Towards an Understanding of the Relationship of Functional Literacy and Numeracy to Geographical Health Inequalities

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Abstract

The relative contributions of functional literacy and functional numeracy to health disparities remain poorly understood in developed world contexts. We seek to unpack their distinctive contributions and to examine how these contributions are framed by place-based deprivation and rurality. We present a multilevel logistic analysis of the 2011 Skills for Life Survey (SfLS), a representative governmental survey of adults aged 16-65 in England. Outcome measures were self-assessed health status and the presence of self-reported long-term health conditions. Exposure variables were functional literacy (FL) and functional numeracy (FN). Age, sex, individual socio-economic status, ethnicity, whether English was a first language, non-UK birthplaces, housing tenure and geography were included as potential confounders and mediators. Geography was measured as area-based deprivation and urban/rural status. FL and FN were both independently associated with self-assessed health status, though the association attenuated after taking account of confounders and mediators. For long-term conditions, the association with FN remained significant following inclusion of confounders

and mediators whilst FL attenuated to non-significance. Rurality did not influence these associations. Area deprivation was a significant factor in attenuating the association between FL and self-assessed health status. Policy makers and health professionals will need to be aware of the distinctive impact of FN as well as FL when combating health inequalities, promoting health and managing long-term conditions.

Keywords: England; health inequalities; functional literacy; functional numeracy; area deprivation

Introduction

Literacy and numeracy skills are required for citizens to 'achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society' (UNESCO, 2004, p 13). This recognition has been evident in health policy for many years, particularly in resource-poor settings in the global south where maternal literacy has long been linked to prospects for health improvement (Preston, 1980; Grosse and Aufray, 1989; Phillips 1990; Le Vine et al 1994). In more recent years this work has been developed and extended through the formulation of the concept of health literacy (Nutbeam, 2000, 2008; Rudd, 2010; Kickbusch et al. 2013), a concept that has become a dominant framework for research into the impact of numeracy and numeracy on health status. At its 'functional' level (Nutbeam, 2000), health literacy relates to the ability to read and understand basic health-related information. This encompasses both the ability to read and understand words (termed literacy in this paper), and the ability to use quantitative information (which we term numeracy) (Berkman et al., 2011, Baker, 2006).

One shortcoming of empirical studies of functional health literacy is that, notwithstanding a concern with both literacy and numeracy, most have tended to focus either explicitly on literacy, or on a collective undifferentiated construct embracing both literacy and numeracy. Studies seeking to differentiate the effects of literacy and numeracy on health are rare. One health literacy study indicates that comprehension of food labelling is more strongly associated with higher level skills with numbers rather than words (Rothman et al. 2006). Others have included considerations of numeracy and literacy in relation to glycaemic control (Osborn et al., 2010), breast cancer risk interpretation (Brown et al., 2011), colorectal screening (Ciampa et al., 2010) and portion size estimation (Huizinga 2009).

There are potentially important differences in the pathways through which literacy and numeracy might be hypothesised to impact differentially on health (Schonlau et al., 2011). These distinctive pathways relate to the differentiated consequences of being unable to follow or understand textual or numerical information (Peerson and Saunders, 2009). In the case of textual material (reading words), it may relate to service users' understanding of written communications from health professionals, pre-referral questionnaires or hospital information sheets. Shortfalls may reduce preparation for care and comprehension both of health

conditions and of care regimes. Lower numeracy may, in contrast, impact on effective use of health care systems via understanding access tools such as bus timetables and opening hours, to compliance with medication through comprehension of dosage regimes. Aspects of health information and decision-making using numbers and numerical constructs (such as balancing the risks and benefits of different medical procedures, and understanding and taking medication correctly) differ from those aspects of health information transmitted via words (such as a description of diseases and treatments).

Within this context there is an increasing recognition of the importance of numeracy as a 'stand-alone' risk factor for poor health (Rothman et al., 2006; Anker and Kaufman, 2007; Donelle et al. 2007; Peters et al., 2007). In their systematic review Berkman et al. (2011) reviewed the small number of published studies exploring numeracy and health including accuracy of risk perception, knowledge, skills taking medication, and disease prevalence and severity. Studies employed a wide variety of numeracy measures, reported significantly varying proportions of individuals with low numeracy, and found mixed associations with health. This led Berkman et al. to judge the overall strength of evidence for an association between health numeracy to health outcomes to be insufficient and an area for potential research.

A second shortcoming to studies of health literacy relates to limited knowledge of its association with place-based disadvantage. Systematic reviews reveal associations between low functional health literacy skills (undifferentiated between literacy and numeracy) and individual health disadvantage (De Walt and Hink, 2009; Berkman et al., 2011; Sheridan et al., 2011; Sorensen et al, 2012). Lower skill levels are associated with greater 'inappropriate' use of medical services such as increased hospitalisations and greater emergency care use, lower use of preventative care such as mammography and vaccine uptake, poorer ability to demonstrate taking medications appropriately, poorer ability to interpret labels and health messages, poorer ability to manage long-term illnesses, and, among older people, poorer overall health status and higher mortality. These findings clearly implicate poorer health literacy, generally defined, in the generation and maintenance of individual health inequality. The few studies giving explicit attention to place-based disadvantage and health literacy tend to focus on geographical variations in maternal health literacy in the Global South (Andrejewski et al., 2009; Kumar et al., 2012; Rajan et al., 2013) though there have been attempts in the US to develop tools to map health literacy at small area levels (Martin et al.,

2010) and comparative studies of the association with health outcomes between different US cities (Baker et al., 1997). National scale comparisons of levels of health literacy in Europe are also evident, though they do not distinguish literacy and numeracy (eg. HLS-EU Consortium 2012). The extensive body of research on compositional, contextual and collective effects on health outcomes (Macintyre et al., 2002) points to a need to uncover whether place-based factors may compound or dampen the individual level associations of health status with literacy and numeracy.

Study Aims

From the brief review above we identify a need for further research on (a) the relative importance of numeracy and literacy as factors associated with health status, and (b) the extent to which place-based factors affect this association. Our contribution is framed in three specific ways. First, we focus upstream, investigating the underpinning of health literacy by functional literacy and functional numeracy – the socially-differentiated presences of generic skills in reading texts and understanding numbers. We seek to provide important evidence of the independent and distinctive impact of baseline literacy and numeracy skills on health building on work using longitudinal data from the 1970 British Cohort Study (Sabates and Parsons, 2012) showing that a lack of adult numeracy skill was more strongly associated with deteriorating self-rated health than literacy skills even when socio-economic position at birth and indicators of childhood health were taken into account.

A second frame for our study is that, while many studies of inequalities in health in more developed settings mention literacy or indeed numeracy in passing, discussion is generally hypothetical and seldom grounded in empirical analysis. Survey evidence suggests that this is not a reflection of the disappearance of illiteracy (or innumeracy) in more developed countries (Kirsch et al. 2002; DBIS, 2012; OECD 2013) although its significance in the less-developed world is undoubted (Smith-Greenaway, 2015). We focus on the developed setting of England, providing insights on the neglected role of literacy and numeracy in health inequalities in a developed world setting.

Third, we step away from the standard focus evident in studies of health literacy to consider the association of literacy and numeracy with health status rather than measures of the

(health) effectiveness of user engagement with health services. We view health status both as a likely consequence of shortcomings in health service uptake and also as a construct deeply structured in its own right by social inequality at both the individual and area level. Within this context, following the cumulative complexity model of Shippee et al. (2012), we see health status as relating to the burden of disease, and literacy and numeracy as elements of patient capacity to deal with that burden and the associated treatment regimes.

In the following section we set out the data and methods used to address our two key aims: elucidating the independent association of literacy and numeracy with health status, and assessing the impact of place-based disadvantage on this association

Methods

Data and Measures

We use data from the English Skills for Life Survey (SfLS) (DBIS, 2012). The SfLS provides a nationally representative sample of adults aged 16-65 living in non-institutional settings. Participants were sampled between May 2010 and February 2011. This survey was commissioned by the English Department for Education and Skills to produce a national profile of adult literacy, numeracy and Information and Communication Technology (ICT) skills. To achieve this aim SfLS respondents were randomly pre-allocated for skills testing, with 4,871 people being assigned to both literacy and numeracy assessments. This sub-sample forms the basis of the research reported in this paper.

We present analyses for two outcome measures of health status: self-assessed health and self-reported possession of a long-term health condition. Poor self-reported health has long been associated with mortality (Kaplan and Commacho, 1983; Sunquist and Johannsson, 1997) and health care utilisation (Miilunpalo et al., 1997)) A meta-analysis suggests that persons with “poor” self-rated health have a two-fold higher mortality risk compared with persons with “excellent” self-rated health even after adjustment for key covariates such as functional status, depression, and co-morbidity.(De Salvo et al., 2006). Baker at al., (1997) noted a stronger association between self-assessed health and literacy than between self-assessed health and educational qualifications. Long-term health conditions are similarly associated with mortality, morbidity and use of health services (Heyworth et al., 2009; Hewitson et al., 2014) Poor health literacy is associated with shortcomings in the management of long-term health conditions (Edwards et al., 2012)..

We used standard UK measures of self-assessed health and the presence of long-term health conditions. Respondents self-assessed their health using a five-point scale (very good, good, moderate, poor, very poor), and self-reported their experience of long-term health conditions. For our analyses we dichotomised self-assessed health into good/less good health (very good/good v moderate/poor/very poor health), and worked with the binary indicator of the presence or absence of long-term health conditions provided in the SfLS and defined in relation to a listing of conditions and the UK statistical definition of long-standing illness, disability or infirmity as anything that had troubled the participant over a period of time or that is likely to affect the participant for a period of time (DBIS, 2012).

Our key exposure variables were literacy and numeracy test results defined by the English Qualifications and Credit Framework (QAA, 2008). We used the standard dichotomised measures distinguishing individuals above or below the 'functional competency thresholds', the skills levels required by an individual to 'achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society' (UNESCO, 2004). These thresholds have been set at level 1 (and above) for literacy skills, and Entry Level 3 (and above) for numeracy skills (Table 1) by the UK Department of Business Innovations and Skills (DBIS, 2012)

<<Table 1 about here>>

Eight confounder and mediating variables were entered into the analysis. Prime among these for the purposes of our research aims were measures capturing putative place effects that might modify the association between our outcome and exposure variables. We examined two candidate place effects: a five-fold categorisation of the 2010 English Index of Deprivation, based on scores of 1-9, 10-19, 20-29, 30-39 and 40+ with higher scores reflecting greater area deprivation (DCLG, 2011), and a 2004 index distinguishing urban and rural census output areas (Countryside Agency et al., 2004). The Index of Deprivation is based on a factor analysis of administrative data constructing seven 'domains' of deprivation (income, employment, health and disability, education and training, barriers to housing and services, living environment, and crime) that are then combined into a single index. The index of rurality identifies as urban those census output areas that form part of a built-up area

of more than 10,000 people. Both measures were provided within the SfLS dataset on the basis of a pre-created geocoding of respondent residential postcodes linking respondents' area of residence to lower super output area data on deprivation and rurality. The use of lower super output areas, aggregations of output areas, protects respondent anonymity. Lower super output areas are small localised zones for reporting census data with an average population of 1514 people (ONS, 2012)

The rationale for the choice of our two place variables lies in the extensive health inequalities literatures separately linking both health status and literacy and numeracy to deprivation and to rurality. These linkages are better established for deprivation (Williams, 2003;Jama and Dugdale, 2012: Marmot et al., 2010). Evidence on associations with regard to rurality is more mixed (Riva et al., 2009). Smith et al. (2008), in an international comparative review, note that rurality can link to access to and provision of health services but may not confer health disadvantage, while Midouhas and Flouri (2013) suggest that UK children do not vary in numeracy skills with respect to urban or rural residence but reading age tends to be higher in major urban areas.

Other chosen confounder and mediator variables were identified from previous research as being associated with inequalities in education/skills or health (Marmot et 2010; SfLS, 2012; Berkman et al., 2011). Five of these variables were dichotomised: sex (male / female), ethnicity (White / Non-White), whether English was the respondent's first language (yes / no), whether the respondent was born in the UK (yes / no) and housing tenure (own or part-own home / non-home ownership). Socio-Economic Status (SES) was divided into five categories based on the National Statistics Socio-economic Classification (Managerial / Intermediate / Routine / Unemployed / Student) (Rose and Pevalin, 2005) while age was expressed as decadal bandings from 16-25 to 54-65.

We did not include educational qualifications as a confounder/mediator variable. This decision reflected our research aim, focusing on elucidating the distinctive associations between literacy and numeracy, and health status. Our numeracy and literacy data measures competency levels at the time of testing allowing us to study the association between skills and health status with contemporaneous measurement of both constructs. Educational qualifications, in contrast, may have been obtained at varyingly distant times in the past and with varying requirements regarding the deployment of literacy and numeracy skills to

achieve a qualification. Although both literacy and numeracy relate closely to the highest qualification obtained by an individual (and thus risk the introduction of multicollinearity to our analyses), the relationship between qualification level and current skills also varies both between individuals and between different skill domains, with life experiences since the time of taking the qualification influencing the gain or loss of skills (SfLS, 2011).

Statistical Analysis

Following initial exploratory cross-tabulations, multilevel logistic regression models were used to examine the relationships between self-assessed health and the reporting of a long-term health condition, and the chosen target, mediating and confounding variables. Initial data management and exploratory analyses used IBM SPSS Statistics version 19. All multilevel analyses were performed using MLwiN 2.32 using MCMC procedures with binary logistic outcomes (Rasbash et al. 2015; Browne, 2015). We used maximum likelihood methods to develop informative priors. MCMC burn-in and run lengths were then determined using the Brooks-Draper and Raftery-Lewis statistics. The decision to use multilevel modelling reflected the cluster-randomised design of the SfL with respondents nested in primary sampling units (local government wards) within regions. Deprivation and rurality were fitted at the individual level. A four stage random intercepts modelling strategy was undertaken for each outcome; random slopes were tested and found to be non-significant and are consequently not reported. The first models included just Functional Literacy (FL) and Functional Numeracy (FN) as sole predictors. The second models adjusted FL and FN for age and sex. We then adjusted for social and demographic confounding and mediating variables in a third stage of modelling. The final pair of models (stage four) incorporated adjustment for the two geographical measures. A further set of models testing interactions between the independent variables and the possibility of complex effect modification were explored (interacting FN and FL with deprivation, rurality, age and gender). No significant interactions or changes to the fixed and random effects were found and hence these additional models are not reported.

Results

The characteristics of the sample data are shown in Table 2. The 4871 SfL participants allocated to take both the literacy and numeracy assessments were reduced to 4646 (FL) and 4638 (FN) after taking account of patterns of missing data among the independent variables. There was no significant patterning to the missing data. Overall 18% of the available sample self-assessed their health as poor and about 23% self-reported having at least one long-term health condition. Women respondents were more numerous but there was little difference between the sexes in terms of self-assessed health or self-reported long-term health conditions. The expected age gradients and associations with job grade were evident and both poor health and the presence of long-term conditions were associated with not owning a house. Data on ethnicity, place of birth and language gave some suggestion that poor health and long-term conditions were associated with White, English-born people and respondents with English as their first language. Overall roughly 10% of respondents were drawn from Black and minority ethnic groups, non-English speakers and people born outside the UK; around one-third were not home owners.

<<Table two about here>>

The prevalence of poor self-assessed health rose monotonically with increasing area deprivation in our sample data, with levels rising approximately three-fold between the least and the most deprived areas. An increasing gradient with deprivation was also evident for long-term health conditions. People living in urban areas appeared marginally more likely to self-assess their health as poor but there were no urban-rural differences in the reporting of long-term health conditions.

Respondents with levels of literacy and numeracy below the standard thresholds were markedly more likely to register poor self-assessed health and self-report the presence of long-term health conditions. The association with poor literacy and low numeracy appeared to be more marked in the case of self-reported health but the differentials between high and low numeracy and literacy were similar for both outcomes.

Table Three reports the results from the multilevel models of self-assessed health. The odds ratios are based on a contrast with a man aged 16-24 who is UK born, White and speaks English as his first language, who is in a managerial position and owns his own home. He lives in a less deprived urban area but has below threshold literacy and numeracy. Model one

confirms an initial expectation that above threshold literacy and numeracy are both associated with better self-assessed health. The association with literacy is stronger.

<<Table three about here>>

The associations between literacy, numeracy and better self-assessed health are only marginally attenuated in model two when age and sex enter the analysis but change more significantly in model three when socio-economic factors are taken into consideration and are yet further attenuated in model four on the inclusion of the two place-based measures. Checks for multicollinearity confirmed that added variables did not affect analyses.

The nature and pattern of attenuation differ between numeracy and literacy. Bringing socio-economic factors into the modelling process (model three) brings a larger reduction to the independent association of numeracy with self-assessed health, as judged by the changes in odds ratios, than it does to the association with literacy. The significant socio-economic factors, from those selected for analysis, appear to be job grade and home ownership. The observed associations are in the expected direction, with lower grade jobs, unemployment and renting linked to poorer self-assessed health. Ethnicity, place of birth and language were not significantly associated with self-assessed health. The additional inclusion of area characteristics in the modelling brings larger reductions in the odds ratios for literacy compared to those for numeracy. This suggests that, while the association between self-assessed health and numeracy is more strongly confounded by individual socio-economic status than that between area-based characteristics and literacy, the pattern of confounding is reversed when area variables are considered. Model four also indicates that significant independent associations between area variables and self-assessed health are evident after taking into account literacy, numeracy and individual socio-demographic factors. This association is however essentially based on deprivation; there is a clear gradient equating poorer self-assessed health with greater areal deprivation but no significant association with rurality.

Table four provides a similar analysis for the self-reported presence of long-term health conditions. The base categories in the model are the same and the model again focuses on the odds of good health, in this case the absence of long-term health conditions. Model one again suggests significant roles for literacy and numeracy and their effects appear very similar. This

situation changes in a rather different fashion to that for self-assessed health when further terms are added to the model. The overall magnitude of the associations with both literacy and numeracy are lower than they were with self-assessed health. The addition of socio-economic factors (model three) suggests, as with the modelling of self-assessed health, that the association between long-term health conditions and numeracy is attenuated more the association with literacy. The lower magnitude of the associations means however that the association with literacy attenuates to non-significance and the association with numeracy assumes greater importance than that with literacy. The addition of geographical variables in model four has little statistical significance. The non-significant association with literacy persists although it is attenuated more by the place-based variables than the association with numeracy, which retains statistical significance. Inspection of the odds ratios for multiple deprivation suggest that its independent effect is evident only at more deprived levels once numeracy (and literacy) are taken into account though, within that limited context there remains evidence for a deprivation gradient in the association with long-term conditions. Rurality is again not a significant factor.

<<Table Four about here>>

Discussion

The summary picture from our modelling is one where both literacy and numeracy show significant independent associations with self-assessed health in the face of demographic, social and geographical controls. In our models of self-reported long-term health conditions these associations are less strong and, in the face of controls, persist only for numeracy. Place-based deprivation has a greater effect on the strength of the associations with literacy than those for numeracy but the association between long-term conditions and literacy attenuates to non-significance in the face of controls for both individual socio-economic variables and area-based deprivation. Rurality was not significant in either of our analyses suggesting that, in the urbanised English context, any geographical differentiation of the associations between literacy, numeracy and either self-assessed health or long-term conditions is a reflection of deprivation rather than rural disadvantage. The absence of significant interactions in our models also ruled out the possibility of effect modification.

Our first aim focussed on the distinctive independent contributions made by functional literacy and numeracy to self-assessed health and long-term illness. The extensive literature exploring the associations between functional skills and health has to date mostly focused on reading (literacy) skills; the fewer studies exploring the associations between numeracy and health have produced mixed results and it has been argued that more evidence is needed (Berkman et al., 2011). We cast our contribution within this frame. Sabates and Parsons (2011) have pointed to a stronger association between poor numeracy and poor self-assessed health than between poor literacy and poor self-assessed health. Our study draws the opposite conclusion. We used different controls and found stronger associations with literacy. While we concur with Sabates and Parsons that both poor literacy and poor numeracy are associated with self-reported long-term conditions, we suggest that the association with literacy is not robust to controls for socio-economic or spatial confounders and attenuates to statistical non-significance. We speculate that the persistence of the association between numeracy and long-term conditions in the face of social and geographical factors may link to the recurrent everyday encounters with numbers that accompany the drug regimes and health facility attendance associated with living with long-term conditions. This may add depth to the association identified by Edwards et al. (2012) between poor health literacy and poor management of long-term conditions.

Our second aim focussed on the role of place-based disadvantage in the associations between literacy, numeracy, and health. Our review of past work revealed that, while individual disadvantage has been clearly implicated in these associations, studies of place-based disadvantage have been few and descriptive rather than analytical. We sought to move to a more analytical position distinguishing the effect of individual and place-based disadvantage. For self-assessed health, the association with numeracy showed greater attenuation with the inclusion of social variables in the model than the association with literacy. The additional consideration of place-based disadvantage brought little change to the association with numeracy while the association with literacy attenuated further. We hypothesise that the impact of place-based disadvantage on the association of literacy and self-assessed health, reflects what has been called deprivation amplification (Macintyre and Ellaway, 2003; Badland et al., 2013). Our findings regarding place effects on self-reports of long-term health condition differed. As with the analyses of self-assessed health, the association with numeracy attenuated with the inclusion of social variables and reduced only marginally more with the consideration of place-based variables. It did however remain statistically

significant in contrast to that for literacy which attenuated to non-significance suggesting that the apparent association between long-term conditions and literacy is largely an artefact of individual disadvantage.

The strengths of our analysis lie in our use of the SfLS, a well-designed large dataset, nationally representative of the English working-age population incorporating direct measurement of literacy and numeracy skills. It provides a sound empirical base for our research. We have married use of well-found data with a strong multilevel research design. Nonetheless we must acknowledge limitations to our study. Both the health and long-term conditions data in the SfLS were self-reported rather than independently verified. We also chose to focus on functional literacy and numeracy skills rather than health literacy and health numeracy, which might be expected to have a more specific relationship with health and health outcomes. In our introduction we justified this decision and we note that health literacy is highly correlated with more general literacy skills and the same is likely to be true of health numeracy (Easton et al. 2010). Third, we note potential problems with our outcome variables. Though we investigated interactions in our analyses, our measure of self-assessed health may be subject to differential interpretation and by extension differential associations with literacy and numeracy across the lifecourse (d'Uva et al., 2008). Our measure of long-term conditions was circumscribed by the SfLS and does not exclude conditions that respondents were born with; life-long experience of long-term conditions is likely to result in cumulative disadvantage over the lifecourse (Bartley and Plewis, 2002) impacting differently to later-onset long-term conditions on the association between literacy, numeracy and long-term conditions. Nonetheless people with a long-term condition, whether congenital or acquired, all need better literacy and numeracy skills to address their health needs than people without long-term conditions. Fourth, we must of course stress that our study is cross-sectional in design and focussed on associations; we do not make claims regarding causality. We should also recognise the specific UK context of our study although we would contend that our findings may be generalisable to other more developed nations. Finally, our study population were all aged 65 years or less so we are unable to generalise our results to older age groups

These last shortcomings points to potential areas for further research. Health deteriorates with age, and the risk of developing a long-term health condition increases with age. For both these reasons, the interplay of literacy and numeracy with health and illness in older people

should be explored further. An area for particular focus is the numeracy skills of older people, who may face both declining cognitive skills and hence reduced capacity , and the increased demands to (self-) manage the complexities of multimorbidity and polypharmacy. Replicating our study in other more-developed world settings will also allow an assessment of the impact of different national contexts with respect to education, life-long learning and migration. Methodologically, there is scope to extend the modelling of self-assessed health by considering a multinomial rather than binomial outcomes, and longitudinal studies could bring particular insights, enabling further research unravelling the directionality of the causal relationships between health outcomes, literacy, numeracy, individual and place-based disadvantage. Equally there is a strong case for well-designed qualitative research. A fourth area for further work lies in untangling the interplay of literacy, numeracy and educational qualifications in terms of their association with health extending ideas promulgated by Karas-Montez and Freeman (2015). As we stated earlier, our focus in this paper has been on the distinctive impacts of literacy and numeracy. We noted how literacy and numeracy are time-specific and distinct from educational qualifications. There is nonetheless an association, and the extent to which educational qualifications, or more appropriately some measure of lifelong learning, act as a latent construct impacting health clearly has merit as a topic for future research employing a more complex and ideally longitudinal research design.

Notwithstanding its limitations, our work points towards important implications for health care users, professionals, health care organisations and policy makers (including those allocating national health and lifelong learning resources). In particular, health care users face increasing requirements to become experts and manage their own health and illness. They are expected to understand and act on health promotion and disease prevention activities. If they develop an illness, particularly a long-term one, they need to understand the condition, its prognosis and its treatment (DH, 2013). This activity requires ‘work’ on behalf of the patient, and levels of literacy and numeracy influence patients’ self-assessments of their needs and capacity to respond appropriately to this growing workload. (Shippee et al., 2012) As we have noted, previous research has shown that literacy skills are important; our research goes further, indicating that numeracy is equally and independently important, and different from literacy. Service delivery needs to recognise this distinctiveness and measures to address shortfalls in literacy and numeracy need to be aware of their implications for self-assessments of health. Moreover our findings concerning associations with place-based deprivation should also be considered when local health services are developed and delivered. Health

services situated in socially deprived areas may need additional resource to support patients' numeracy and literacy needs in regards to health, through training of staff, simplifying systems and information for patients, and though collaboration with the lifelong learning community to build patient skills.

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Table 1: English National Qualifications Framework

Level	**English National Qualifications Framework age equivalent**	**Literacy** *An adult classified at the level understands*	**Numeracy** *An adult classified at the level understands*	**Examples of typical skills**
Entry 1	5-7 years	Short texts with repeated language patterns on familiar topics. Information from common signs and symbols	Information given by numbers and symbols in simple graphical, numerical and written material	Write short messages. Select floor numbers in lifts
Entry 2	7-9 years	Short straightforward texts on familiar topics. Information from short documents, familiar sources, signs and symbols.	Information given by numbers, symbols, simple diagrams and charts in graphical, numerical and written material	Describe health symptoms. Use a cashpoint machine
Entry 3	9-11 years	Short straightforward texts on familiar topics accurately and independently. Information from everyday sources.	Information given by numbers, symbols, diagrams and charts used for different purposes and in different ways in graphical, numerical and written material.	Understand price labels. Pay household bills
Level 1	Matriculation examinations (GSCE) grade D-G ; normally achieved at age 16	Short straightforward texts of varying length on a variety of topics accurately and independently. Information from different sources	Straightforward mathematical information used for different purposes. Independently select relevant information from given graphical, numerical and written material	GCSE grades D to G
Level 2 or above	GCSE grades A* to C (normally achieved at age 16) or higher qualifications (normally achieved at age 17 or higher)	A range of texts of varying complexity accurately and independently. Can obtain information of varying length and detail from different sources.	Mathematical information used for different purposes and can independently select and compare relevant information from a variety of graphical, numerical and written material	5 grades A* to C GCSE

Table 2: Health and Illness exploratory analyses

		Self-Assessed Health		Long-term Health Conditions	
		Good	**Poor**	**Absent**	**Present**
All	All people	3809 (82.0%)	837 (18.0%)	3575 (77.1%)	1063 (22.9%)
Gender	Male	1659 (81.9%)	366 (18.1%)	1551 (76.5%)	473 (23.4%)
	Female	2150 (82.0%)	471 (18.0%)	2024 (77.4%)	590 (22.6%)
Age	16-24	547 (92.6%)	44 (7.4%)	532 (90.2%)	58 (9.8%)
	25-34	799 (89.0%)	99 (11.0%)	775 (86.5%)	121 (13.5%)
	35-44	882 (84.6%)	160 (15.4%)	845 (81.3%)	195 (18.8%)
	45-54	781 (77.8%)	223 (22.2%)	711 (71.0%)	290 (29.0%)
	55-65	798 (72.0%)	310 (28.0%)	710 (64.1%)	398 (35.9%)
Ethnicity	White	3401 (81.9%)	753 (18.1%)	3176 (76.6%)	972 (23.4%)
	Black & Minority	407 (83.2%)	82 (16.8%)	396 (81.3%)	91 (18.7%)
Place of Birth	Born in UK	3324 (81.6%)	750 (18.4%)	3099 (76.2%)	967 (23.8%)
	Not born in UK	485 (84.8%)	87 (15.2%)	476 (83.2%)	96 (16.8%)
First language	English	3480 (81.7%)	779 (18.3%)	3249 (76.4%)	1003 (23.6%)
	Other than English	329 (85.0%)	58 (15.0%)	326 (84.5%)	60 (15.5%)
Job Grade	Managerial	1521 (87.8%)	212 (12.2%)	1407 (81.4%)	321 (18.6%)
	Intermediate	1096 (80.9%)	259 (19.1%)	1022 (75.6%)	329 (24.4%)
	Routine	929 (75.4%)	303 (24.6%)	891 (72.3%)	342 (27.7%)
	Unemployed	74 (61.2%)	47 (38.8%)	77 (63.6%)	44 (36.4%)
	Student	164 (93.2%)	12 (6.8%)	157 (89.2%)	19 (10.8%)
Home Ownership	Owns home	2525 (86.4%)	397 (13.6%)	2331 (80.0%)	582 (20.0%)
	Does not own home	1256 (74.4%)	432 (25.6%)	1214 (71.9%)	474 (28.1%)
Area deprivation	0 to 9 (least deprived)	887 (89.7%)	102 (10.3%)	804 (81.7%)	180 (18.3%)
	10 to 19	1286 (85.1%)	226 (14.9%)	1189 (78.8%)	320 (21.2%)
	20 to 29	681 (81.9%)	150 (18.1%)	651 (78.4%)	179 (21.6%)
	30 to 39	441 (75.6%)	142 (24.4%)	431 (73.9%)	152 (26.1%)
	40 and over	514 (70.3%)	217 (29.7%)	500 (68.3%)	232 (31.7%)
Urban or Rural	Urban	3094 (81.4%)	707 (18.6%)	2922 (77.1%)	870 (22.9%)
	Rural	715 (84.6%)	130 (15.4%)	653 (77.2%)	193 (22.8%)
Functional Numeracy	Above threshold	2835 (85.6%)	477 (14.4%)	2633 (79.5%)	679 (20.5%)
	Below threshold	970 (72.4%)	370 (27.6%)	954 (71.2%)	386 (28.8%)
Functional Literacy	Above threshold	3381 (84.3%)	630 (15.7%)	3161 (78.8%)	850 (21.2%)
	Below threshold	446 (69.6%)	195 (30.4%)	447 (69.8%)	194 (30.2%)

Table 3: Modelling self-assessed good health

		Model 1 FL & FN only	Model 2 (model 1 plus age and sex)	Model 3 (model 2 plus social factors)	Model 4 (model 3 plus geography)
Variable		**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Functional Numeracy	Above level	**1.67 (1.40 – 1.98)**	**1.71 (1.43 – 2.04)**	**1.37 (1.13 – 1.66)**	**1.32 (1.09 – 1.59)**
Functional Literacy	Above level	**2.10 (1.73 – 2.55)**	**2.01 (1.64 – 2.45)**	**1.83 (1.47 – 2.28)**	**1.51 (1.21 – 1.88)**
Age	25-34	-	**0.62 (0.43 – 0.90)**	**0.48 (0.32 – 0.72)**	**0.51 (0.34 – 0.76)**
	35-44	-	**0.41 (0.29 – 0.58)**	**0.24 (0.17 – 0.36)**	**0.25 (0.17 – 0.37)**
	45-54	-	**0.27 (0.19 – 0.38)**	**0.15 (0.10 – 0.22)**	**0.15 (0.11 – 0.23)**
	55-65	-	**0.20 (0.14 – 0.28)**	**0.10 (0.07 – 0.15)**	**0.10 (0.07 – 0.15)**
Sex	Female	-	1.04 (0.89 – 1.22)	1.04 (0.89 – 1.22)	1.04 (0.88 – 1.22)
Ethnicity	Black & minority	-	-	0.98 (0.70 – 1.39)	1.10 (0.78 – 1.56)
Place of Birth	Not born in UK	-	-	1.39 (0.94 – 2.06)	1.32 (0.89 – 1.95)
First Language	Other than English	-	-	1.48 (0.92 – 2.37)	1.46 (0.91 – 2.34)
Job Grade	Intermediate	-	-	**0.71 (0.58 – 0.88)**	**0.74 (0.61 – 0.91)**
	Routine	-	-	**0.63 (0.51 – 0.78)**	**0.69 (0.56 – 0.85)**
	Unemployed	-	-	**0.24 (0.15 – 0.38)**	**0.28 (0.18 – 0.43)**
	Student	-	-	0.84 (0.44 – 1.61)	0.89 (0.47 – 1.71)
Home ownership	Do not own home	-	-	**0.36 (0.29 – 0.43)**	**0.42 (0.35 – 0.51)**
Area Deprivation	10-19	-	-	-	**0.71 (0.56 – 0.93)**
	20-29	-	-	-	**0.60 (0.45 -0.80)**
	30-39	-	-	-	**0.50 (0.39 – 0.69)**
	40+	-	-	-	**0.41 (0.30 – 0.55)**
Urban or Rural	Rural	-	-	-	1.01 (0.81 – 1.27)

Table 4: Modelling self-reported absence of long-term health conditions

		Model 1 FL & FN only	Model 2 (model 1 plus age and sex)	Model 3 (model 2 plus social factors)	Model 4 (model 3 plus geography)
Variable		**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Functional Numeracy	Above level	**1.42 (1.21 – 1.98)**	**1.46 (1.23 – 1.73)**	**1.27 (1.05 – 1.52)**	**1.21 (1.01 – 1.45)**
Functional Literacy	Above level	**1.50 (1.24 – 2.82)**	**1.38 (1.13 – 1.68)**	1.25 (0.98 – 1.59)	1.16 (0.94 – 1.44)
Age	25-34	-	**0.67 (0.50 – 0.91)**	**0.55 (0.38 – 0.78)**	**0.55 (0.38 – 0.80)**
	35-44	-	**0.45 (0.34 – 0.59)**	**0.30 (0.21 – 0.43)**	**0.30 (0.21 – 0.43)**
	45-54	-	**0.26 (0.20 – 0.34)**	**0.16 (0.11 – 0.23)**	**0.17 (0.12 – 0.24)**
	55-65	-	**0.19 (0.15 – 0.25)**	**0.11 (0.08 – 0.16)**	**0.11 (0.08 – 0.16)**
Sex	Female	-	1.09 (0.94 – 1.26)	1.07 (0.92 – 1.24)	1.06 (0.91 – 1.24)
Ethnicity	Black & minority	-	-	0.92 (0.66 – 1.29)	0.99 (0.71 – 1.38)
Place of Birth	Not born in UK	-	-	1.42 (0.99 – 2.48)	1.42 (0.98 – 2.05)
First Language	Other than English	-	-	1.54 (0.96 – 2.49)	1.50 (0.95 – 2.38)
Job Grade	Intermediate	-	-	**0.82 (0.69 – 0.99)**	0.84 (0.70 – 1.01)
	Routine	-	-	**0.76 (0.62 – 0.93)**	**0.79 (0.65 – 0.97)**
	Unemployed	-	-	**0.36 (0.23 – 0.57)**	**0.39 (0.25 – 0.62)**
	Student	-	-	0.77 (0.44 – 1.33)	0.79 (0.45 – 1.39)
Home ownership	Do not own home	-	-	**0.44 (0.37 – 0.53)**	**0.49 (0.41 – 0.58)**
Area Deprivation	10-19	-	-	-	0.90 (0.73 – 1.11)
	20-29	-	-	-	0.85 (0.66 – 1.09)
	30-39	-	-	-	**0.76 (0.58 – 0.99)**
	40+	-	-	-	**0.61 (0.47 – 0.79)**
Urban or Rural	Rural	-	-	-	0.96 (0.79 – 1.17)