2.8)	1.9 (1.6, 2.2)
Level 2			1.6(1.4, 1.9)		1.5 (1.3, 1.8)	1.3 (1.1, 1.6)
Level 3			1.3(1.1, 1.5)		1.2 (1.0, 1.4)	1.2 (1.0, 1.4)
Level 4/5, highest			Ref		Ref	Ref

Note: All models adjusted for age, employment status, income, gender, country of birth and country fixed effects.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Results

The overall prevalence of self-rated poor health in the PIAAC survey was 24% (Median 19%; inter-quartile range 16 to 23 %), ranging from about 12% in Canada to more than 45% in South Korea and the Russian Federation.[4] The proportion of participants with general literacy proficiency of level 4/5 was 10% (IQR 7 to 14 %), ranging from less than 2% in Chile and Turkey to more than 20% in Japan and Finland (Figure A B.1). Across all countries, those with a tertiary or higher degree had a mean general literacy proficiency score of 292 (Level 3) ranging from 254 (Level 2) in Chile to 313 in Japan (Level 3). Those with a lower secondary degree at most had a mean general literacy proficiency score of 231 (Level 2) ranging from 177 (Level 1) in Chile to 260 in Japan (Level 2). On average, the difference between the average general literacy scores of those with a tertiary degree and those with a lower secondary degree at most was the highest in the United States and Singapore, and the lowest in the Russian Federation[5] and Cyprus[6] (Table A B.2).

[4] See note 2.

[5] See note 2.

[6] See note 1.

The prevalence of self-rated poor health was highest in those aged 55 and more (34%, range 16 to 74%), and those who were unemployed (38%, range 19 to 65%) in all countries. Self-rated poor health was more prevalent in women compared to men in 28 out of 33 countries (Table A B.3). The prevalence of self-rated poor health was highest at general literacy proficiency of level 1 and below (34%, range 18% to 69%) for all countries, and was more than three times that at Level 4/5 (10%, range 3% to 40%) (Figure 2; Table A B.4). The difference in prevalence of self-rated poor health between lowest and highest categories of general literacy proficiency was the lowest in Greece (9%) and the Russian Federation[7] (10%), and the highest in Chile (47%) and Turkey (37%). The prevalence of self-rated poor health was highest in those in the lowest categories of self-education (35%, range 20 to 74%), and parental education (father's education: 22%, range 13 to 55%; mother's education: 22%, range 12 to 54%) for all countries (Table A B.4).

General literacy proficiency and self-rated poor health

After adjusting for age, employment status, income, gender, country of birth and country fixed effects (Model 3), the odds ratio of self-rated poor health for those with general literacy proficiency of level 1 and below compared to those in level 4/5 was 2.5 (95% CI 2.2 to 3.0) (Table 2). After additional adjustment for parental education (Model 5), the odds ratio attenuated slightly to 2.4 (95% CI 2.0 to 2.8), and with further adjustment for self-education (Model 6), the odds ratio was 1.9 (95% CI 1.6 to 2.2). There was a clear gradient in the unadjusted and adjusted odds ratios for the association between general literacy proficiency and self-rated poor health, with higher odds ratios for lower levels of general literacy proficiency.

Attenuation analysis

The pooled probability of self-rated poor health for those with self-education of lower secondary degree at most reduced by 20% after adjustment for parental education, and by an additional 22% after adjustment for general literacy proficiency (Table A B.5). This suggests that slightly more than 20% of the effect of self-education on health may be potentially mediated through general literacy proficiency. The relative change in the pooled probability of self-rated poor health for those with general literacy proficiency level 1 and below was -29% after adjustment for parental education, and -63% after further adjustment for self-education, suggesting that general literacy proficiency may have a substantial direct effect on poor health, independent of the effect of parental education and self-education (Table A B.5).

Heterogeneity in the general literacy proficiency-self-rated poor health association by age and self-education

The adjusted odds ratio (Model 6) for self-rated poor health was significant only at general literacy proficiency levels of 2 and below in all age groups, except for ages 25 to 34 where it was not significant at any level (Table A B.6; Table A B.7). The odds ratio of self-rated poor health for general literacy proficiency level 1 and below was highest for

[7] See note 2.

ages 35 to 44 [OR 3.4 (95% CI 1.6 to 7.2)], and slightly lower for ages 45 to 54 [OR 3.1 (95% CI 1.3 to 7.7)], and ages 55 and older [OR 3.1 (95% CI 1.4 to 7.1)].

For those with self-education of tertiary or higher degree, the odds ratio of self-rated poor health was 3.0 (95% CI 1.6, 5.5) at general literacy proficiency levels of 1 and below, 2.0 (95% CI 1.3, 3.2) at level 2 and not significant at level 3, after adjusting for parental education (Model 5). For those with at most an upper secondary degree, the odds ratio for self-rated poor health was significant only at general literacy proficiency levels of 1 and below [OR 2.1 (95% CI 1.0, 4.2)]. The association was not significant for those with a lower secondary degree at most (Annex B).

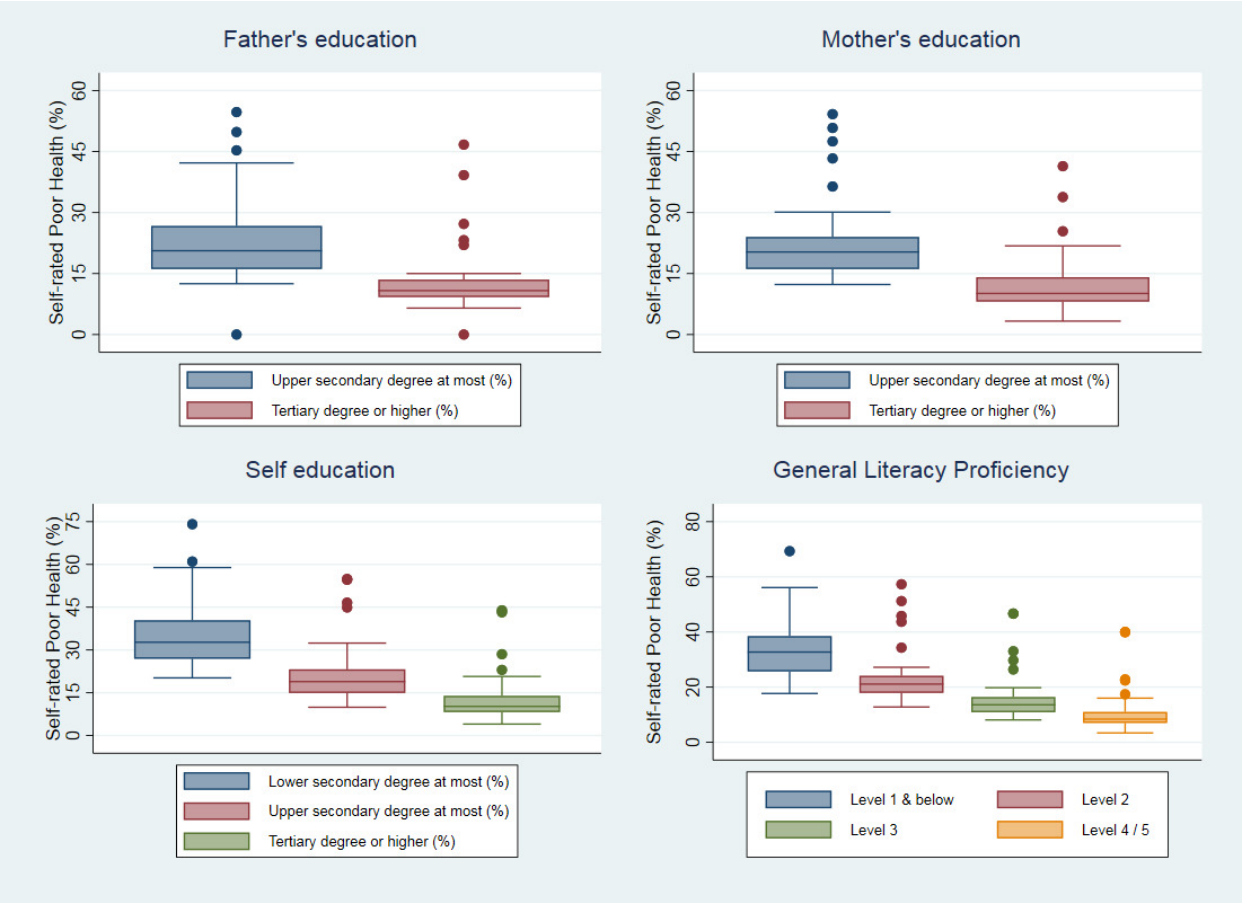
Heterogeneity in the general literacy proficiency – self-rated poor health association by time and country

The adjusted odds ratio for self-rated poor health by general literacy proficiency in the PIAAC survey was less than that in the ALL survey for Norway, about the same for Italy and the United States, and greater than that in the ALL survey for the Netherlands, Canada and New Zealand (Figure 3).

Across countries, the adjusted odds ratio (Model 6) of self-rated poor health for those in the lowest general literacy proficiency category was not significant in 17 countries, and in the remaining 16 countries, ranged from 1.4 in Estonia to 3.9 in Germany (Figure 4) For self-education, the adjusted odds ratio of self-rated poor health for those with lower secondary education at most was not significantly different from 1 in Germany and Spain, and in the other 31 countries, ranged from about 1.5 in England (United Kingdom) and the Russian Federation[8] to 4.9 in the Czech Republic.

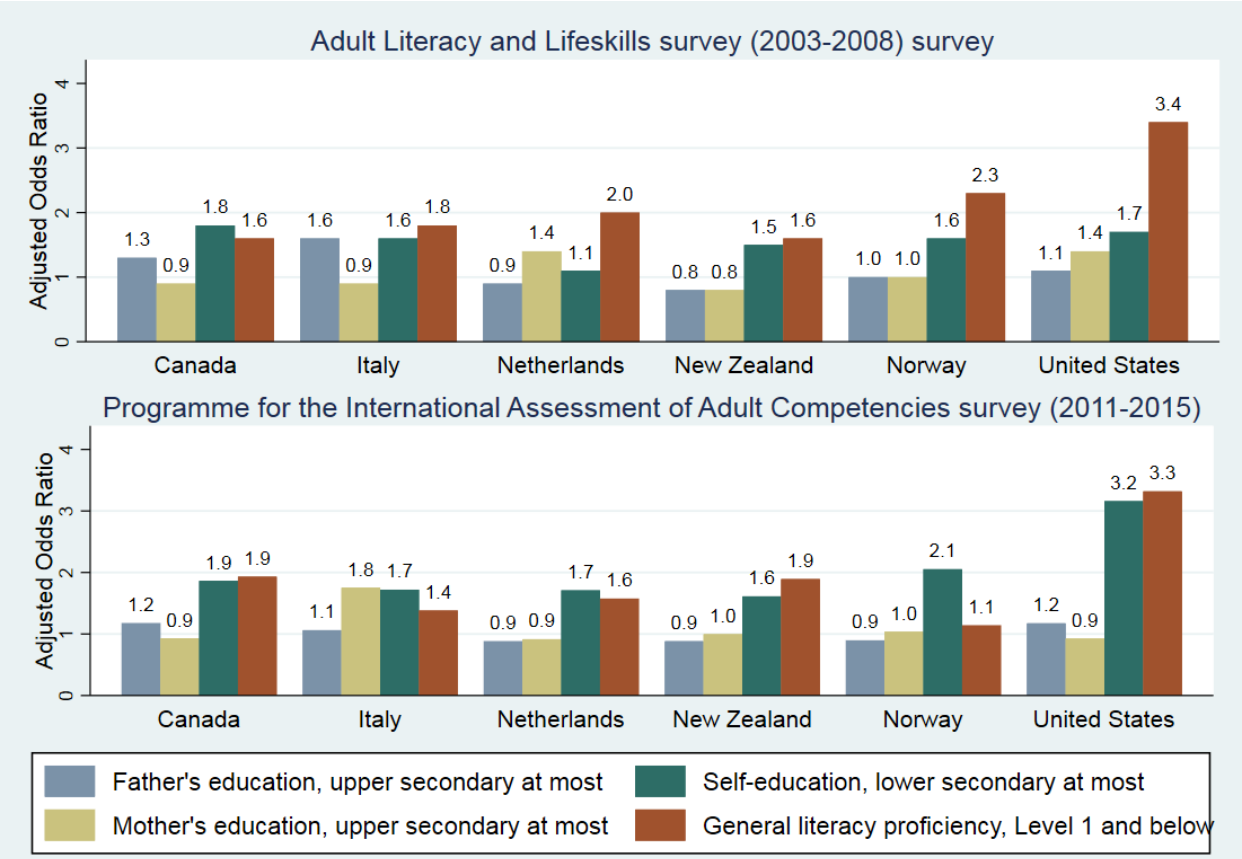
[8] See note 2.

Figure 2. Proportion of participants with self-rated poor health by levels of parental education, self-education and general literacy proficiency in the Programme for the International Assessment of Adult Competencies survey data from 33 high- and upper-middle-income countries and national sub-regions (2011-2015)



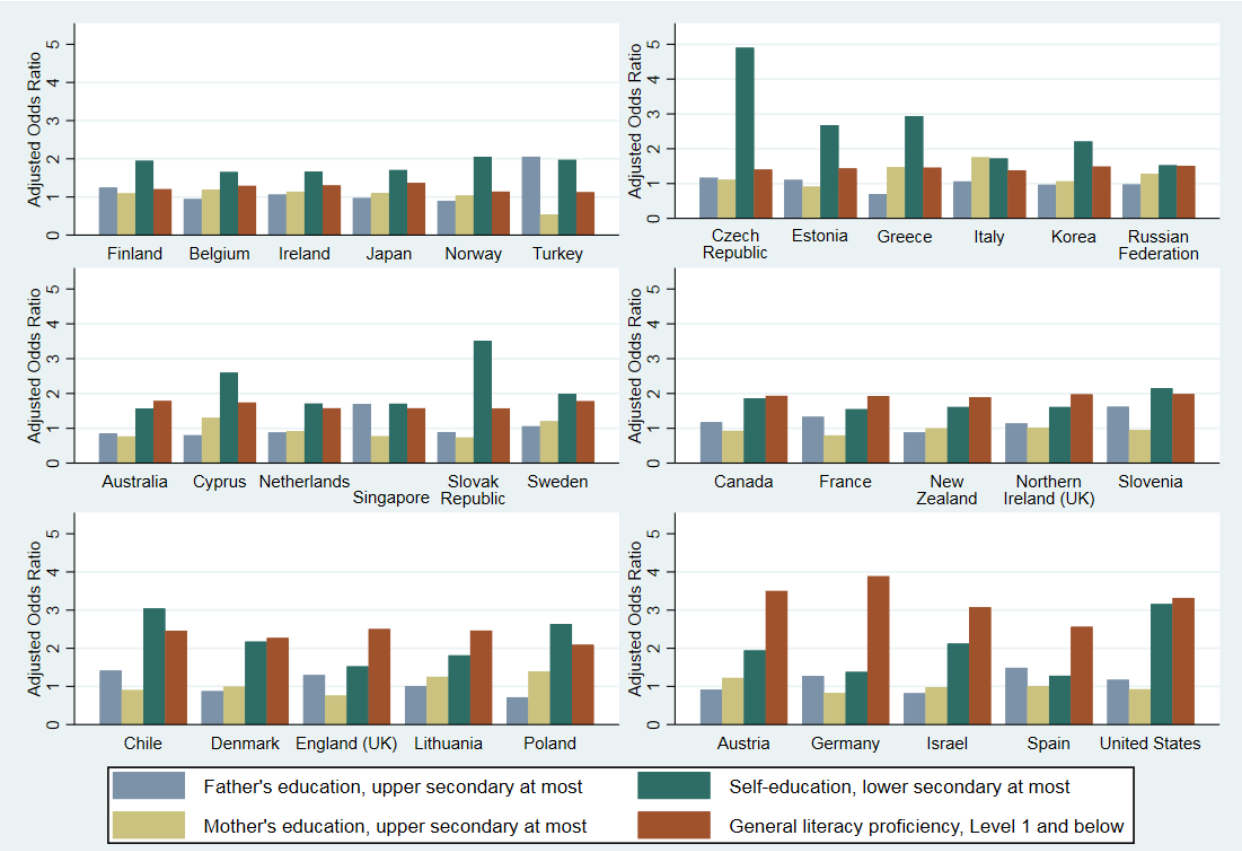
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Figure 3. Comparison of adjusted odds ratios for self-rated poor health for lowest level of parental education, self-education and general literacy proficiency in six high-income countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies survey (2011-2015)



Note: Adjusted for age, gender, employment status, income, country of birth, parental education, self-education and general literacy proficiency.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015)* www.oecd.org/skills/piaac/publicdataandanalysis.

Figure 4. Adjusted odds ratio for self-rated poor health in 33 high- and upper-middle-income countries and national sub-regions from the Programme for the International Assessment of Adult Competencies survey (2011-15)



Note: Adjusted for age, employment status, gender, income, country of birth, parental education, self-education and general literacy proficiency.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015)* www.oecd.org/skills/piaac/publicdataandanalysis.

Discussion

Our study has three key findings: First, we show that there is a strong and robust association across countries between general literacy proficiency and self-rated poor health, independent of self-education, parental education and income. Second, general literacy proficiency appears to account moderately-to-substantially for the association between self-education and self-rated poor health. Third, there is substantial heterogeneity across countries for the general literacy proficiency-self-rated poor health association, even after accounting for parental education, self-education and income. These key findings need to be considered alongside the following observations revealed through sensitivity analysis: a) The strength of the general literacy proficiency-self-rated

poor health association varies by country, but is robust over time; b) After taking parental education, self-education and income into account, there seems to be no association between general literacy-proficiency and self-rated poor health for young adults (ages 25 to 34 years), although the strength of the association remains stable from middle age (35 to 55 years) to old age (55 years and older); c) After taking parental education and income into account, the association between general literacy-proficiency and self-rated poor health is strongest for those with a self-education of tertiary or higher degree.

The study has the following data limitations. First, the cross-sectional study design does not allow us to establish a causal link between general literacy proficiency and self-rated poor health. However, except for younger age groups, it is unlikely that poor health leads to lower general literacy proficiency. Second, the PIAAC measures general literacy proficiency as it applies to engagement with written text, and this may not reflect an individual's ability to critically engage with and use information more generally to maximise health. Third, the association between general literacy proficiency and health may vary depending on the health condition being studied, (Wolf et al., 2010) and self-rated poor health may only differentially capture different health conditions. Finally, the PIAAC literacy assessment does not evaluate the ability to write or produce text, skills commonly falling within the definition of general literacy proficiency.

The objective measurement of general literacy proficiency using a standardised assessment is an important strength of the PIAAC. Previous studies have used various instruments to measure general literacy proficiency, including but not limited to the Wide Range Achievement Test (WRAT), Rapid Estimate of Adult Literacy in Medicine (REALM) and the Test of Functional Health Literacy in Adults (TOHFLA) (Dewalt et al., 2004). The first two assess word recognition only, while the TOHFLA assesses literacy and numeracy proficiency without being able to tease apart the difference between the two, and does so only in a health context. Furthermore, the TOHFLA only has face validity (Dewalt et al., 2004). In contrast, the PIAAC general literacy assessment measures general literacy proficiency as an individual's ability to understand, evaluate, use and engage with printed and digital written text in educational, work, personal and social contexts. The assessment of general literacy proficiency using digital text is especially relevant in the face of the information age. The PIAAC instrument has been rigorously tested for reliability across countries, (OECD, 2013) although its validity has been a subject of debate (Reder, 2011).

Our findings are critical from a policy perspective. Our study reveals a large degree of heterogeneity both within and across countries in the general literacy proficiency of individuals who obtained the same educational qualifications with important implications for their health. Such differences may be related to differences in the quality of the formal education and training individuals received, and to differences in the opportunities for skill development and consolidation individuals experienced after they completed formal education. While educational attainment tends to be relatively fixed over the life-course, general literacy proficiency can be enhanced by life-long learning opportunities and therefore presents policy makers with an important lever to reduce inequities in health. Additionally, from a monitoring perspective, it is critical that in survey-based assessments of skills health is considered as a factor that may influence general literacy proficiency, in addition to being an outcome of interest.

Conclusion

Our study confirms that low general literacy proficiency is associated with self-rated poor health, both independently and as a potential mediator of the effect of parental and self-educational attainment on health. This association is robust over time, consistent across countries and may vary in magnitude depending on contextual factors. Future studies are needed to establish causality and variance of this association across health conditions, and unpack the construct of general literacy further to establish what it is about general literacy proficiency that matters the most for health. Further research is also needed to explain between-country differences in the general literacy proficiency-self-rated poor health gradients.[9]

[9] The study was approved by the Institutional Review Board of the Harvard T.H. Chan School of Public Health. The authors declare that they have no conflict of interest.

References

Bauer, U.E., et al. (2014), "Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA", *The Lancet*, No. 384/9937, pp. 445-52, https://doi.org/10.1016/S0140-6736(14)60648-6

Berkman, N. D., S. L. Sheridan and K. E. Donahue (2011), "Low health literacy and health outcomes: An updated systematic review", *Annals of Internal Medicine*, 155/2, pp. 97-107, http://annals.org/article.aspx?articleid=747040.

Chatterji, P. (2014), "Education and health: Disentangling causal relationships from associations", in Culyer, A. J. (ed) *Encyclopaedia of Health Economics*, Elsevier, pp. 250-258. https://www.myscienceworks.com/publication/show/452b6829d7c208fba1d0d37088e3b4df.

Conti, G., J. Heckman and S. Urzua (2010), "The Education-Health Gradient." *Papers and Proceedings of the Annual Meeting of the American Economic Association*, American Economic Association 100/2, pp. 234–38, http://dx.doi.org/10.1257/aer.100.2.234.

Cutler, D. M. and A. Lleras-Muney (2006), "Education and Health: Evaluating Theories and Evidence", (No. w12352), National Bureau of Economic Research, http://www.nber.org/papers/w12352, accessed 25 February 2017.

Dewalt, D. A. et al. (2004), "Literacy and health outcomes: A systematic review of the literature" *Journal of General Internal Medicine,* Vol. 19/12, pp. 1228–39, http://dx.doi.org/10.1111/j.1525-1497.2004.40153.x.

van Doorslaer, E. and U. G. Gerdtham (2003), "Does inequality in self-assessed health predict inequality in survival by income?, Evidence from Swedish data.", *Social Science & Medicine* (1982), Vol. 57/9, pp. 1621–29, http://www.ncbi.nlm.nih.gov/pubmed/12948571.

Farmer, M. M., and K. F. Ferraro (1997), "Distress and perceived health: Mechanisms of health decline." *Journal of Health and Social Behavior,* Vol. 38/3, pp. 298-311, http://www.ncbi.nlm.nih.gov/pubmed/9343966.

Franks, P., M. R. Gold and K. Fiscella (2003), "Sociodemographics, self-rated poor health and mortality in the US." *Social Science & Medicine* (1982) Vol. 56/12, pp. 2505-14, http://www.ncbi.nlm.nih.gov/pubmed/12742613.

Idler, E. L, and Y. Benyamini (1997), "Self-rated health and mortality: A review of twenty-seven community studies", *Journal of Health and Social Behavior*, Vol. 38/1, pp. 21-37, http://www.ncbi.nlm.nih.gov/pubmed/9097506.

OECD (2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis.

OECD (2013), "*Technical Report of the Survey of Adult Skills (PIAAC)*", https://www.oecd.org/skills/piaac/_Technical Report_17OCT13.pdf, accessed 25 February 2017.

Reder, S. (2011), "Some Thoughts on IALS Measurement Validity, Program Impact, and Logic Models for Policy Development", The Centre for Literacy, Canada, accessed 25 February 2017, http://www.centreforliteracy.qc.ca/sites/default/files/Rederthinkpiece.pdf.

Satherley, P., E. Lawes and S. Sok (2008), *The Adult Literacy and Life Skills (ALL) Survey: Overview and International Comparisons*, http://ala.asn.au/public/docs/report/ALL_Overview_V2.pdf, Comparative Education Research Unit, Research Division, Ministry of Education, New Zealand., accessed 25 Feburary 2017.

Schleicher, A. (2008), "PIAAC: A new strategy for assessing adult competencies", *International Review of Education,* Vol. 54/5-6, pp. 627-650, https://doi.org/10.1007/s11159-008-9105-0.

UNESCO Institute for Statistics (2013), *International Standard Classification of Education 2011*, UNESCO-UIS, Montreal, CA.

Wolf, M. S. et al. (2010), "In search of 'low health literacy': threshold vs. gradient effect of literacy on health status and mortality", *Social Science & Medicine* (1982), Vol. 70/9, pp. 1335–41, http://dx.doi.org/10.1016/j.socscimed.2009.12.013.

Annex A. Review of literature

General literacy proficiency and health

There is no recent literature review that focuses exclusively on the association of general literacy with health. We conducted a literature review to evaluate this relationship. We excluded studies assessing 'health literacy' from this review, since we were interested in the effect of general literacy, and also because systematic reviews on health literacy already exist (Berkman et al., 2011). An initial search of the MEDLINE database using medical subject headings for general literacy and health status showed very few results. To broaden the scope of our search, we conducted a search in the Education Resources Information Center (ERIC) database, which is an online library of educational research and information, to identify instruments used to assess general literacy. These were then used as keywords for the PubMed search strategy. We also included keywords pertaining to 'reading' and 'English language proficiency' to further broaden the scope of our search (Box A A.1). Our search was restricted to peer-reviewed studies published in the English language.

Box A A.1. Search strategy

ERIC:

DE "Literacy" AND (DE "Measurement" OR DE "Testing" OR DE "Evaluation")

PubMed:

("Literacy"[Mesh] OR "National Adult Literacy Survey"[tw] OR "NALS"[tw] OR "Wide Range Achievement Test" [tw] OR "WRAT" [tw] OR "Woodcock Johnson Passage Comprehension" [tw] OR "Signature Time" [tw] OR "International Adult Literacy Survey" [tw] OR "Self-assessed literacy" [tw] OR "Self-rated literacy" [tw] OR "Adult Performance Level" [tw] OR "English Language Proficiency" [tw] OR "ELPS" [tw] OR "National Assessment of Education Progress" [tw] OR "NAEP" [tw] OR "National Chicano Survey" [tw] OR "Adult Basic Education" [tw] OR "TABE" [tw] OR "California Adult Student Assessment System" [tw] OR "CASAS" [tw] OR "Basic Reading Skills Mastery" [tw] OR "Reading/Everyday Activities in Life" [tw] OR "Adult Basic Learning Examination" [tw] OR "Basic Occupational Literacy Test" [tw] OR "General Educational Performance" [tw] OR "Reading Index" [tw] OR "Adult Basic Reading Inventory" [tw] OR "Harris Graded Word List" [tw] OR "Informal Textbook Test" [tw] OR "Individual Reading Placement Inventory" [tw] OR "Initial Testing Locator" [tw] OR "Reading Evaluation Adult Diagnosis" [tw] OR "Literacy Assessment and Monitoring Programme" [tw] OR "LAMP" [tw] OR "Comprehensive Adult Student Assessment System" [tw] OR "Wonderlic Basic Skills" [tw] OR "Test of Applied Literacy Skills" [tw] OR "Adult Literacy and Lifeskills" [tw] OR "International Adult Literacy Survey" [tw] OR "IALS" [tw] OR "Programme for the International Assessment of Adult Competencies" [tw] OR "PIAAC" [tw] OR "Reading ability" [tw] OR "Reading skill" [tw]) AND "Health Status"[Mesh]

Synthesis

Of the 65 articles found, 23 articles were found to be relevant for this review (Table A A.1) Study designs were predominantly cross-sectional (n=21), with one systematic review and one longitudinal cohort study. Most studies were conducted in developed countries (n=20), especially United States (n=14). Number of participants ranged from 120 to 123 639, with ages ranging from 16-84 years. Study populations were representative of general population (n=6), elderly (n=6), socially underprivileged groups viz. immigrants, uninsured, orphans (n=7), and health status based groups (n=6). Literacy was assessed about evenly using objective assessments (n=12) as well as self-reports (n=10). Outcomes assessed ranged from general self-rated health status (n=8), specific health outcomes (n=8), use of preventive and curative health services (n=4) and cognitive function (n=4).

General literacy proficiency and self-rated health

Three multi-country studies found a positive relationship between comprehensively assessed general literacy proficiency and better self-rated health, while one study found a similar relationship between simpler assessments of reading skills and self-rated health. Two out of three studies that assessed self-rated general literacy found a positive association with self-rated health.

General literacy proficiency and specific health outcomes

Two studies comprising a study population from four developing countries found a positive association between objectively assessed reading ability and better complementary feeding practices in mothers. One nationally representative study that comprehensively assessed general literacy skills found no association with long-term self-reported health conditions in England (United Kingdom). One study found that self-assessed English proficiency was a strong predictor of depression in Korean elderly in Arizona. Similarly, a study among Chinese and Korean elderly immigrants in the United States found that self-reported English language proficiency was related to six out of eight health outcomes. A nationally representative study in the United States found that higher objectively assessed general literacy skills were associated with lower odds of having a condition that keeps one from work, and completely accounted for race-based disparities within the same. A population-based prospective study in Dutch elderly found that lower scores on the Dutch Adult Reading Test (DART) predicted incident dementia better than low level of education.

General literacy proficiency and use of health services

A study in the United States among pregnant women and young mothers found that compared to women with adequate self-perceived English language proficiency, women with lower English language proficiency had lower odds of using the Internet to find health information and in general, of using email and social networking sites. Another study found that non-English speaking adolescents were less likely to continue community-based mental health visits, after accounting for socio-economic and clinical characteristics. A study in California, United States, found that among the uninsured, increasing distance to the nearest safety-net clinic was significantly associated with a lower probability of having a usual source of care and having a physician visit only among uninsured adults with self-reported limited English proficiency, but not among

those who reported themselves to English proficient. Similarly, another study found children with asthma who poorly proficient in English had higher odds of not having a usual source of care, even after accounting for age, poverty, insurance status, region of residence and health status.

General literacy proficiency and cognitive function

A multi-country study of community-dwelling older individuals (age >50 years) found that self-rated general literacy was more strongly associated with general literacy than education level, and that this association was stronger in older age groups. Two studies on cognition among United States elderly, and one study on HIV positive adults, respectively, found that reading score on the Wide Range Achievement Test-3 (WRAT-3) was consistently predictive of cognitive ability, after accounting for potential confounders including self-education.

Table A A.1. Literature review on general literacy skills and health

Journal year	2016
Author	Borgonovi et al. (Borgonovi and Pokropek, 2016)
Title	Education and Self-Reported Health: Evidence from 23 Countries on the Role of Years of Schooling, Cognitive Skills and Social Capital.
Countries	23 countries from the PIAAC Survey (2012)
Participants and sample size	N='123' 639; 25-65 year olds
Study design	23 OECD countries (PIAAC Survey)
Literacy measure	Standardised PIAAC literacy assessment
Outcome	Self-rated health
Confounders	Age, gender, employment status, number of books at home, having children, living with partner, immigrant status.
Conclusion	We find a strong positive relationship between self-reported health and literacy and in the majority of countries. A difference of one standard deviation in literacy scores is associated with a difference of 0.13 in self-reported health.
Journal year	2015
Author	Ickes et al. (Ickes, Hurst, and Flax, 2015)
Title	Maternal Literacy, Facility Birth, and Education Are Positively Associated with Better Infant and Young Child Feeding Practices and Nutritional Status among Ugandan Children
Countries	Uganda
Participants and sample size	2006 and 2011 Ugandan Demographic and Health Survey (DHS) data; all last-born singleton birth children ages 0–23 months with anthropometric data, and their mothers.
Study design	Cross-sectional
Literacy measure	Ability to read all or part of a simple sentence printed in all the major languages spoken in Uganda. Those with a secondary education or higher were assumed to be literate.
Outcome	1) Child complementary feeding practices in the 24 hours prior to interview, as reported by caregiver and 2) anthropometry.
Confounders	Maternal education , household wealth, delivery in health facility, maternal exposure to media, participation in household decisions, age of first birth, maternal employment, marital status, physical autonomy.
Conclusion	In 2006 data, maternal literacy was associated with greater likelihood of feeding children the minimum frequency [OR 1.9 (95% CI 1.3 to 2.7)], dietary diversity [OR 1.3 (95% CI 0.9 to 2.0)], iron rich foods [OR 1.6 (95% CI 1.1 to 2.4)], and minimum acceptable diet [OR 2.3 (95% CI 1.1 to 4.5)]. These findings were similar in magnitude, but not significant in 2011.In comparison, maternal education was not associated with any child feeding indicator in either survey year. Direction of association with maternal literacy consistently demonstrated a protective effect against malnutrition, but this was statistically significant only for being underweight in the 2006 data: OR 0.6 (95% CI 0.43 to 0.82). Maternal education and household wealth were consistent predictors of nutritional status.

Journal year	2015
Author	Issaka et al. (Issaka et al., 2015)
Title	Determinants of Suboptimal Complementary Feeding Practices Among Children Aged 6–23 Months In Four Anglophone West African Countries
Countries	Ghana, Liberia, Nigeria and Sierra Leone
Participants and sample size	12 623 children aged 6–23 months
Study design	Cross-sectional
Literacy measure	Ability to read all or part of a simple sentence.
Outcome	Child complementary feeding practices in the 24 hours prior to interview, as reported by mother.
Confounders	Step-wise regression that eliminated non-significant independent variables: Parental employment, parental education, mother's literacy, mother' age, maternal BMI, factors related to delivery, maternal access to media, household wealth, rural vs urban residence.
Conclusion	In Ghana, mother's illiteracy was associated with higher odds of non-introduction of solid, semi-solid or soft foods. [OR 3.5 (95% CI 1.1 to 12.0)]No significant association of outcome with maternal literacy seen for other countries.
Journal year	2015
Author	Moon et al. (Moon et al,. 2015)
Title	Towards An Understanding Of The Relationship Of Functional Literacy And Numeracy To Geographical Health Inequalities
Countries	England (United Kingdom)
Participants and sample size	4 871 non-institutionalised adults aged 16-65 years from the 2011 English Skills for Life Survey.
Study design	Cross-sectional multi-level analysis.
Literacy measure	Functional literacy defined as a dichotomous measure distinguishing individuals above or below the competency threshold of level 1, defined by the English Qualifications and Credit Framework.
Outcome	1) Odds of reporting good/ very good self-assessed health 2) Absence of self-reported long-term health conditions.
Confounders	Confounders: Age, sex, functional numeracy, individual socio-economic status, ethnicity, whether English was a first language, country of birth, housing tenure, geography. Mediators: index of deprivation, index of rurality.
Conclusion	Functional literacy (FL) is independently associated with self-assessed health status [OR 2.1 (95%CI 1.7 to 2.6)], though the association attenuated after taking account of confounders [OR 1.8 (95%CI 1.5 to 2.3)] and mediators [OR 1.5 (95%CI 1.2 to 1.9)]. For long-term conditions, the association with FL attenuated to non-significance following inclusion of confounders and mediators.

Journal year	2015
Author	Chilukuri et al. (Chilukuri et al., 2015)
Title	Information and Communication Technology Use Among Low-Income Pregnant and Postpartum Women by Race and Ethnicity: A Cross-Sectional Study.
Countries	United States
Participants and sample size	246 women recruited from hospital outpatient clinics who were aged 18 years or older and pregnant or within 1 year of delivery.
Study design	Cross-sectional
Literacy measure	Self-perceived English language proficiency.
Outcome	Information and communication technology (mobile phone/short message service [SMS] text message, Internet, and social network) use.
Confounders	Age, income, marital status, self-reported medical history, pregnancy status, insurance status.
Conclusion	Compared to women with adequate English language proficiency, women with lower English language proficiency were equally likely to SMS text message (OR 0.97, 95% CI 0.34-2.72), but had a lower likelihood of using the Internet (OR 0.20, 95% CI 0.08-0.47), email (OR 0.19, 95% CI 0.09-0.41), social networking (OR 0.27, 95% CI 0.13-0.57), Internet used to obtain health information (OR 0.27, 95% CI 0.13-0.56), and Internet used to find others with similar concerns (OR 0.08, 95% CI 0.02-0.28).
Journal year	2015
Author	Prins et al. (Prins and Monnat, 2015)
Title	Examining Associations between Self-Rated Health and Proficiency in Literacy and Numeracy among Immigrants and U.S.-Born Adults: Evidence from the Program for the International Assessment of Adult Competencies (PIAAC)
Countries	United States
Participants and sample size	5 010 U.S. respondents of the 2012 PIAAC Survey
Study design	Cross-sectional
Literacy measure	PIAAC literacy assessment
Outcome	Self-rated health
Confounders	Age, sex, immigrant status, race/ethnicity, household size, marital status, U.S. census region, presence of disability, health insurance, flu vaccination status, parental education self-education, employment status, income quintile, English proficiency.
Conclusion	In the unadjusted model, a 10-point increase in literacy was associated with about 11% greater odds of being in a better SRH category. In the fully adjusted model, a 10-point increase in literacy was associated with about 3% greater odds of being in a better SRH category (95% CI = 1.00– 1.05, p = 0.02).

Journal year	2015
Author	Goodman et al. (Goodman et al., 2015)
Title	How Can We Improve Healthcare Access And General Self-Rated Health Among Orphans And Vulnerable Children? Findings From A Kenyan Cross-Sectional Study
Countries	Kenya
Participants and sample size	n = 707 families participating in a programme designed to empower orphan and vulnerable children (OVC)
Study design	Cross-sectional
Literacy measure	Ability to read two simple sentences in the local language and were dichotomised as either being able to read all of both sentences (literate) or only able to read some or none of both sentences (not-literate)
Outcome	Excellent/very good general self-rated health (GSRH)
Confounders	Age, programme participation, income, educational costs, food security.
Conclusion	Respondents who were literate had odds of higher GSRH that were nearly twice those of respondents who could not read all of two simple sentences.
Journal year	2014
Author	Lunze et al. (Lunze and Paasche-Orlow, 2014)
Title	Limited Literacy and Poor Health: The Role of Social Mobility in Germany and the United States
Countries	Germany and the United States
Participants and sample size	PIAAC survey participants from Germany and United States
Study design	Cross-sectional
Literacy measure	PIAAC Literacy Assessment
Outcome	Self-rated health
Confounders	Age, gender, educational attainment, immigrant and language background.
Conclusion	The literacy–health relationship may be due to deep-rooted educational stratification that exists in these countries (United States and Germany) and may reflect layers of disempowerment that are not easily removed.

Journal year	2014
Author	Fransen et al. (Fransen et al., 2014)
Title	Self-rated literacy level does not explain educational differences in health and disease.
Countries	United Kingdom
Participants and sample size	N='4257;' 25-75 year olds
Study design	Cross-sectional
Literacy measure	Self-rated literacy, defined as self-reported confidence in reading written English
Outcome	Self-rated health, long term conditions (illness, disability, infirmity)
Confounders	Age, ethnicity, gender, educational level
Conclusion	Self-rated reading skills DOES NOT contribute significantly to the explanation of educational differences in health and disease
Journal year	2012
Author	Kave et al. (Kave et al., 2012)
Title	Formal Education Level Versus Self-Rated Literacy as Predictors of Cognitive Aging
Countries	Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, The Netherlands, Spain, Sweden and Switzerland
Participants and sample size	Representative sample of 28 535 community-dwelling older individuals (= 50), participating in the Survey of Health, Ageing, and Retirement in Europe.
Study design	Cross-sectional
Literacy measure	Self-rated literacy (reading and writing)
Outcome	Cognitive functioning (measured by verbal recall, word fluency, and arithmetic ability).
Confounders	Age, sex, education level, household income, medical conditions, activities of daily living, reading eyesight, and country of origin.
Conclusion	Self-rated literacy was more strongly associated with cognitive functioning than was education level, and this association was stronger in older age groups.

Journal year	2012
Author	Aratani et al. (Aratani and Cooper, 2012)
Title	Racial and Ethnic Disparities in the Continuation of Community-Based Children's Mental Health Services
Countries	California, United States
Participants and sample size	Individuals under 25 years of age from 2004–2006 California Department of Mental Health's (DMH) Consumer and Services Information (CSI) system
Study design	Cross-sectional
Literacy measure	Individuals were classified as English speakers and non-English speakers based on the primary language used by the service user at the first visit.
Outcome	Continuation of the community-based mental services, defined as 'returning to the mental health service facility after one session'
Confounders	Age, gender, income, race/ethnicity, county characteristics, clinical characteristics
Conclusion	Non-English speakers were found to be 38% less likely to continue community-based mental health visits (OR 0.62, 95% CI 0.58-0.66) than English speakers, after accounting for socioeconomic and clinical characteristics
Journal year	2011
Author	Fazeli et al. (Fazeli et al., 2011)
Title	Predictors of Cognition in Adults with HIV: Implications for Nursing Practice and Research
Countries	Alabama, United States
Participants and sample size	98 HIV positive adults. Non-English speakers were excluded
Study design	Cross-sectional
Literacy measure	Wide Range Achievement Test-3 reading score subtest
Outcome	Cognitive measures: speed of processing, psychomotor speed, visuomotor co-ordination, attention, working memory, reasoning and executive functioning,
Confounders	Age, gender, socioeconomic status, mood disturbance score, medical problems composite, CD4+ lymphocyte cell count, years with HIV, HIV medication usage, social networks, hardiness, psychoactive drug use
Conclusion	Those who had poorer reading scores had worse performance across all cognitive domains. Reading scores were the most consistent predictors of cognitive performance after adjusting for confounders?

Journal year	2011
Author	Cordasco et al. (Cordasco et al., 2011)
Title	English Language Proficiency and Geographical Proximity to a Safety Net Clinic as a Predictor of Health Care Access
Countries	California, United States
Participants and sample size	2 740 uninsured, non-pregnant, urban subjects from the 2005 California Health Interview Survey
Study design	Cross-sectional
Literacy measure	Self-reported English language proficiency
Outcomes	1) Having a usual source of care 2) Having at least one physician visit in the past 12 months
Confounders	Sociodemographic characteristics, employment, household characteristics, spousal insurance status, health characteristics, census tract characteristics, community health care availability, spouse insurance status
Conclusion	Increasing distance to the nearest safety-net clinic was significantly associated with a lower probability of having a usual source of care and having a physician visit among uninsured adults with limited English proficiency. By contrast, distance to the nearest safety-net clinic was not associated with having a usual source of care among English proficient uninsured adults.
Journal year	2010
Author	Zoraster (Zoraster, 2017)
Title	Vulnerable Populations: Hurricane Katrina as a Case Study
Countries	United States
Participants and sample size	N/A
Study design	Systematic review
Literacy measure	N/A
Outcomes	N/A
Confounders	N/A
Conclusion	Language barrier was a socio-economic risk factor resulting in higher vulnerability to the impact of hurricane Katrina, especially evacuation efforts.

Journal year	2009
Author	Walton et al. (Walton et al., 2009)
Title	Does Place of Education Matter? Contextualizing the Education and Health Status Association Among Asian Americans
Countries	United Stated
Participants and sample size	2 095 Asian American respondents aged 25 years and older from the 2002 National Latino and Asian American Study
Study design	Cross-sectional
Literacy measure	Self-reported English language proficiency
Outcomes	Good self-rated health
Confounders	Age, gender, educational attainment, place of education (foreign education versus U.S. education.), ethnicity, marital status, household income, social support
Conclusion	English language proficiency is a profound mediator of the effect of education on health in those with a foreign-education, and completely negates its detrimental effect.
Journal year	2009
Author	Kang et al. (Kang, Domanski and Moon, 2009)
Title	Ethnic Enclave Resources and Predictors of Depression Among Arizona's Korean Immigrant Elders
Countries	Arizona, United States
Participants and sample size	120 Korean immigrant elders, aged 64 and over, not living in nursing homes or assisted facilities
Study design	Cross-sectional
Literacy measure	Self-assessment of ability to read, write, and speak English
Outcomes	Depression, measured using the standardised Geriatric Depression Scale (GDS)
Confounders	Sociodemographic variables, degree of acculturation, perceived self-rated health, number of medical conditions, social support
Conclusion	English language proficiency had the most powerful effect on explaining depression in Korean elderly in Arizona

Journal year	2008
Author	Gordon et al. (Gordon and Iribarren, 2008)
Title	Health-related characteristics and preferred methods of receiving health education according to dominant language among Latinos aged 25 to 64 in a large Northern California health plan
Countries	Northern California, United States
Participants and sample size	1 086 Latino men and women aged 25–64 differed among members of a large Northern California health plan.
Study design	Cross-sectional
Literacy measure	Language proficiency classified as English-dominant, Spanish-dominant and bilingual based on self-reported information and insurance data
Outcomes	Health status (general self-rated health, emotional health and other specific health conditions)
Confounders	Age, gender , education
Conclusion	Spanish dominant Latinos were less likely than English dominant Latinos to rate overall health and emotional well-being as good, very good, or excellent.
Journal year	2007
Author	Mui et al. (Mui et al., 2007)
Title	English Language Proficiency and Health-Related Quality of Life among Chinese and Korean Immigrant Elders
Countries	United States
Participants and sample size	105 Chinese and 100 Korean elderly immigrants from the Asian American Elders in New York City survey
Study design	Cross-sectional
Literacy measure	
Outcomes	Health status measured using SF-36 Health Survey
Confounders	Sociodemographic factors, coping resources, life stressors
Conclusion	English-language proficiency was related to 6 out of 8 health-related quality of life outcomes (general health, mental health, social functioning, physical functioning, physical limitations and vitality)

Journal year	2007
Author	Baird et al. (Baird, Ford and Podell, 2007)
Title	Ethnic differences in functional and neuropsychological test performance in older adults
Countries	United States
Participants and sample size	54 African American and 85 European American elders, suffering from cognitive impairment
Study design	Cross-sectional
Literacy measure	Wide Range Achievement Test 3 Reading subtest
Outcomes	Cognitive ability measured through several tests
Confounders	Age, general cognitive impairment, formal education
Conclusion	African Americans had lower scores than European Americans on measures of confrontation naming, visual pattern matching, and money related skills and knowledge. These differences were eliminated or reduced when we adjusted scores for oral word reading, which also was lower in the African American group
Journal year	2006
Author	Sentell et al. (Sentell and Halpin, 2006)
Title	Importance of Adult Literacy in Understanding Health Disparities
Countries	United States
Participants and sample size	Nationally representative sample of 23 889 noninstitutionalised U.S. adults. (1992 National Adult Literacy Survey)
Study design	Cross-sectional
Literacy measure	Ability to perform everyday tasks of various levels of difficulty in 3 skill domains: prose, document, and quantitative (Measured on a continuous scale and classified across 5 levels)
Outcomes	Poor health status, measured as 1) presence of a work-impairing condition and 2) a long-term illness
Confounders	Sex, age, employment status, family income, income non-responder, marital status, receipt of food stamps, living in a metropolitan statistical area (MSA), census region, English language proficiency, and being born in the United States
Conclusion	Literacy was significantly associated with having a condition that keeps one from work when other factors were controlled (OR, 0.90; CI, 0.88 to 0.92). Once literacy was included, African-American race no longer predicted having a condition that keeps one from work; the OR decreased 32% to 1.04 (CI, 0.85 to 1.26). The education variable also lost explanatory power, with the OR ratio changing 32% to a nonsignificant 0.99 (CI, 0.90 to 1.09).A 10-point increment in literacy score was significantly associated with having a long-term illness when other factors were controlled (OR, 0.96; CI, 0.94 to 0.98), and literacy's inclusion reduced the OR of African-American race from 14% to 1.07 (CI, 0.89 to 1.30). Education also lost statistical significance, with the OR decreasing from 11% to 0.93 (CI, 0.85 to 1.02).

Journal year	2006
Author	Greek et al. (Greek et al., 2006)
Title	Family Perceptions of the Usual Source of Care among Children with Asthma by Race/Ethnicity, Language, and Family Income
Countries	United States
Participants and sample size	2 100 children with asthma aged 0-17 years from the 1996–2000 Medical Expenditure Panel Survey (MEPS) Household Component
Study design	Cross-sectional
Literacy measure	Self-reported preference of language of interview (English vs requiring bilingual interviewers)
Outcomes	Having a usual source of care
Confounders	Age, poverty status index, child's medical insurance status, health status, region of residence, residence in a Metropolitan Statistical Area (MSA)
Conclusion	There were significant differences in USC attributes by race/ethnicity, language, and income, with the largest differences by type of provider and accessibility. Hispanics with poor English language proficiency had the highest odds of not having a USC [OR 2.71 (95%CI 1.17–6.27)
Journal year	1999
Author	Albert et al. (Albert and Teresi, 1999)
Title	Reading ability, education, and cognitive status assessment among older adults in Harlem, New York City
Countries	New York City, United States
Participants and sample size	164 elders (ages 65+) from the Harlem Household Survey
Study design	Cross-sectional
Literacy measure	Wide Range Achievement Test- Revised (WRAT- R), Level 1
Outcomes	Cognitive Status, measured using Mini Mental State Examination (MMSE) score as a dichotomous outcome
Confounders	Educational attainment
Conclusion	Relative to subjects scoring above the median on both measures, the odds ratio was 5.0 (95% confidence interval [CI] = 1.4, 17.7) for subjects with low education only, 5.6 (95% CI= 1.6, 18.7) for subjects with low reading ability only, and 12.7 (95% CI = 4.1, 52.5) for subjects scoring below the median on both measures.

Journal year	1997
Author	Schmand et al. (Schmand et al., 1997)
Title	The effects of intelligence and education on the development of dementia. A test of the brain reserve hypothesis
Countries	
Participants and sample size	Population based sample of elderly subjects (N='2063;' age range 65-84; Amsterdam Study of the Elderly)
Study design	Longitudinal study with 4 year follow-up
Literacy measure	Dutch Adult Reading Test (DART)
Outcomes	Incident dementia, diagnosed using the Geriatric Mental State examination (GMS).
Confounders	Age, gender, years of education, occupational level, no of subordinates, no of diseases, family history of dementia
Conclusion	Low DART-IQ predicted incident dementia [OR 0.61 (95% CI 0.41-0.91)] better than low level of education [OR 0.86 (95% CI 0.57-1.31)

Notes: CD4+: cluster of differentiation 4; CI: confidence interval; CSI: consumer and services information; DART: Dutch Adult Reading Test; DHS: Demographic Health Survey; DMD: Department of Mental Health; FL: functional literacy; GDS: Geriatric Depression Scale; GMS: Geriatric Mental State Examination; GSRH: general self-rated health; HIV: human immunodeficiency virus; IQ: Intelligence Quotient; MEPS: Medical expenditure panel survey; MMSE: Mini Mental State Examination; MSA: Metropolitan Statistical Area; OECD: Organisation for Economic Co-operation and Development; OR: Odds Ratio; OVC: orphan and vulnerable children; PIAAC: Programme for the International Assessment of Adult Competencies; SMS: short message service; SRH: Self-rated health; US: the United States; USC: usual source of care; WRAT: Wide Range Achievement Test; WRAT-R: Wide Range Achievement Test-Revised.

References

Albert, S. M. and J. A. Teresi (1999), "Reading ability, education, and cognitive status assessment among older adults in Harlem, New York City", *American Journal of Public Health,* Vol.89/1, pp. 95–97, http://www.ncbi.nlm.nih.gov/pubmed/9987476.

Aratani, Y. and J. L. Cooper (2012), "Racial and ethnic disparities in the continuation of community-based children's mental health services", *The Journal of Behavioral Health Services & Research,* Vol. 39/2, pp. 116–29, http://dx.doi.org/10.1007/s11414-011-9261-z.

Baird, A., M. Ford and K. Podell (2007), "Ethnic differences in functional and neuropsychological test performance in older adults", *Archives of Clinical Neuropsychology,* Vol. 22/3, pp. 309–18, http://dx.doi.org/10.1016/j.acn.2007.01.005.

Berkman, N. D., S. L. Sheridan and K. E. Donahue (2011), "Low health literacy and health outcomes: An updated systematic review", *Annals of Internal Medicine*, 155/2, pp. 97-107, http://annals.org/article.aspx?articleid=747040.

Borgonovi, F. and A. Pokropek (2016), "Education and Self-Reported Health: Evidence from 23 Countries on the Role of Years of Schooling, Cognitive Skills and Social Capital." Edited by Joshua L Rosenbloom. PLOS ONE 11 (2): http://dx.doi.org/e0149716. doi:10.1371/journal.pone.0149716.

Chilukuri, N. et al. (2015), "Information and communication technology use among low-income pregnant and postpartum women by race and ethnicity: A cross-sectional study", *Journal of Medical Internet Research,* Vol. 17/7, http://dx.doi.org/e163. doi:10.2196/jmir.3916.

Cordasco, K. et al. (2011), "English language proficiency and geographical proximity to a safety net clinic as predictor of health care access", *Journal of Immigrant and Minority Health*, Vol. 13/2, pp. 260-67, http://dx.doi.org/10.1007/s10903-010-9425-6.

Fazeli, P. L. et al. (2011), "Predictors of cognition in adults with HIV: Implications for nursing practice and research", *The Journal of Neuroscience Nursing : Journal of the American Association of Neuroscience Nurses,* Vol. 43/1, pp. 36-50, http://www.ncbi.nlm.nih.gov/pubmed/21338043.

Fransen, M. P., G. R., K. Ef Leenaars and M. L. Essink-Bot (2014), "Self-rated literacy level does not explain educational differences in health and disease", *Archives of Public Health = Archives Belges de Sante Publique* Vol. 72/1, pp. 14, http://dx.doi.org/10.1186/2049-3258-72-14.

Goodman, M. L., et al. (2015), "How can we improve healthcare access and general self-rated health among orphans and vulnerable Children? Findings from a Kenyan cross-sectional study", *International Journal of Public Health,* Vol. 60/5, pp. 589–97, http://dx.doi.org/10.1007/s00038-015-0681-z.

Gordon, N. P. and C. Iribarren (2008), "Health-related characteristics and preferred methods of receiving health education according to dominant language among Latinos aged 25 to 64 in a large northern California health plan", *BMC Public Health* Vol. 8/1, pp. 305, http://dx.doi.org/10.1186/1471-2458-8-305.

Greek, A. A., et al. (2006), "Family perceptions of the usual source of care among children with asthma by race/ethnicity, language, and family income", *Journal of Asthma,* Vol. 43/1, pp. 61–69, http://dx.doi.org/10.1080/02770900500448639.

Ickes, S. B., T. E. Hurst and V. L. Flax (2015), "Maternal literacy, facility birth and education are positively associated with better infant and young child feeding practices and nutritional status among Ugandan children", *The Journal of Nutrition,* Vol. 145/11, pp. 2578-86, http://dx.doi.org/10.3945/jn.115.214346.

Issaka, A., et al. (2015), "Determinants of suboptimal complementary feeding practices among children aged 6-23 months in four Anglophone West African countries", *Maternal & Child Nutrition 11* (October), pp.14–30, http://dx.doi.org/10.1111/mcn.12194.

Kang, S. Y., M. Dietz Domanski and S. S. Moon (2009), "Ethnic enclave resources and predictors of depression among Arizona's Korean immigrant elders", *Journal of Gerontological Social Work*, Vol. 52/5, pp. 489-502, http://dx.doi.org/10.1080/01634370902983153.

Kavé, G., et al. (2012), "Formal education level versus self-rated literacy as predictors of cognitive aging", *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* Vol. 67/ 6, pp. 697-704, http://dx.doi.org/10.1093/geronb/gbs031.

Lunze, K. and M. K. Paasche-Orlow (2014), "Limited literacy and poor health: The role of social mobility in Germany and the United States", *Journal of Health Communication,* Vol. 19/2, pp. 15–18, http://dx.doi.org/10.1080/10810730.2014.946115.

Moon, G., G. Aitken, P. Roderick, S. Fraser and G. Rowlands (2015), "Towards an understanding of the relationship of functional literacy and numeracy to geographical health inequalities", *Social Science & Medicine* (1982), Vol. 143 (October), pp. 185-93, http://dx.doi.org/10.1016/j.socscimed.2015.08.045.

Mui, A. C. et al. (2007), "English language proficiency and health related quality of life among Chinese and Korean immigrant elders", *Health & Social Work*, Vol. 32/2, pp. 119-27, http://www.ncbi.nlm.nih.gov/pubmed/17571645.

Prins, E. and S. Monnat (2015), "Examining associations between self-rated health and proficiency in literacy and numeracy among immigrants and U.S.-born adults: Evidence from the Programme for the International Assessment of Adult Competencies (PIAAC)", Edited by Kimon Divaris. PloS One, Vol. 10/7, http://dx.doi.org/e0130257. doi:10.1371/journal.pone.0130257.

Schmand, B., et al. (1997), "The effects of intelligence and education on the development of dementia. A test of the brain reserve hypothesis," *Psychological Medicine*, Vol. 27, No. 6, pp. 1337-44, http://www.ncbi.nlm.nih.gov/pubmed/9403905.

Sentell, T. L. and H. A. Halpin. (2006), "Importance of adult literacy in understanding health disparities*", Journal of General Internal Medicine,* Vol. 21/8, pp. 862-66, http://dx.doi.org/10.1111/j.1525-1497.2006.00538.x.

Walton, E., et al. (2009), "Does place of education matter? Contextualizing the education and health status association among Asian Americans", *Biodemography and Social Biology,* Vol. 55/1, pp. 30-51 , http://dx.doi.org/10.1080/19485560903054648.

Zoraster, R. M. (2017), "Vulnerable populations: Hurricane Katrina as a case study", *Prehospital and Disaster Medicine*, Vol. 25/1, pp. 74-78, accessed 26 February 2017, http://www.ncbi.nlm.nih.gov/pubmed/20405467.

Annex B. Supplementary tables and figures

Table A B.1. Interpretation of general literacy proficiency levels in the Programme for the International Assessment of Adult Competencies (2011-2015) assessment

General literacy proficiency	Score range on the continuous scale	Interpretation
Below Level 1	Below 176 points	The tasks at this level require the respondent to read brief texts on familiar topics to locate a single piece of specific information. Only basic vocabulary knowledge is required, and the reader is not required to understand the structure of sentences or paragraphs or make use of other text features. Tasks do not make use of any features specific to digital texts.
Level 1	176 to less than 226 points	Most of the tasks at this level require the respondent to read relatively short digital or print continuous, non-continuous or mixed texts to locate a single piece of information which is identical to or synonymous with the information given in the question or directive. Some tasks may require the respondent to enter personal information into a document, in the case of some non-continuous texts. Little, if any, competing information is present. Some tasks may require simple cycling through more than one piece of information. Knowledge and skill in recognising basic vocabulary, evaluating the meaning of sentences, and reading of paragraph text is expected.
Level 2	226 to less than 276 points	At this level, the complexity of text increases. The medium of texts may be digital or printed, and texts may comprise continuous, non-continuous or mixed types. Tasks in this level require respondents to make matches between the text and information, and may require paraphrase or low-level inferences. Some competing pieces of information may be present. Some tasks require the respondent to: • cycle through or integrate two or more pieces of information based on criteria, • compare and contrast or reason about information requested in the question, or • navigate within digital texts to access and identify information from various parts of a document.
Level 3	276 to less than 326 points	Texts at this level are often dense or lengthy, including continuous, non-continuous, mixed or multiple pages. Understanding text and rhetorical structures become more central to successfully completing tasks, especially in navigation of complex digital texts. Tasks require the respondent to identify, interpret or evaluate one or more pieces of information and often require varying levels of inferencing. Many tasks require the respondent construct meaning across larger chunks of text or perform multistep operations in order to identify and formulate responses. Often tasks also demand that the respondent disregard irrelevant or inappropriate text content to answer accurately. Competing information is often present, but it is not more prominent than the correct information.
Level 4	326 to less than 376 points	Tasks at this level often require respondents to perform multiple-step operations to integrate, interpret, or synthesise information from complex or lengthy continuous, noncontinuous, mixed, or multiple type texts. Complex inferences and application of background knowledge may be needed to perform successfully. Many tasks require identifying and understanding one or more specific, non-central ideas in the text in order to interpret or evaluate subtle evidence claim or persuasive discourse relationships. Conditional information is frequently present in tasks at this level and must be taken into consideration by the respondent. Competing information is present and sometimes seemingly as prominent as correct information.
Level 5	Equal to or more than 376 points	At this level, tasks may require the respondent to search for and integrate information across multiple, dense texts; construct syntheses of similar and contrasting ideas or points of view; or evaluate evidence-based arguments. Application and evaluation of logical and conceptual models of ideas may be required to accomplish tasks. Evaluating reliability of evidentiary sources and selecting key information is frequently a key requirement. Tasks often require respondents to be aware of subtle, rhetorical cues and to make high-level inferences or use specialised background knowledge.

Source: OECD (2013), *Technical Report of the Survey of Adult Skills (PIAAC),* https://www.oecd.org/skills/piaac/_Technical Report_17OCT13.pdf, accessed 25 February 2017.

Table A B.2. Mean general literacy proficiency in 33 high- and upper-middle-income countries from the Programme for the International Assessment of Adult Competencies survey (2011-2015), by country and self-education

Country name	Self-education			
	Lower secondary at most	Upper secondary	Tertiary	Difference between adults with tertiary and adults with lower than upper secondary
Australia	248 (1.5)	278 (1.6)	303 (1.2)	55
Austria	239 (2.1)	268 (0.9)	296 (1.4)	57
Canada	219 (2.1)	265 (1.1)	290 (0.8)	71
Chile	177 (1.8)	219 (1.7)	254 (2.6)	77
Czech Republic	242 (3.4)	269 (1)	302 (2.3)	60
Denmark	234 (2.1)	264 (1.2)	292 (1.1)	58
England (UK)	241 (1.6)	273 (1.5)	296 (1.5)	54
Estonia	244 (2)	267 (1)	289 (1)	46
Finland	245 (2.8)	276 (1.4)	309 (1.1)	64
Flanders (Belgium)	232 (2)	265 (1.2)	302 (1.2)	70
France	224 (1.3)	258 (0.9)	294 (0.9)	70
Germany	220 (3)	262 (1.1)	293 (1.3)	73
Greece	235 (2.3)	254 (1.7)	273 (2.2)	38
Ireland	232 (1.8)	266 (1.5)	292 (1.3)	60
Israel	201 (2.6)	241 (1.5)	275 (1.2)	74
Italy	231 (1.6)	263 (1.3)	281 (1.6)	50
Japan	260 (2.6)	287 (1)	313 (0.9)	53
Korea	230 (1.7)	265 (1)	291 (0.9)	61
Netherlands	246 (1.7)	283 (1.3)	310 (1.3)	64
New Zealand	247 (2.1)	278 (1.5)	299 (1.1)	51
Northern Ireland (UK)	239 (2.6)	270 (2.6)	295 (2.6)	57
Norway	251 (1.8)	271 (1.4)	301 (0.9)	49
Poland	227 (2.6)	254 (1)	297 (1.3)	70
Slovak Republic	238 (1.9)	275 (0.9)	295 (1.4)	58
Slovenia	218 (2)	252 (1.3)	286 (1.3)	68
Spain	225 (1.3)	258 (1.4)	282 (1.2)	57
Sweden	238 (2.2)	277 (1.2)	305 (1.2)	67
Turkey	210 (1.7)	245 (1.6)	258 (1.6)	48
United States	211 (2.7)	259 (1.4)	297 (1.5)	87
Cyprus	248 (1.9)	266 (1.2)	284 (1.3)	35
Lithuania	244 (3.5)	256 (1.2)	286 (1.4)	41
Russian Federation	248 (7.5)	272 (4.2)	279 (2.7)	31
Singapore	185 (2.1)	238 (1.3)	288 (1.2)	103
OECD average	**231 (0.4)**	**264 (0.3)**	**292 (0.3)**	**61**

Note: See note 1 for Cyprus. See note 2 for the Russian Federation.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Table A B.3. Proportion of self-rated poor health, by socio-demographic characteristics in the Programme for the International Assessment of Adult Competencies Survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015)

Country name	Age group (%)				Gender (%)		Employed (%)		Born in the country (%)	
	25 to 34	35 to 44	45 to 55	55+	Men	Women	Yes	No	Native-born	Foreign-born
Australia	10.6	13.9	16.6	23.0	15.6	16.0	11.1	31.2	16.2	16.0
Austria	0.00	11.2	23.4	29.6	17.8	18.5	12.9	36.0	18.1	20.2
Canada		8.2	12.9	18.8	11.7	11.6	7.6	27.0	11.3	12.9
Chile	22.0	0.0	45.1	55.4	29.2	42.3	30.7	56.1	36.5	20.5
Czech Republic	3.6	6.5	15.8	25.9	12.5	13.1	5.7	31.8	12.8	14.4
Denmark	10.7	15.7	20.8	26.2	18.0	19.4	12.1	41.1	18.6	20.1
England (UK)	8.9	12.9	18.7	23.7	16.1	15.8	10.2	33.9	16.8	12.8
Estonia	15.7	27.4	51.0	65.7	38.9	40.1	32.7	64.1	36.6	57.0
Finland	8.5	11.0	19.9	35.8	22.6	17.5	13.4	41.3	20.1	20.5
Flanders (Belgium)	7.3	11.7	17.6	20.1	13.9	15.5	11.0	30.9	15.3	18.2
France	9.6	15.3	23.7	33.8	19.5	22.5	15.7	34.2	20.6	25.0
Germany	4.5	10.5	14.3	20.0	11.1	14.0	9.0	27.2	11.9	17.5
Greece	4.6	9.2	14.4	27.4	11.2	16.4	9.7	18.8	13.5	18.2
Ireland	5.6	10.7	15.6	22.9	12.3	13.2	6.0	25.8	13.5	10.3
Israel	4.7	11.1	23.7	34.8	17.0	16.6	12.3	32.8	14.1	26.5
Italy	6.0	13.0	22.4	39.0	16.1	23.8	13.1	31.7	20.8	14.3
Japan	19.1	24.5	31.1	35.4	28.0	27.8	26.5	33.7	28.2	
Korea	39.6	51.2	57.9	68.3	47.5	59.9	49.9	65.2	54.0	40.5
Netherlands	10.7	16.3	20.2	29.2	17.3	21.6	14.0	41.0	18.1	31.2
New Zealand	10.1	11.0	12.2	16.3	12.3	12.5	9.1	27.4	13.8	10.0
Northern Ireland (UK)	9.3	16.2	24.1	29.9	17.5	21.4	8.9	45.9	20.6	11.7
Norway	12.4	11.9	19.3	29.0	16.7	19.3	12.3	48.1	18.6	17.7
Poland	6.0	11.2	26.8	46.9	21.8	22.9	12.4	42.7	22.4	
Slovak Republic	6.3	13.1	27.4	46.0	20.6	24.6	14.4	40.1	22.3	34.4
Slovenia	5.8	11.8	24.3	36.2	17.9	21.9	12.3	34.3	19.8	21.1
Spain	9.1	15.8	27.2	43.6	21.2	25.5	17.2	34.3	24.7	16.5
Sweden	10.1	13.7	18.3	25.0	14.8	19.4	11.9	38.7	16.2	21.1
Turkey	15.9	26.0	33.3	53.8	25.0	33.8	21.0	37.8	30.1	
United States	9.5	13.6	17.9	22.8	14.9	16.9	10.7	35.9	16.4	17.7
Cyprus	4.2	9.2	13.6	25.0	9.0	15.0	9.6	29.2	16.0	9.9
Lithuania	16.3	23.9	42.0	62.7	33.4	40.3	29.8	61.3	38.8	42.4
Russian Federation	29.6	36.6	54.9	73.6	42.8	52.5	41.5	59.5	47.8	48.8
Singapore	18.9	21.5	29.6	36.3	25.8	27.2	24.9	34.9	28.9	21.0
OECD Average	**10.4**	**15.5**	**24.0**	**33.9**	**19.3**	**22.2**	**15.0**	**37.6**	**20.8**	**22.3**

Note: See note 1 for Cyprus. See note 2 for the Russian Federation.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Table A B.4. Proportion of self-rated poor health, by parental education, self-education and general literacy proficiency categories in the Programme for the International Assessment of Adult Competencies Survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015)

Country name	Father's education		Mother's education		Self-education			General literacy proficiency			
	Tertiary or higher (%)	Upper secondary at most (%)	Tertiary or higher (%)	Upper secondary at most (%)	Tertiary	Upper secondary	Lower secondary at most	Level 1 and below	Level 2	Level 3	Level 4/5
Australia	13.3	15.8	13.5	15.8	10.2	16.3	23.9	28.7	17.9	13.3	10.1
Austria	13.4	0.00	8.2	19.1	9.8	16.9	32.5	33.7	20.8	12.2	5.5
Canada	7.1		7.6	12.3	7.7	13.1	26.0	21.5	13.2	8.4	5.3
Chile	0.0	37.1	19.7	36.4	14.9	32.4	58.9	47.4	23.5	13.6	
Czech Republic	6.5	13.3	3.3	13.4	4.0	12.6	32.6	19.3	15.7	10.2	3.4
Denmark	13.8	20.1	12.3	20.3	10.5	19.1	35.2	35.7	21.0	12.4	8.2
England (UK)	9.4	17.4	10.7	16.4	10.5	14.9	26.3	28.4	18.2	12.3	7.8
Estonia	27.2	42.2	25.4	43.3	28.5	44.9	58.3	56.1	45.8	33.0	22.4
Finland	9.9	21.3	10.1	21.0	10.9	23.2	38.2	37.2	27.2	15.8	9.6
Flanders (Belgium)	10.2	16.2	8.4	16.1	9.9	16.0	26.9	24.5	18.2	11.9	8.8
France	10.8	22.3	11.2	21.6	11.2	20.7	33.0	34.4	21.3	14.1	9.3
Germany	8.2	13.8	8.1	13.0	7.9	13.6	24.3	25.3	13.5	8.1	3.5
Greece	9.2	14.4	6.1	14.4	7.0	9.9	24.8	17.7	14.1	10.9	8.5
Ireland	6.9	13.3	5.8	13.4	6.4	11.4	22.6	23.0	12.8	8.9	7.1
Israel	12.5	18.5	10.9	19.0	11.3	18.3	37.4	31.8	14.6	9.1	5.0
Italy	10.1	20.6	5.3	20.7	10.0	12.9	27.6	25.7	20.6	14.7	7.6
Japan	23.2	29.2	21.8	29.0	23.0	30.5	40.4	42.0	34.3	26.4	22.8
Korea	46.7	54.7	41.4	54.2	43.2	54.6	74.1	69.3	57.3	46.7	39.9
Netherlands	15.0	20.6	14.1	20.2	12.1	18.9	30.8	38.9	21.9	16.4	11.0
New Zealand	10.5	12.5	10.0	12.6	8.2	14.6	20.2	21.7	15.2	10.3	7.3
Northern Ireland (UK)	9.9	20.9	8.2	20.5	10.0	17.1	30.3	32.7	22.5	14.1	7.0
Norway	14.1	19.8	12.0	19.7	10.6	18.9	32.7	30.5	23.2	14.3	10.6
Poland	12.8	23.0	6.8	23.4	7.9	24.9	47.6	38.5	23.3	14.9	8.4
Slovak Republic	12.4	23.5	9.7	23.2	8.9	21.1	46.5	36.9	27.0	17.1	11.3
Slovenia	7.4	21.2	6.7	21.2	8.7	19.3	36.8	30.7	21.4	10.8	6.2
Spain	10.9	24.7	11.3	24.0	13.9	20.3	31.6	37.0	21.1	15.3	8.7
Sweden	10.8	18.6	9.5	19.0	9.7	16.0	32.3	32.6	20.7	13.0	7.4
Turkey	9.8	30.6	15.3	30.1	14.3	21.3	35.9	37.2	24.1	19.8	
United States	9.2	18.6	9.2	18.4	7.0	20.0	37.6	32.3	18.6	10.3	4.8
Cyprus	7.5	16.0	5.6	15.8	5.8	12.0	22.4	25.3	16.6	11.2	7.8
Lithuania	22.0	45.3	20.4	47.5	20.7	46.6	44.8	52.9	43.7	29.7	17.4
Russian Federation	39.2	49.8	33.8	50.8	43.9	54.9	61.0	50.2	51.2	46.6	40.0
Singapore	13.5	28.7	16.8	27.6	18.6	29.1	43.3	39.0	24.8	19.8	16.0
OECD Average	**13.1**	**21.9**	**11.8**	**21.8**	**12.0**	**20.5**	**35.4**	**33.5**	**22.4**	**15.1**	**9.9**

Note: See note 1 for Cyprus. See note 2 for the Russian Federation.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Table A B.5. Attenuation of self-education- self-rated poor health association by general literacy proficiency in pooled data from 33 high- and upper-middle-income countries and national sub-regions in the Programme for the International Assessment of Adult Competencies Survey (2011-2015)

	Probability of self-rated poor health adjusted for parental education	Probability of self-rated poor health adjusted for parental education and general literacy proficiency
		Probability (% change)
Lower secondary at most	0.060	0.049 (-22%)
Upper secondary degree	0.039	0.036 (-10%)
Tertiary degree or higher	0.027	0.026 (-3%)

Note: All models adjusted for mother's education, age, employment status, gender, income, country of birth and country fixed effects.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataand analysis.

Table A B.6. Confounding of general literacy proficiency-self-rated poor health association by parental education and self-education in pooled data from 33 high- and upper-middle-income countries and national sub-regions in the Programme for the International Assessment of Adult Competencies Survey (2011-2015)

	Unadjusted probability of self-rated poor health	Adjusted for parental education alone	Adjusted for self-education and parental education
		Probability (% change)	
Level 1 and below	0.078	0.061 (-29%)	0.048 (-63%)
Level 2	0.051	0.040 (-28%)	0.035 (-48%)
Level 3	0.040	0.032 (-26%)	0.030 (-35%)
Level 4/5	0.032	0.027 (-22%)	0.026 (-25%)

Note: All models adjusted for mother's education, age, employment status, gender, income, country of birth and country fixed effects.
Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataand analysis.

Table A B.7. Comparison of adjusted odds ratios for self-rated poor health by age group, for seven upper-middle-income countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies (2011-2015) survey

Age group	25 to 34		35 to 44		45 to 54		55+	
	ALL	PIAAC	ALL	PIAAC	ALL	PIAAC	ALL	PIAAC
General literacy proficiency								
Level 1 and below, lowest	1.4 (0.5, 4.1)	1.1 (0.4, 2.8)	5.3 (2.3, 12.3)	3.4 (1.6, 7.2)	2.3 (0.7, 6.9)	3.1 (1.3, 7.7)	3.7 (0.8, 18.0)	3.1 (1.4, 7.1)
Level 2	1.2 (0.5, 2.8)	0.9 (0.4, 1.8)	3.0 (1.3, 6.7)	2.6 (1.4, 5.1)	2.1 (0.8, 5.7)	1.9 (0.8, 4.8)	2.1 (0.5, 8.1)	2.0 (0.9, 4.1)
Level 3	1.4 (0.5, 3.4)	1.1 (0.5, 2.3)	1.7 (0.7, 4.0)	1.7 (0.9, 3.3)	1.1 (0.4, 3.6)	1.7 (0.7, 4.0)	1.4 (0.3, 6.9)	1.5 (0.7, 3.0)
Level 4/5, highest	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Father's education								
Upper secondary at most	1.2 (0.7, 2.0)	1.7 (1.0, 2.8)	1.1 (0.5, 2.3)	1.2 (0.8, 1.9)	0.9 (0.5, 1.7)	0.8 (0.5, 1.3)	1.1 (0.6, 2.1)	1.1 (0.7, 1.6)
Tertiary degree	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Mother's education								
Upper secondary at most	1.5 (0.9, 2.7)	0.8 (0.5, 1.2)	1.1 (0.7, 1.7)	0.9 (0.6, 1.4)	1.9 (1.0, 3.6)	1.3 (0.8, 2.3)	1.5 (0.6, 3.5)	1.1 (0.6, 2.0)
Tertiary degree	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Self-education								
Upper secondary degree	0.8 (0.5, 1.2)	2.1 (1.3, 3.5)	1.0 (0.7, 1.3)	1.7 (1.1, 2.5)	1.4 (0.9, 1.9)	1.9 (1.3, 2.8)	1.4 (0.9, 2.3)	1.6 (1.1, 2.2)
Lower secondary at most	1.4 (0.7, 2.6)	2.4 (1.3, 4.6)	1.2 (0.7, 2.2)	2.6 (1.5, 4.3)	2.2 (1.3, 3.7)	2.6 (1.8, 3.8)	1.9 (1.2, 3.0)	2.4 (1.7, 3.4)
Tertiary degree	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

Notes: All models adjusted for age, employment status, gender, income, country of birth, country fixed effects, parental education, self-education and general literacy proficiency. Seven upper-middle-income countries: Australia, Canada, Italy, Netherlands, New Zealand, Norway, United States. ALL: Adult Literacy and Lifeskills. PIAAC: Programme for the International Assessment of Adult Competencies.

Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

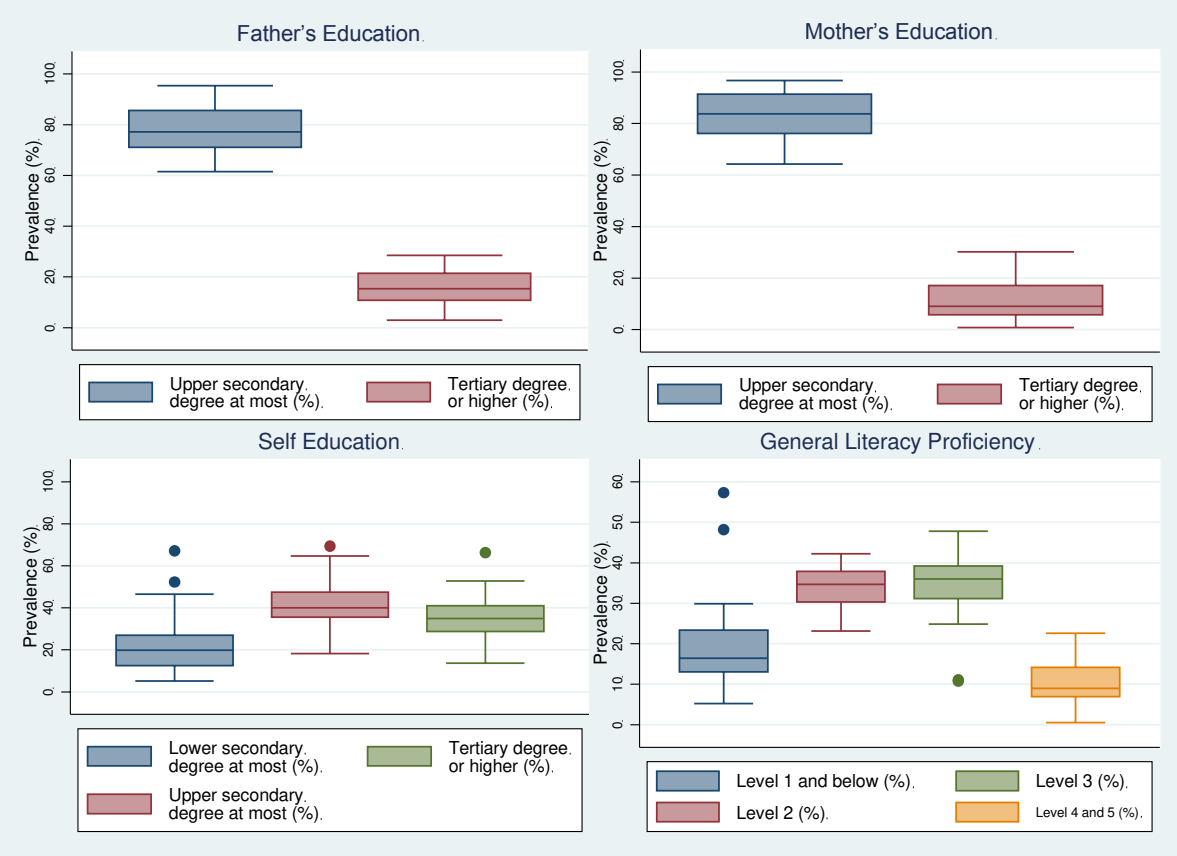
Table A B.8. Comparison of adjusted odds ratios for self-rated poor health by level of self-education, for seven upper-middle-income-countries common to the Adult Literacy and Lifeskills survey (2003-2008) and the Programme for the International Assessment of Adult Competencies (2011-2015) survey

Self-education	Lower secondary or lower degree		Upper secondary degree at most		Tertiary degree	
	ALL	PIAAC	ALL	PIAAC	ALL	PIAAC
General literacy proficiency						
Level 1 and below, lowest	1.5 (0.3, 8.0)	1.6 (0.6, 4.8)	2.9 (1.1, 8.1)	2.1 (1.0, 4.2)	2.3 (1.0, 5.1)	3.0 (1.6, 5.5)
Level 2	1.0 (0.2, 5.3)	1.1 (0.4, 3.0)	1.7 (0.8, 3.7)	1.4 (0.8, 2.6)	2.2 (1.1, 4.4)	2.0 (1.3, 3.2)
Level 3	0.7 (0.1, 4.4)	1.1 (0.4, 3.4)	1.1 (0.4, 2.5)	1.2 (0.6, 2.4)	1.6 (0.8, 3.1)	1.5 (1.0, 2.3)
Level 4/5, highest	Ref	Ref	Ref	Ref	Ref	Ref
Father's education						
Upper secondary at most	0.9 (0.3, 2.8)	0.7 (0.3, 1.4)	1.2 (0.8, 1.8)	1.3 (0.9, 1.9)	1.1 (0.7, 1.5)	1.0 (0.8, 1.3)
Tertiary degree	Ref	Ref	Ref	Ref	Ref	Ref
Mother's education						
Upper secondary at most	1.2 (0.5, 3.2)	1.2 (0.5, 2.8)	1.3 (0.8, 2.3)	0.8 (0.6, 1.1)	1.4 (0.9, 2.3)	1.1 (0.8, 1.4)
Tertiary degree	Ref	Ref	Ref	Ref	Ref	Ref

Note: All models adjusted for age, employment status, gender, income, country of birth, country fixed effects, parental education and general literacy proficiency. Seven upper middle-income countries: Australia, Canada, Italy, Netherlands, New Zealand, Norway, United States. ALL: Adult Literacy and Lifeskills. PIAAC: Programme for the International Assessment of Adult Competencies.

Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015),* www.oecd.org/skills/piaac/publicdataandanalysis

Figure A B.1. Proportion of respondents across levels of parental education, self-education and general literacy proficiency in the Programme for the International Assessment of Adult Competencies survey of 33 high- and upper-middle-income countries and national sub-regions (2011-2015)



Source: (OECD, 2016), *Survey of Adult Skills (PIAAC) (2012, 2015)*, www.oecd.org/skills/piaac/publicdataandanalysis.