

## RESEARCH

# Association between low functional health literacy and mortality in older adults: longitudinal cohort study

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## Abstract

**Objective** To investigate the association between low functional health literacy (ability to read and understand basic health related information) and mortality in older adults.

**Design** Population based longitudinal cohort study based on a stratified random sample of households.

**Setting** England.

**Participants** 7857 adults aged 52 or more who participated in the second wave (2004-5) of the English Longitudinal Study of Ageing and survived more than 12 months after interview. Participants completed a brief four item test of functional health literacy, which assessed understanding of written instructions for taking an aspirin tablet.

**Main outcome measure** Time to death, based on all cause mortality through October 2009.

**Results** Health literacy was categorised as high (maximum score, 67.2%), medium (one error, 20.3%), or low (more than one error, 12.5%). During follow-up (mean 5.3 years) 621 deaths occurred: 321 (6.1%) in the high health literacy category, 143 (9.0%) in the medium category, and 157 (16.0%) in the low category. After adjusting for personal characteristics, socioeconomic position, baseline health, and health behaviours, the hazard ratio for all cause mortality for participants with low health literacy was 1.40 (95% confidence interval 1.15 to 1.72) and with medium health literacy was 1.15 (0.94 to 1.41) compared with participants with high health literacy. Further adjustment for cognitive ability reduced the hazard ratio for low health literacy to 1.26 (1.02 to 1.55).

**Conclusions** A third of older adults in England have difficulties reading and understanding basic health related written information. Poorer understanding is associated with higher mortality. The limited health literacy capabilities within this population have implications for the design and delivery of health related services for older adults in England.

## Introduction

Health literacy has been defined as “the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make basic health decisions.”<sup>1 2</sup> The World Health Organization and organisations responsible for public health in the United States and Canada have identified health literacy as an important determinant of population health.<sup>3-5</sup> A rapidly growing body of research is exploring the gap between patients’ health literacy and the capabilities needed to effectively manage health.<sup>2 6</sup> For example, lower health literacy is associated with less knowledge of chronic disease processes,<sup>7</sup> poorer mental and physical health, limited use of preventive services, and higher rates of hospital admissions.<sup>8</sup> Evidence for these associations emanates largely from the United States.<sup>9</sup> In the United Kingdom, patients are increasingly expected to become active partners in their care, yet neither “health literacy” nor “literacy” is explicitly mentioned by the government in recent health strategies.<sup>10 11</sup> Is health literacy an important determinant of health outcomes in the context of universal healthcare provision? We investigated the association between health literacy and mortality among older adults in England.

In this study we focus on functional health literacy—being able to apply reading skills and basic knowledge in a health context.<sup>12</sup> Health literacy, based on widely used measures of health related word recognition and comprehension, correlates strongly with general literacy<sup>13 14</sup> but is assessed with greater health specific content.<sup>15</sup> Health literacy is also associated with cognitive abilities, including processing speed and working memory.<sup>16 17</sup> Low health literacy is predicted by older age, lower income, fewer education qualifications, and being from an ethnic minority group, yet the relation between health literacy and health is reported to persist after accounting for education and other socioeconomic indicators.<sup>2 7 8</sup> Although educational attainment is typically stable after early adulthood, an

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Appendix 1: details of full health literacy assessment and scoring criteria

Appendix 2: description of multiple imputation procedures for missing data

Appendix 3: table showing association between low health literacy and all cause mortality

individual's health literacy may increase (for example, through interaction with peers or medical professionals), or decrease as part of a general decline in cognitive capabilities with age.<sup>18</sup> Intervention studies to tackle low health literacy have led to improvements in self care and quality of life, lending importance to health literacy as a potentially modifiable risk factor.<sup>19</sup>

Low health literacy may lead to particularly harmful consequences in older age, given the complexities of managing chronic disease and age related cognitive decline.<sup>20 21</sup> We investigated whether low health literacy was associated with an increased risk of mortality in older adults in England, independent of established risk factors, including age, socioeconomic position, and pre-existing illness. We hypothesised that harmful lifestyle behaviours and weaker cognitive function would contribute to a significant association between low health literacy and increased mortality.

## Methods

The sample was drawn from the second wave (2004-5) of the English Longitudinal Study of Ageing, a national cohort study established in 2002 to study health and ageing in adults aged 50 years and above.<sup>22</sup> Participants are contacted every two years for interview and every four years for a health examination. The initial interview (wave 1) included a nationally representative sample of 12 099 adults aged 50 or more from private households who had participated in the health survey for England in 1998, 1999, and 2001—an annual government health survey based on a stratified random sample of all households in England. The second wave of the English Longitudinal Study of Ageing included 8781 core participants, 81.5% of eligible participants.<sup>23</sup> Non-response was higher among those with no educational qualifications, of non-white ethnicity, or with limiting illness, and among women aged 85 or more.

## Functional health literacy

We assessed health literacy using a brief four item comprehension test based on instructions similar to those found on a packet of aspirin bought over the counter. The test was used in the international adult literacy survey<sup>24</sup> and the adult literacy and life skills survey.<sup>25</sup> Participants were asked to read a fictitious medicine label, enlarged to A4 size. They were able to refer to the label while responding to questions asked by the interviewer, such as “what is the maximum number of days you may take this medicine?” and “list one condition for which you might take the tablet.” The task was developed according to a conceptual framework that defines literacy as an ability to fulfil goal directed tasks, in this case in a health context.<sup>26</sup> (See appendix 1 for the full health literacy assessment and scoring criteria.) Each correct answer scored 1 point, resulting in a health literacy score of 0 to 4.

## Outcome

We obtained data on all cause mortality through October 2009 from the National Health Service central data registry.

## Covariates

From the wave 2 interview we obtained data on sex; age; ethnicity (white or non-white); and education, based on the highest qualification achieved (no qualifications, below degree level, and degree or equivalent). To preserve anonymity, participants aged more than 90 are recoded to 99 years, therefore we collapsed age into four groups (52-59, 60-69, 70-79, and ≥80). We coded occupational class according to the National

Statistics Socioeconomic Classification in to three categories (managerial, intermediate, and routine). To account for different distributions of wealth in older age, we categorised total non-pension net wealth for the household into age related fifths (above and below age 65).

Measures of baseline health included self reported doctor diagnosed disease for six separate major life threatening chronic conditions: diabetes, stroke, cancer, asthma, chronic lung disease (including bronchitis or emphysema), and heart disease (including angina, heart attack, congestive heart failure, and abnormal heart rhythm). We coded participants as being positive for depressive symptoms if they scored more than 4 on the eight item Center for Epidemiological Studies depression scale.<sup>27</sup> Participants were also asked if they had one or more illnesses, disabilities, or infirmities that had affected or could affect them for a prolonged period. If this condition limited their activities we classified them as having a limiting longstanding illness. Physical capabilities were also assessed by asking respondents whether health or physical problems interfered with any of six activities of daily living, such as dressing, walking, and using the toilet; we coded yes to any question as a positive response.<sup>28</sup>

Self reported health behaviours included smoking (current or not current) and frequency of alcohol consumption (daily/almost daily or less than daily). Physical activity was coded as a dichotomous variable based on moderate to vigorous leisure time activity reported once a week or less than once a week. We excluded body mass index (weight (kg)/height(m)<sup>2</sup>) from the primary analysis owing to the low sample size agreeing to a visit from the nurse (n=6192), but we included this variable in sensitivity analyses.

Participants completed in private a battery of interviewer administered cognitive function tests with the health literacy assessment. We selected three measures to assess memory and executive function that are known to be sensitive to age related decline and would be minimally influenced by reading skills: orientation in time (correctly stating the year, month, date, and day of the week, yes or no); immediate recall (recall of 10 aurally presented words); and verbal fluency (number of animals listed in one minute).<sup>23</sup>

## Statistical analyses

Only core participants of the English Longitudinal Study of Ageing with valid data for health literacy, month of interview, and month of death and who consented to follow-up were eligible for inclusion. We excluded from the primary analyses those participants who survived fewer than 13 months from interview. Based on this sample, the rate of missing data was 9.1% for ethnicity, 5.2% for wealth, and less than 1.5% for all remaining variables. In the case of missing values for a given covariate, we created a separate missing category and included this in the models.<sup>29</sup> To provide a minimum of 10% of the population per category (n>786), we grouped health literacy scores into three categories: high (no errors), medium (one error), or low (more than one error). To compare baseline characteristics across health literacy categories we used the  $\chi^2$  test for linear trend for categorical variables and analysis of covariance for continuous variables. We estimated the risks of mortality by multivariable Cox proportional hazards regression. Survival time was measured in months from date of interview to date of death, or to follow-up in October 2009. We hypothesised that lower health literacy scores would be associated with an increased risk of mortality. Demographics, measures of socioeconomic position, and baseline health measures were identified a priori as potential confounding

factors. We identified health behaviours and cognitive function measures as possible mediators on the pathway between health literacy and mortality. Covariates were entered in blocks, with log likelihood tests carried out for each block to assess improvements to model fit.

In secondary analyses we tested for differences in the association between health literacy and mortality by age, sex, ethnicity, education, or existing chronic disease (any of heart disease, stroke, diabetes, cancer, asthma, or chronic lung disease) by adding interaction terms into separate regression models. We hypothesised that the association between health literacy and mortality would be greater for those with chronic illnesses that required complex self management behaviours.

To test the robustness of the association between health literacy and mortality, we re-ran regression models, treating health literacy as two and four categories. We also ran models based on complete cases, with and without body mass index. Since terminal cognitive decline may begin two to three years before death, we tested the effect of excluding patients who died within 24 months after interview, and we compared the results with all participants, regardless of survival time. To investigate further the influence of missing data, we also used multiple imputation of missing values for health literacy, baseline covariates, and survival time. We included all variables in the primary analyses in the imputation models, along with self rated sight (excellent to poor, or blind (n=33), on a six point scale), to create 20 imputed datasets.<sup>30</sup> Imputation procedures are described in detail in web appendix 2. All analyses were done using SPSS version 18.0.

## Results

Among core participants who were interviewed at wave 2 of the English Longitudinal Study of Ageing, 8316 (94.7%) completed the assessment of health literacy. The main reasons for non-completion were sight (n=132) and health problems (n=59). Older participants were less likely to complete the health literacy assessment (83.2% of those aged more than 80;  $P<0.001$ ). Outcome data were not available for a further 324 participants with no consent for follow-up (n=318) or missing survival data (n=6). After exclusion of 135 participants who died within 12 months of interview, the analytical sample comprised 7857.

Health literacy was categorised as high (maximum score, 67.2%), medium (one error, 20.3%), or low (more than one error, 12.5%). Low health literacy included those scoring 2 (9.0%), 1 (2.7%), and 0 (0.7%). Lower scores were associated with increasing age and indicators of low socioeconomic position but not with ethnicity (table 1). One quarter of adults aged less than 60 could not correctly answer all four questions (25.1%), compared with almost half of adults aged more than 80 (48.4%). Participants with no educational qualifications were four times more likely to have low health literacy than participants with degree level qualifications (21.3% v 4.9%). Lower health literacy was also associated with a higher prevalence of depressive symptoms, physical limitations, and chronic diseases; specifically heart disease, diabetes, stroke, and asthma. Smoking, physical inactivity, and alcohol consumption less than daily were positively related to low health literacy. Higher health literacy scores were associated with stronger cognitive abilities, including orientation, verbal fluency, and working memory.

Length of follow-up ranged from 13 to 66 months, mean 63.2 months (5.3 years). During follow-up 621 deaths occurred: 321

(6.1%) in the high health literacy category, 143 (9.0%) in the medium category, and 157 (16.0%) in the low category.

Low and medium health literacy were associated with a 75% and 24% increased risk of mortality, respectively, compared with high health literacy, after adjusting for age and sex (table 2, model 1). Adjustment for indicators of socioeconomic position, including wealth, education, income, and ethnicity, reduced the hazard ratio for low health literacy from 1.75 to 1.57 (95% confidence interval 1.29 to 1.92, model 2). After additional adjustment for baseline health status, including major chronic diseases, disabling illness, and physical health, the relation between low health literacy and mortality was further attenuated but remained significant (1.47, 1.20 to 1.79, model 3).

The influence of health behaviours on the association between low health literacy and mortality was explored. Adjustment for smoking, alcohol consumption, and regular physical activity had a limited effect on the relation between low health literacy and mortality, with the hazard ratio decreasing to 1.41 (1.15 to 1.73, model 4).

Including cognitive measures within the regression model decreased the hazard ratio for low health literacy and mortality to 1.26 (1.03 to 1.56, model 5). In addition to low health literacy, sex, age, limiting longstanding illness, limited activities of daily living, cancer, smoking, physical activity, and the cognitive measures of fluency and time orientation were significant predictors of mortality (see table in appendix 3). Likelihood ratio tests confirmed that the addition of each block of covariates in models 2 to 5 resulted in a significantly improved fit compared with the previous model ( $P\leq 0.001$ ).

The association between health literacy and mortality did not vary significantly by age, sex, ethnicity, education, or pre-existing illness (interaction terms,  $P>0.05$ ).

## Sensitivity analyses

The regression analyses were repeated with health literacy in four categories, by further dividing low health literacy into those scoring 2 out of 4 (n=711) and those scoring 0 or 1 (n=271). A graded effect was evident, with the lowest scoring group having a consistently higher risk of mortality. For example, in the model adjusted for health behaviours, the hazard ratio for scores of 2 was 1.34 (1.06 to 1.68) and for less than 2 was 1.59 (1.18 to 2.14). To investigate the potential influence of preterminal cognitive decline, we re-ran the regression models after exclusion of 153 participants who died within 24 months of the interview. Low health literacy remained a significant predictor, with a hazard ratio of 1.32 (1.04 to 1.67) in the fully adjusted model. Increasing the analytical sample to include all eligible participants (n=7992), regardless of survival time, did not alter the relation between low health literacy and mortality. Introducing body mass index into the model reduced the sample size (n=5685), but the hazard ratio for low health literacy remained significant. Using multiple imputation for missing values generated similar results to analyses based on complete cases; low health literacy remained a significant predictor of mortality after adjusting statistically for demographics, socioeconomic position, health status, and health behaviours. (See appendix 2 for the hazard ratios for low health literacy based on multiple imputation.)

## Discussion

One in three older adults in England were unable to understand basic usage instructions on a medicine label, indicating limited

health literacy. Adults with low health literacy, with scores in the lowest 12.5%, were more than twice as likely to die within five years as adults with no health literacy limitations, and those with moderate health literacy showed an intermediate pattern. Differences in age, socioeconomic position, baseline health status, and health behaviours explained less than half of the increased risk. After adjusting for measures of cognitive function, low health literacy was still a significant predictor of mortality.

### Strengths and weaknesses of the study

This is the first national prospective study to examine the association between health literacy and outcomes in England. Poor health outcomes are thought to be a factor of both individuals' health literacy and interactions with the healthcare system,<sup>2,31</sup> so research findings from the United States may not necessarily apply in England, where healthcare is free at the point of delivery. Studies based on two mid-sized (<3300 participants) American cohorts of elderly community dwelling adults found that low health literacy was associated with more than a 1.5-fold increase in mortality in multivariable analyses.<sup>20,21</sup> One study in adults aged over 71 reported a 1.75-fold (95% confidence interval 1.27-fold to 2.41-fold) increased risk of mortality for those with the lowest 23.7% reading levels.<sup>20</sup> Another study reported a hazard ratio of 1.48 (1.23 to 1.79) for the quarter of Medicare enrollees with inadequate health literacy, or 1.27 (1.03 to 1.57) after adjustment for cognitive function.<sup>32</sup> We found similar results despite differences in health literacy measures, sample composition, and statistical analyses. In terms of sample composition, the English Longitudinal Study of Ageing population was younger and had a lower prevalence of chronic diseases. Neither previous study adjusted for wealth as a measure of socioeconomic position, which is a more accurate measure of economic resources than income in older age.<sup>33</sup> One did not adjust for measures of physical functioning or physical activity at baseline<sup>20</sup> and the other did not adjust for specific comorbidities.<sup>21</sup>

The four item health literacy assessment used in this study was taken from a validated international test of literacy.<sup>26</sup> The task had the advantage that it could be administered quickly and simply in a large scale population survey. Respondents were required to read and interpret written health related information. This task arguably had greater face validity than the more widely used rapid estimate of adult literacy in medicine (REALM), a brief health literacy assessment in which respondents are tested on their pronunciation (not understanding) of medical vocabulary.<sup>14,34</sup> A disadvantage was that separate validation, performance metrics, or comparison data for individual items from the international adult literacy survey were not available. The only previous population survey of health literacy in the United Kingdom used the test of functional health literacy in adults (TOFHLA), which takes about 20 minutes to administer.<sup>35</sup> According to a survey of 759 adults, 30% of those aged 65 or more had marginal or inadequate health literacy, which is similar to the 32.8% of participants scoring below the maximum score in this study. We did not have a validated cut-off point for "low" health literacy, but a graded relation between health literacy and mortality has been reported previously, with a noticeable increase in the risk of mortality for the lowest 11.2% scores.<sup>36</sup> Our results were consistent with an increasing risk of mortality for lower health literacy scores.

A major weakness of the study, inherent in any population based survey of health literacy, is the potential for non-response bias. Adults with low literacy levels may try to hide their reading difficulties<sup>37</sup> and therefore be less likely to respond to surveys.

Completion of the health literacy assessment was high (94.7%), but overall, older, non-white, less qualified adults were under-represented in wave 2 of the English Longitudinal Study of Ageing (81.5% eligible participants), so the prevalence of low literacy is likely to be an underestimate.<sup>23</sup> Our response rates do compare favourably with other similar studies (for example, 54.7% response rate reported by one).<sup>38</sup> The association between low health literacy and mortality was robust in several sensitivity analyses, including analyses based on multiple imputation for missing data, giving confidence to the main findings. We relied on self reported doctor diagnosed illness, which has been found to be fairly consistent with doctor diagnoses in studies carried out in adults of a similar age.<sup>39,40</sup> We are not aware of evidence that low health literacy is systematically associated with under-reporting or over-reporting of doctor diagnosed illness, which would be a potential source of bias. A recent study in patients with heart failure found an association between health literacy and mortality even after accounting for objective measures of disease severity.<sup>29</sup> An investigation into under-reported hypertension in the English Longitudinal Study of Ageing, comparing self report with objectively measured blood pressure, did not find a consistent relation with wealth (which is correlated with health literacy),<sup>23</sup> but this is a potential area for further research. The population in this study was broadly representative of adults aged 52 or more in England, but the results may not apply to younger age groups or to international settings.

This is the first study to exclude deaths in the period immediately after assessment of health literacy. In an elderly population, the relation between mortality and health literacy could be driven by sharp declines in aspects of cognitive function preceding death.<sup>41</sup> In the current study, we found that health literacy predicted mortality whether or not deaths up to 24 months were excluded, suggesting that a steep precognitive terminal decline did not account for the association.

### Possible explanations and implications for research, policy, and practice

The pathways between low health literacy and adverse health outcomes are not well understood.<sup>31</sup> Theoretical frameworks propose that low health literacy causes adverse outcomes through differences in access to and utilisation of healthcare, ineffective patient-provider communication, and self care behaviours (including lifestyle behaviours).<sup>18,31</sup> Differences may be explained not only by lack of knowledge and skills but also by attitudinal and motivational differences, such as less information seeking and lower self efficacy for health related actions.<sup>18,42</sup> We found that unhealthy behaviours accounted for a small but significant amount of the increased risk of mortality for older adults with low health literacy. Our findings are consistent with data from the United Kingdom, which found that low health literacy predicted poor diet, smoking, and lack of physical activity across a wide age range, independent of socioeconomic indicators.<sup>43</sup> Low health literacy may also be associated with lower involvement in screening,<sup>44</sup> and later presentation of illness. This has important implications for health promotion initiatives, which should consider media and messages appropriate for adults with low literacy levels.

For those with a chronic illness it has been suggested that repeated interactions with the healthcare system contribute to differences in survival by literacy level.<sup>29,45</sup> Patients with low health literacy are less likely to recall and adhere to instructions for complex drug or self care regimens.<sup>46-48</sup> Low health literacy can also be a barrier to the effectiveness of shared decision making.<sup>49,50</sup> There is evidence that doctors tend to over-estimate

patients' reading abilities,<sup>51</sup> leading to patients' confusion and anxiety when they are given written information.<sup>52</sup> It is plausible that repeated anxiety and shame associated with reading difficulties may contribute to the higher levels of depression associated with low health literacy reported in this and other studies.<sup>20 37</sup> We had expected to find a stronger relation between low health literacy and mortality for participants with chronic disease, but there was no statistical interaction between pre-existing chronic condition and health literacy in this study. It may be that there were too few deaths among patients without a chronic illness to identify a significant interaction. Future analyses with longer follow-up and cause specific mortality may clarify this issue.

This study supports the conceptualisation of low health literacy as an indicator of broader cognitive difficulties beyond reading ability, including impaired information processing and memory.<sup>17 18 53</sup> When measures of cognitive function were added to our fully adjusted model (model 5), this significantly attenuated but did not eliminate the association between low health literacy and mortality. This is consistent with previous studies showing that despite considerable overlap, independent mechanisms may link cognition and health literacy to health.<sup>16 30 54</sup> This apparent independence may depend on the breadth of capabilities assessed by the health literacy measure. Poor literacy skills may be associated with specific disadvantages for managing health over and above other cognitive deficits. For example, patients who lack the skills to write and read drug or appointment reminders may find it harder to cope with a failing memory.<sup>54</sup> Cognitive difficulties in older adulthood are likely to be related to childhood cognitive ability (which is heavily influenced by early social and environmental context),<sup>55</sup> educational opportunities, acquisition of knowledge during adult life, and age related cognitive decline.<sup>56</sup> Statistical adjustment for socioeconomic indicators accounted for about a third of the association between low health literacy and mortality. Health literacy, in terms of the knowledge and capabilities to manage health, may mediate the influence of socioeconomic indicators, such as educational attainment, on health outcomes in older age.<sup>20 57 58</sup> If disparities in health literacy related outcomes can be understood and effectively prevented, improving patients' health literacy has the potential to reduce socioeconomic health inequalities.<sup>57 59</sup>

Efforts to improve health related outcomes for patients with health literacy have been described at the levels of interactions with healthcare professionals, healthcare systems, and within the wider community.<sup>19</sup> For example, use of visual aids and "teach back" communication techniques by clinicians led to improved anticoagulant outcomes in a randomised controlled trial.<sup>60</sup> System level interventions include simplification of drug instructions and dosing regimens, interactive online educational programmes, and complex interventions for the self management of chronic disease.<sup>61</sup> Tailored programmes have resulted in improved diabetic control<sup>62</sup> and lower rates of admission to hospital and mortality for patients with heart failure who have low health literacy.<sup>63</sup> Although there is evidence that specific intensive interventions can reduce disease severity, few studies have reported long term follow-up of clinical outcomes, and so the potential effects on mortality are hard to estimate.<sup>19 61</sup> The prevalence of low functional health literacy in older adults in England suggests that in addition to targeted interventions, a population approach may be warranted, whereby consideration of health literacy becomes embedded throughout healthcare design and delivery.<sup>64</sup> For example, rather than screening patients for health literacy, healthcare professionals could routinely employ evidence based "teach back" communication

techniques.<sup>65</sup> Failure to consider patients' health literacy, in terms of both functional skills and health related motivation, may help to explain low uptake of services, such as the NHS HealthSpace personal electronic health record.<sup>66</sup>

Longitudinal research designs, ideally from a life course perspective, will be necessary to clarify the mechanisms linking low health literacy to adverse health outcomes, and the effectiveness of prevention activities. It has been argued that, in addition to healthcare system factors, more comprehensive health literacy measures are needed that assess higher level capabilities such as interpersonal communication skills.<sup>12 67</sup> It remains to be seen whether broader conceptualisations of health literacy will improve prediction of health outcomes and understanding of the pathways leading to mortality.

## Conclusions

This study suggests that a third of older adults in England have difficulties reading and understanding basic health related written information. Poorer understanding is associated with higher mortality. This study comes at time when the prevalence of long term conditions is rising and patients are increasingly encouraged to become responsible and active partners in their care.<sup>10</sup> This study serves as a reminder to all healthcare professionals to adopt communication techniques that are effective for patients with low health literacy. At a broader level, the design and delivery of health related services for older adults in England should be sensitive to the limited health literacy capabilities within this population.

**Contributors:** SB did the statistical analysis, wrote the first draft of the manuscript, and is the guarantor. Both authors designed the study; analysed and interpreted the data; drafted and critically revised the manuscript for important intellectual content; and approved the final version.

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**Competing interests:** All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

**Ethical approval:** The English Longitudinal Study of Ageing was approved by the London Multicentre Research Ethics Committee (MREC/01/2/91) and informed consent was obtained from all participants.

**Data sharing:** Users registered with the Economic and Social Data Service (ESDS) have access to the English Longitudinal Study of Ageing datasets, available at [www.esds.ac.uk](http://www.esds.ac.uk).

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**What is already known on this topic**

- Low functional health literacy is associated with a wide range of adverse health outcomes
- Two regional studies in the United States have reported that low health literacy is independently associated with mortality in elderly adults
- The scale of literacy problems in older adults in England is not known

**What this study adds**

- One in three adults over the age of 65 in England had difficulty understanding basic health related written information
- Poorer understanding was associated with a higher risk of death over five years, even after accounting for socioeconomic circumstances and baseline health
- The limited health literacy capabilities within this population have implications for the design and delivery of health related services for older adults in England

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## Tables

**Table 1 | Participant characteristics at baseline by health literacy score. Values are numbers (percentages) unless stated otherwise**

Characteristics	Health literacy score			P value, for trend
	High (n=5278)	Medium (n=1597)	Low (n=982)	
<b>Age group (years):</b>				
52-59	1815 (34.4)	433 (27.1)	175 (17.8)	<0.001
60-69	1852 (35.1)	518 (32.4)	284 (28.9)	
70-79	1179 (22.3)	449 (28.1)	315 (32.1)	
≥80	432 (8.2)	197 (12.3)	208 (21.2)	
Men	2384 (45.2)	669 (41.9)	462 (47.0)	0.998
<b>Educational qualifications:</b>				
None	1552 (29.4)	735 (46.0)	618 (62.9)	<0.001
Up to degree level	2141 (40.6)	577 (36.1)	267 (27.2)	
Degree or equivalent	1585 (30.0)	284 (17.8)	96 (9.8)	
<b>Occupational class:</b>				
Managerial	2055 (38.9)	379 (23.7)	168 (17.1)	<0.001
Intermediate	1272 (24.1)	386 (24.2)	216 (22.0)	
Routine	1885 (35.7)	816 (51.1)	572 (58.2)	
<b>Wealth fifth:</b>				
1, lowest (poorest)	757 (14.3)	330 (20.7)	294 (29.9)	<0.001
2	948 (18.0)	309 (19.3)	209 (21.3)	
3	309 (19.2)	316 (19.8)	186 (18.9)	
4	1090 (20.7)	306 (19.2)	139 (14.2)	
5, highest (wealthiest)	1210 (22.9)	244 (15.3)	102 (10.4)	
Missing	261 (4.9)	92 (5.8)	52 (5.3)	
<b>Ethnicity:</b>				
White	4662 (88.3)	1430 (89.5)	879 (89.5)	0.173
Non-white	120 (2.3)	28 (1.8)	22 (2.2)	
Missing	496 (9.4)	139 (8.7)	81 (8.2)	
Limiting longstanding illness	1620 (30.7)	587 (36.8)	462 (47.0)	<0.001
Limited activities of daily living	2894 (54.8)	1002 (62.7)	700 (71.3)	<0.001
Depressive symptoms	644 (12.2)	257 (16.1)	232 (23.6)	<0.001
Heart disease*	940 (17.8)	335 (21.0)	721 (26.6)	<0.001
Diabetes	294 (5.6)	124 (7.8)	98 (10.0)	<0.001
Stroke	110 (2.1)	51 (3.2)	55 (5.6)	<0.001
Cancer	149 (2.8)	49 (3.1)	27 (2.7)	0.922
Asthma	524 (9.9)	165 (10.3)	125 (12.7)	0.016
Chronic lung disease	69 (1.3)	24 (1.5)	20 (2.0)	0.086
<b>Health behaviours:</b>				
Current smoker	724 (13.7)	270 (16.9)	179 (18.2)	0.003
Exercise once weekly	4300 (81.5)	1198 (75.0)	612 (62.3)	<0.001
Daily/almost daily alcohol consumption	1649 (31.2)	410 (25.7)	225 (22.9)	<0.001
Mean (SD) body mass index†	27.8 (4.7)	28.3 (5.0)	27.9 (4.8)	0.492
<b>Cognitive function:</b>				
Time orientation (correct date)	4395 (83.3)	1222 (76.5)	688 (70.1)	<0.001
Mean (SD) recall (No of words)	6.0 (1.6)	5.4 (1.7)	4.7 (1.7)	<0.001
Mean (SD) fluency (animals)	21.2 (6.2)	18.9 (6.0)	16.6 (5.8)	<0.001

\*Includes self reported angina, heart attack, abnormal heart rhythm, or congestive heart failure.



**Table 1 (continued)**

Characteristics	Health literacy score			P value, for trend
	High (n=5278)	Medium (n=1597)	Low (n=982)	
†Measured at nurse visit (n=6149).				

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**Table 2 | Association between health literacy score and all cause mortality, based on participants surviving more than 12 months after interview (n=7857)**

Models	Hazard ratios (95% CI)*			
	Medium health literacy	P value	Low health literacy	P value
Crude hazard ratio	1.49 (1.23 to 1.82)	<0.001	2.77 (2.29 to 3.35)	<0.001
Model 1: adjusted for age and sex	1.24 (1.02 to 1.51)	0.034	1.75 (1.44 to 2.12)	<0.001
Model 2: model 1+education, wealth, occupation, and ethnicity	1.20 (0.98 to 1.46)	0.076	1.57 (1.29 to 1.92)	<0.001
Model 3: model 2+baseline health status†	1.16 (0.95 to 1.42)	0.144	1.47 (1.20 to 1.79)	<0.001
Model 4: model 3+health behaviours‡	1.15 (0.94 to 1.41)	0.168	1.41 (1.15 to 1.73)	0.001
Model 5: model 4+cognitive function§	1.07 (0.87 to 1.31)	0.508	1.26 (1.03 to 1.56)	0.027

\*Obtained from sequentially adjusted multivariable Cox proportional hazards regression models with high health literacy as reference category.

†Included longstanding limiting illness, limited activities of daily living, depressive symptoms, and self reported doctor diagnosed disease: heart disease, diabetes, stroke, cancer, asthma, and chronic lung disease.

‡Included current smoking, moderate or vigorous exercise once or more weekly, and daily or almost daily alcohol consumption.

§Cognitive function included orientation in time, immediate recall of word list, and fluency in an animal naming task.