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Cross-sectional study of healthcare professionals' estimates of the health numeracy of inpatients and outpatients in a UK secondary care setting

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ABSTRACT

Introduction A cross-sectional study to identify whether healthcare professionals (HCPs) can accurately estimate the health numeracy of patients.

Methods A convenient sample of inpatients and outpatients, in an urban UK general hospital, undertook a validated health numeracy assessment and associated demographics questionnaire. HCPs who had a care interaction with the patient were shown the health numeracy assessment, informed of the mean score and SD in the assessment's validation study, and were then asked to estimate their patient's score. Outcome measures were the proportion of underestimations, correct estimations and overestimations by HCPs and a comparison of HCP estimates to the patient's score on the assessment as assessed through the intraclass correlation coefficient (ICC).

Results Health numeracy assessments were completed by 142 patients with a mean score of 38.9% and an SD of 33.4%. There were 220 estimations of patients' health numeracy obtained from HCPs. All HCP groups overestimated patient health numeracy with overestimates accounting for 66.8% of all estimates. ICC was below 0.4 for all HCP groups (ICC 0.054; 95% CI −0.078 to 0.185) indicating poor agreement between the HCPs' estimations and the patient's health numeracy as measured by the health numeracy assessment. Senior doctors (consultants and registrars) were most likely to correctly estimate patient health numeracy (20.8% and 20.0% of estimates, respectively).

Conclusions Good health numeracy is vital to effective understanding of risk, shared decision-making and the consenting process. However, HCPs of varying professional backgrounds struggle to correctly estimate their patient's health numeracy and tend to overestimate it. Given that health numeracy is poor for a large proportion of patients, there is a risk that HCPs may fail to identify scenarios in which their patient's poor health numeracy could undermine shared decision-making and/or lead to poor outcomes.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Higher health numeracy has been linked with improved comprehension of medical risk, improved compliance with medical therapies and better self-rated health. However, patient health numeracy is frequently poor and in England nearly half of working age adults have numeracy skills below the standard of GCSE grades D–G. Previous research in the field has focused on health literacy and has found that healthcare professionals can overestimate health literacy.

WHAT THIS STUDY ADDS

⇒ This is the first study of its kind from the UK and we explore health numeracy as its own domain and identify the accuracy of healthcare professional estimates of patient health numeracy in a 'real-world' clinical setting. We find that healthcare professionals from a variety of professional groups overestimate patient health numeracy.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Given what is already known on this topic, our finding that healthcare professionals tend to overestimate patient health numeracy highlights the need for further research on the reasons as to why this occurs and the potential harms that may arise.

INTRODUCTION

Numeracy is an individual's ability to confidently apply mathematical skills to everyday problems at home, at work or at school.[1] Health numeracy, as defined by Golbeck *et al*, is "the degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions."[2] Health numeracy is related to, but distinct from health literacy, which represents the ability to use literacy skills to understand and process health-related information.[2–4] Crucially, both health numeracy and health literacy involve more than just the ability to read and understand health information, but also the ability to act

on information by processing and applying it to achieve positive health outcomes.[2 4] Greater health numeracy has been linked with improved comprehension of risk during shared decision making, improved compliance with medications and therapies, and better self-rated health.[5–10]

In England, nearly half (49.1%) of working age adults have numeracy skills below the standard of grades D–G in the General Certificate of Secondary Education.[11 12] This suggests that in the healthcare setting, they might struggle to understand appointment times when described using the 24-hour clock or be unable to calculate and describe the degree of weight loss experienced.[13] Even basic self-care requires individuals to draw on multiple numeracy skills; for example, correctly dosing paediatric paracetamol requires caregivers to read a thermometer to recognise a fever, calculate the correct dose in millilitres and adhere to 4-hourly intervals and 24-hour maximum dosing limits.[14–17] The numerical complexity of this common intervention is demonstrated by multiple studies[18–20] and a retrospective analysis of cases of paracetamol-associated paediatric acute liver failure in Australia and New Zealand between 2002 and 2012 found that paracetamol overdose secondary to medication error was the leading cause of paediatric acute liver failure.[21] A 2010 experimental study which enrolled 302 parents found that, when using a dosing cup with printed markings, less than a third of parents were able to accurately dose a liquid medication.[7]

A 2015 study of health information materials found that 61% of adults were below the combined literacy and numeracy levels required to adequately understand the material.[22] Importantly, however, patients do not want written information to be a substitute for spoken information from a healthcare professional (HCP).[23] Arguably, for this reason and others, it is vital that HCPs are able to make an accurate estimation of a patient's health numeracy—this would then enable them to tailor the delivery of numeracy-based health information and facilitate patient understanding. The evidence outlined above demonstrates that a failure to identify and account for poor health numeracy risks substandard care for large proportions of the population. This study aims to identify whether HCPs are able to accurately estimate patient health numeracy in the clinical setting.

METHODS

Study design, recruitment and data collection

This was a cross-sectional study of medical and surgical inpatients and outpatients and their treating HCPs in an English urban secondary care setting. Patients and HCPs were recruited opportunistically from a mixture of inpatient wards (covering cardiology, gastroenterology, general medicine, geriatrics, haematology and oncology) and outpatient clinics (covering bariatric surgery, ear, nose and throat, general surgery, urology, outpatient endoscopy and ambulatory care). Patients were invited to the study by either their healthcare team in the ward setting or a clinic receptionist in the outpatient setting. Patients who wished to participate were then approached by the research team, received a participant information sheet and were reviewed for eligibility and, if eligible, gave written consent.

Full inclusion and exclusion criteria are listed in the online supplemental file. Adult medical or surgical inpatients or outpatients were eligible unless clinical or personal factors would impede their ability to consent or participate in the study; for example, due to acute confusion or the use of translation services for their care.

Eligible patients were invited to complete a health numeracy questionnaire and a demographics sheet which were distributed by the investigators. We used the pen and paper questionnaire GHNT-6 (General Health Numeracy Test short form)[24 25] questionnaire (figure 1), which comprises six questions with a final score of 0 to 6. The GHNT-6 is a validated tool for assessing health numeracy. Higher scores are significantly associated with: objective numeracy as assessed by validated arithmetic measures; patient subjective self-rated assessment of their numeracy and with patient medication understanding.[25] The demographics questionnaire used a sample of questions similar to the 2021 Office for National Statistics census for England and Wales. Both questionnaires were available in large-print format.

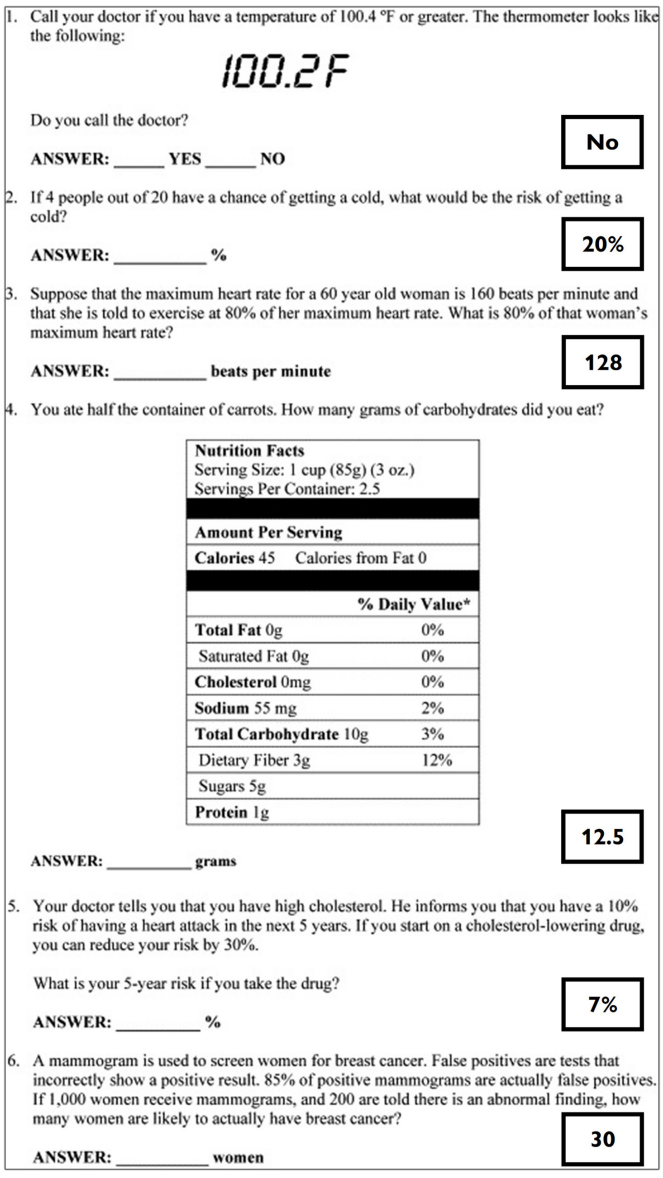
Participating patients were requested to complete the GHNT-6 independently and were permitted the use of a calculator. The GHNT-6 comprises six questions with patients scoring 1 point for each correct answer to a maximum of 6 points with no negative marking.[25] Inpatients were permitted up to 1 day to complete the questionnaire; outpatients were not restricted beyond the time they wished to remain in the care setting to complete the questionnaire.

Following completion of the questionnaire and demographics sheet by the patient, the investigator then invited eligible members of the patient's healthcare team to participate in a HCP's assessment of health numeracy. Any registered HCP who had provided recent face-to-face care for the patient was eligible to participate unless this was solely during the treatment of a medical emergency or provision of anaesthesia or sedation. Full inclusion and exclusion criteria are listed in Appendix A.

Eligible HCPs who wished to partake in the study were consented and then shown the GHNT-6 questionnaire. Alongside the questionnaire, the investigator explained that in the validation sample the average score was 42% (ie, between 2 and 3 correct questions) with an SD of 30%. The HCP was then asked to estimate the patient's score and this was recorded, alongside the HCP's role.

The study was observational and neither patients nor HCPs were informed of the other party's performance/estimate.

A power calculation was conducted using 95% confidence, a 0.175% uncertainty and a kappa of 0.03, resulting in a minimum patient sample size of 137.



1. Call your doctor if you have a temperature of 100.4 °F or greater. The thermometer looks like the following:

100.2F

Do you call the doctor?

ANSWER: _____ **YES** _____ **NO** — **No**

2. If 4 people out of 20 have a chance of getting a cold, what would be the risk of getting a cold?

ANSWER: _____ **%** — **20%**

3. Suppose that the maximum heart rate for a 60 year old woman is 160 beats per minute and that she is told to exercise at 80% of her maximum heart rate. What is 80% of that woman's maximum heart rate?

ANSWER: _____ **beats per minute** — **128**

4. You ate half the container of carrots. How many grams of carbohydrates did you eat?

Nutrition Facts	
Serving Size: 1 cup (85g) (3 oz.)	
Servings Per Container: 2.5	
Amount Per Serving	
Calories 45	Calories from Fat 0
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 55 mg	2%
Total Carbohydrate 10g	3%
Dietary Fiber 3g	12%
Sugars 5g	
Protein 1g	

ANSWER: _____ **grams** — **12.5**

5. Your doctor tells you that you have high cholesterol. He informs you that you have a 10% risk of having a heart attack in the next 5 years. If you start on a cholesterol-lowering drug, you can reduce your risk by 30%.

What is your 5-year risk if you take the drug?

ANSWER: _____ **%** — **7%**

6. A mammogram is used to screen women for breast cancer. False positives are tests that incorrectly show a positive result. 85% of positive mammograms are actually false positives. If 1,000 women receive mammograms, and 200 are told there is an abnormal finding, how many women are likely to actually have breast cancer?

ANSWER: _____ **women** — **30**

Figure 1 GHNT-6 questionnaire with correct answers overlaid on the right-hand edge*.[25] * Adapted from Patient Education and Counselling.[25] Copyright 2013, with permission from Elsevier. GHNT-6, General Health Numeracy Test Short Form.

Statistical analysis

Following collection on paper forms, the data were transcribed into a Microsoft Excel spreadsheet for subsequent analysis in R (V.4.2.3).

Demographic characteristics were analysed using descriptive statistics and missing demographic characteristics were not imputed. To protect anonymity and aid with the identification of trends, ethnicity data and education level were aggregated using the ONS 6a classification and national qualifications framework, respectively.[26 27]

The accuracy of HCP estimations was assessed using descriptive statistics by first assessing the proportions of underestimations, correct estimations and overestimations, and then through use of the intraclass correlation coefficient (ICC) to assess agreement between HCP estimates and measured health numeracy. The ICC and 95% CIs were calculated on R using the 'irr' package. ICC was calculated based on single ratings, one-way random effects model and interpreted using the criteria in Cicchetti (1994) with ICC less than 0.4 indicating poor agreement, 0.4–0.59 fair agreement, 0.6–0.74 good agreement and 0.75–1 excellent agreement.[28]

To compare the relationship between demographic characteristics and health numeracy as assessed by the GHNT-6, a multivariable ordinal logistic regression was conducted, without imputation. To ensure sufficient power, demographic variables with poor response rates were dropped. To inform the choice of variables, a directed acyclic graph was used. The regression was calculated on R using the 'MASS' package and the 'polr' function.

The proportion of correct answers for individual GHNT-6 questions was also recorded. Questions 1 and 4 identified the proportion of patients who were able to correctly answer questions on common health-related information (interpreting a thermometer and a food nutrition label respectively); while questions 5 and 6 (which considered risk reduction from medical treatment and the potential benefits from a screening programme) identified the proportion of patients with adequate numeracy skills to effectively understand and engage with shared decision making around medical risk.

Patient and public involvement

Patients from the study site were involved to aid the study design and were consulted on the aims of the study, its acceptability to patients in different clinical settings, and how the study design could be improved. Patients also reviewed the first iteration of the study questionnaires with feedback subsequently used to improve the study design.

RESULTS

Study patient population

A sample of 142 patients was recruited over 8 months. Compared with the national population in England,[29] there was a greater proportion of female patients (57.7% in the study population compared with 48.3% nationally), and the study population was on average older (mean age 53.2 years, SD 18.2) than the national population (mean 40.6, SD 23.6).

English was the first language of 82.4% of patient participants compared with 89.9% nationally. Similarly, a smaller proportion of the study population were born in the UK (67.6%) and were of white ethnicity (65.0%) when compared with the proportion in the national population (82.6% and 81.0%, respectively).

The patients in the study were more likely to be educated to degree level than the national population (49.2% vs 33.9%, respectively) but less likely to be in employment

Table 1 Further demographic characteristics of the study patient population and national population

Characteristic	Study population % (n)	National population[29] %
Ethnicity: (n=137)		
Asian/Asian British	6.6 (9)	9.6
Black/Black British/ Caribbean/African	13.9 (19)	4.2
Mixed or multiple	9.5 (13)	3.0
Other	5.1 (7)	2.2
White	65.0 (89)	81.0
First language: (n=142)		Main language:
English	82.4 (117)	89.9
Other	17.6 (25)	10.1
English language fluency for participants where English is not their first language (self-rated): (n=25)		
Well or very well	84 (21)	79.8
Not well	12 (3)	17.1
Not at all	4 (1)	3.1
Highest qualification achieved: (n=138)		
Degree or equivalent	49.2 (68)	33.9
A-level, AS-level or equivalent	13.7 (19)	16.9
GCSE or equivalent	21.0 (29)	23.0
None	11.6 (16)	18.1
Other	4.3 (6)	–
Employment status: (n=134)		
Employed	50.0 (67)	57.4
Long-term sick or disabled	14.2 (19)	4.1
Homemaker or carer	6.0 (8)	4.8
Retired	23.9 (32)	21.5
Student, unemployed or voluntary work	12.2 (8)	12.2

AS-level, Advanced Subsidiary levels; GCSE, General Certificate of Secondary Education (post-16 qualification).

(50.0% vs 57.4%) with greater proportions of individuals who were retired or long-term sick/disabled.

Table 1 presents further demographic characteristics within the study population compared with the national population in England as reported from the UK 2021 census.

GHNT-6 performance

The mean patient GHNT-6 score was 2.33 (38.9%) with an SD of 2.00 (33.4%), median score was 2. Online supplemental table 1 presents patient score by frequency.

Reviewing GHNT-6 questions 1 and 4, question 1 (interpreting medical advice and a thermometer reading) was correctly answered by 59.2% of individuals (n=84) and question 4 (interpreting a food nutrition label) was correctly answered by 16.2% of individuals (n=23). For question 5 (calculating an individual's absolute risk reduction from medical treatment) 28.9% of individuals (n=41) answered correctly and for question 6 (calculating the anticipated number of women with breast cancer in a screening programme) 31.7% of individuals (n=45) answered correctly.

The multivariable logistic regression (online supplemental table 2) demonstrated a positive association between White ethnicity and GHNT-6 score (OR 2.19 (95% CI 1.07 to 4.55)) and a positive association between education to a level 4 standard (equivalent to a certificate of higher education or a higher apprenticeship)[27] or higher and GHNT-6 score, when compared with no qualification (OR 16.4 (95% CI 5.14 to 55.91)).

HCP estimates

A total of 220 HCP numeracy estimations were obtained; 55% of estimations (N=121) were from doctors, 35% (N=77) were from nurses and 10% (N=22) were from allied health professionals (AHPs).

In total, 15.9% (N=35) of all estimates by HCPs were correct. Senior doctors were most likely to correctly estimate (registrars 20.8% and consultants 20.0%) patients' health numeracy. All professional groups most commonly overestimated patients' scores on the GHNT-6. Resident doctors (foundation doctors and senior house officers) (14.9%) and nurses (14.3%) performed similarly in terms of correct estimations, although resident doctors more commonly overestimated when compared with nurses (74.5% vs 66.2%, respectively). AHPs were most likely to overestimate and least likely to correctly estimate health numeracy (77.3% overestimates vs 9.1% correct estimates). Table 2 details the proportion of different estimates among the HCP groups.

ICC was below 0.4 for all HCP groups (table 3) showing poor agreement between HCP estimations of patients' health numeracy and measured health numeracy level using GHNT-6.

DISCUSSION

Principal findings

This study is the first UK study of its kind looking at the accuracy of HCP estimations of patients' health numeracy as compared with assessed health numeracy using GHNT-6 in a secondary care setting. The study found that HCPs overestimated patients' health numeracy 66.8% of the time. All HCP groups had a low proportion of correct estimates of patients' health numeracy (9.1%–20.8%) with senior doctors having the greatest proportion of correct estimates.

ICC was below 0.4 for all HCP groups. This indicates that there is poor agreement between HCPs' estimations of patients' health numeracy and the measured health numeracy using GHNT-6.

Table 2 Proportion of overestimations, underestimations and correct estimations by healthcare professional groups

	Overestimations		Underestimations		Correct estimations	
Professional group	N	%	N	%	N	%
Foundation doctors and senior house officers	35	74.5	5	10.6	7	14.9
Registrars	10	41.7	9	37.5	5	20.8
Consultants	34	68.0	6	12.0	10	20.0
Nurses	51	66.2	15	19.5	11	14.3
AHPs	17	77.3	3	13.6	2	9.1
All HCPs	147	66.8	38	17.3	35	15.9

AHPs, allied health professionals; HCPs, healthcare professionals.

The mean patient score on the health numeracy assessment tool was 38.9%. The study found 40.8% of patients were unable to answer a question on interpreting a thermometer and 71.1% of patients were unable to correctly calculate an absolute risk reduction for a notional medical treatment given sufficient information.

Patient performance on the GHNT-6, when assessed using multivariable ordinal logistic regression, was positively associated with White ethnicity (OR 2.19 (95% CI 1.07 to 4.55)) and having a level 4 qualification (equivalent to a certificate of higher education or a higher apprenticeship)[27] or higher (OR 16.4 (95% CI 5.14 to 55.91)).

What does this study mean and add to existing data?

Prior research within the field has principally focused on health literacy, with health numeracy often being considered only as a subset of health literacy.[2] Studies looking solely at health numeracy have generally focused on the measurement of patient health numeracy within different populations—these have found that a substantial proportion of patients, across various clinical settings, have poor health numeracy.[30–33] This is a finding we have replicated with a sizeable minority (40.8%) of the patients in our study having health numeracy too poor to interpret a thermometer and associated instructions.

Table 3 Intraclass correlation coefficient assessing inter-rater agreement between HCP estimates and health numeracy as measured by GHNT-6, by healthcare professional groups and 95% CIs

Professional group	Total estimations provided	ICC (95% CI)
Foundation doctors and senior house officers	47	0.25 (–0.03 to 0.50)
Registrars	24	0.23 (–0.17 to 0.57)
Consultants	50	–0.09 (–0.36 to 0.19)
Nurses	77	–0.12 (–0.34 to 0.10)
AHPs	22	0.28 (–0.14 to 0.62)
All HCPs combined	220	0.05 (–0.08 to 0.19)

AHPs, allied health professionals; GHNT-6, General Health Numeracy Test Short Form; HCPs, healthcare professionals; ICC, intraclass correlation coefficient.

Where studies have included investigation into the estimation of patients' health numeracy by HCPs, this has been through the use of mixed literacy/numeracy assessment tools such as Newest Vital Sign and Short version of the Test of Functional Health Literacy in Adults.[34–36] Both of these assessments provided a more limited assessment of numeracy when compared with the GHNT-6 and do not distinguish between literacy and numeracy skills within the composite total score.[37 38] There is an emerging body of evidence demonstrating that literacy and numeracy are different skills with different cognitive processing pathways, and so it cannot be assumed that a health literacy/numeracy composite measure is a valid indicator of health numeracy in isolation.[39–43]

This study explores health numeracy as its own domain, using a validated measure that solely assesses health numeracy (the GHNT-6), and alongside measurement of objective patient health numeracy also explores the subjective estimations of patient health numeracy by HCPs. Additionally, this study assesses health numeracy in a 'real-world' clinical setting where the HCPs are providing direct clinical care to patients, and where patients are being assessed while in the 'clinical state' in which they would typically seek health information from a HCP. To the authors' knowledge, this is the first study to compare HCP estimates against a single, objective measure of patient health numeracy in a clinical setting. Thus, our finding that HCPs are most commonly overestimating health numeracy is a novel finding that has important implications for practice.

The assessment and application of health numeracy skills could conceivably apply to almost all direct patient care. Previous research has shown that greater health numeracy has been linked with improved comprehension of risk during shared decision making.[5 6 9 10] Yet, in our study population, which had a higher level of tertiary education than the national population, only 28.9% were able to correctly calculate the absolute risk reduction for a patient starting cholesterol-lowering treatment for ischaemic heart disease.

It could be harmful to overestimate health numeracy even during relatively common clinical interactions. For example, we can consider 'safety netting', a clinical method for managing diagnostic uncertainty by highlighting when a patient should seek further medical support.[44] In our study 4 in 10 patients were unable to identify a fever by comparing a thermometer reading to a previous instruction—a common mechanism of 'safety netting'. This could impede safety netting and cause a delay in seeking further care.

These examples highlight the potential risk of overestimating a patient's health numeracy and the importance of taking steps to ensure that numerical information is provided in a way that can be understood and used by the patient. Currently, health information is often not presented in a manner that is accessible to patients' health numeracy level[22 45] despite evidence for interventions that improve comprehension of numerical health information.[46] This may undermine meaningful shared decision making and support for patients in self-care.

Unanswered questions and future research

Our study has identified that in the secondary care setting, HCP estimation alone is not able to reliably estimate patient health numeracy levels. Further study is needed to understand if the accuracy of HCP estimates varies in primary or tertiary care given the different levels of continuity of care. Additionally, as a quantitative survey, our study cannot provide qualitative insights that might explain why HCPs overestimate health numeracy. Future research on health numeracy should use a mixture of methodological approaches to help improve our understanding of the factors HCPs use to gauge health numeracy in patients. Our study also does not investigate any impact on clinical outcomes nor HCP or patient decision-making—further research on the potential harms related to patient health numeracy and its estimation by HCPs is required. Finally, it is also not known which interventions, if any, work to improve HCP estimates of health numeracy and the role health numeracy tools can play in the clinical setting outside of research to support HCPs' understanding of their patients' health numeracy.

Strengths and weaknesses of this study

The study population was recruited and tested within the clinical setting in which they will be required to use their health numeracy skills. Patients were therefore assessed in 'real-world' conditions reflecting elements that might impair their health numeracy level such as illness or anxiety. Additionally, this study adds to the literature by including colleagues across the multidisciplinary team (MDT), as most published literature to date in health literacy focuses primarily on the accuracy of estimations in doctors, with some literature including nurses and physiotherapists.[35 47] This increases the generalisability of the findings across the MDT, particularly at a time of workforce and role development within the National Health Service (NHS).[48] Our methodology was designed to maximise the accessibility of the study with no requirement to use a digital device and with methodology adaptations to improve access. In this study, this was particularly important as these could act as barriers to patients with lower health literacy and numeracy. For example, patients had a choice of standard and large print type and investigators were permitted to read aloud the questions.

There are a number of limitations to the design of this study. As a single cross-sectional survey, it is not possible to explore how HCP estimates of health numeracy may change over time. The study recruitment was opportunistic, leading to inherent volunteer bias, which may mean patients with lower health numeracy were less likely to take part. Further, due to the use of convenience sampling in areas with dynamic populations, it was not possible to accurately determine a sampling frame and so a response rate. The study also recruited participants from a single site, a secondary care setting. As such, there is a risk that the study population is not representative of the UK population as a whole and thus the findings' generalisability may be limited—for example, the study population is older and more educated than the national average. Due to the diverse languages spoken within the hospital's community it was not feasible to have health numeracy questionnaires in other languages; this led to the exclusion of patients' needing a translator and so impacts the generalisability of the findings to this diverse population. While the GHNT-6 is a validated tool for assessing health numeracy, it may not fully capture context-specific enablers and barriers for health numeracy within the clinical setting. Similarly, although patients were assessed in 'real-world' conditions, they were permitted to use calculators which may not reflect the routine clinical environment, limiting ecological validity. Finally, although we met our recruitment target to achieve sufficient statistical power for the overall analysis, subgroups analyses are underpowered, particularly among AHPs. This limits the ability to compare findings between professional groups.

CONCLUSIONS

Good health numeracy is vital for effective patient understanding of medical risk and shared decision-making.[5 6 9 10] In this study, we have found that the health numeracy of patients in a secondary care setting is frequently poor—40.8% of patients were unable to interpret a thermometer alongside medical instructions and 71.1% of patients were unable to correctly calculate an absolute risk reduction for a notional medical treatment given sufficient information.

We also found that HCPs from a range of professional backgrounds most commonly overestimate the health numeracy of their patients as measured by GHNT-6 questionnaire. All HCP groups had a low proportion of correct estimates of patients' health numeracy (9.1%–20.8%).

Given that health numeracy is poor for a large proportion of patients,[30–33] there is a risk that HCPs' poor estimations of their patients' health numeracy could undermine meaningful shared decision-making and support for patients or lead to adverse outcomes.

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Contributors CA contributed to study design, recruitment, data collection, statistical analysis and interpretation, and manuscript development. CB contributed to recruitment, data collection, interpretation of statistical analysis and produced the first manuscript draft. RM, AM and LG contributed to recruitment, data collection and manuscript development. SB contributed to statistical analysis and interpretation and manuscript development. CP was the chief investigator for the study and contributed to study design, statistical analysis and interpretation, and manuscript development. CP and CA are responsible for the overall content (as guarantors).

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Health Research Authority and Health and Care Research Wales (22/NS/0053) and ethics approval was given by the North of Scotland Research Ethics Committee. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data comprises deidentified participant data (health numeracy assessments, patient demographics, healthcare professional estimates) and are available on reasonable request to Kathryn Simpson, Head of Research at the Whittington Health NHS Trust at whh-tr.researchsupport@nhs.net.

Author note Transparency Declaration: All authors affirm that this manuscript is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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