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# General Practitioners' Risk Literacy and Real-World Prescribing of Potentially Hazardous Drugs: A Cross-Sectional Study

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**What is already known on this topic:** The pervasive issue of overusing medical care, particularly in the context of potentially hazardous drugs, poses a threat to patients' safety and quality of care. Previous studies using hypothetical scenarios indicate that physicians' risk literacy can influence the propensity for low-value prescribing, but correlations with real-world prescriptions are lacking.

**What this study adds:** In our cross-sectional study involving 304 English general practitioners (GPs) and their National Health Service (NHS) prescription data, we observed that GPs with lower risk literacy were considerably more likely to prescribe potentially hazardous drugs such as opioids or benzodiazepines compared with GPs with higher risk literacy. In addition, GPs with lower risk literacy reported more conflicts of interest and more often misevaluated the benefit–harm ratio of drugs in low-value prescribing scenarios.

**How this study might affect research, practice or policy:** Given the associations between GPs' levels of risk literacy and overprescribing potentially hazardous drugs teaching programs on risk in medical school and ongoing medical training should be made mandatory in order to foster safer patient care.

**Abstract**

**Background.** Overuse of medical care is a pervasive problem. Studies using hypothetical scenarios suggest that physicians' risk literacy influences medical decisions; real-world correlations, however, are lacking. We sought to determine the association between physicians' risk literacy and their real-world prescriptions of potentially hazardous drugs, accounting for conflicts of interest and perceptions of benefit–harm ratios in low-value prescribing scenarios.

**Setting & Sample.** Cross-sectional study—conducted online between June and October 2023 via field panels of [name of survey sampling institute] (city, country)—with a convenience sample of 304 English general practitioners (GPs).

**Methods.** GPs' survey responses on their treatment-related risk literacy, conflicts of interest, and perceptions of the benefit–harm ratio in low-value prescribing scenarios were matched to their UK National Health Service (NHS) records of prescribing volumes for antibiotics, opioids, gabapentin, and benzodiazepines and analyzed for differences.

**Results.** 204 GPs (67.1%) worked in practices with ≥6 practicing GPs and 226 (76.0%) reported 10–39 years of experience. Compared with GPs demonstrating low risk literacy, GPs with high literacy prescribed fewer opioids (mean [*M*]: 60.60 vs. 43.88 prescribed volumes/1,000 patients/6 months, $P = 0.016$), less gabapentin (*M*: 23.84 vs. 18.34 prescribed volumes/1,000 patients/6 months, $P = 0.023$), and fewer benzodiazepines (*M*: 17.23 vs. 13.58 prescribed volumes/1,000 patients/6 months, $P = 0.037$), but comparable volumes of antibiotics (*M*: 48.84 vs. 40.61 prescribed volumes/1,000 patients/6 months, $P = 0.076$). High risk literacy was associated with lower conflicts of interest ($\phi = 0.12$, $P = 0.031$) and higher perception of harms outweighing benefits in low-value prescribing scenarios ($P = 0.007$). Conflicts of interest and benefit–harm perceptions were not independently associated with prescribing behavior (all *P*s > 0.05).

**Conclusions and Relevance.** The observed association between GPs with higher risk literacy and the prescription of fewer hazardous drugs suggests the importance of risk literacy in enhancing patient safety and quality of care.

## BACKGROUND

The provision of too much medicine—which is likely to cause more harm than good—is a pervasive problem in high-income countries.[1] Directly measuring medicine overuse is challenging due to the difficulty of defining appropriate care for patients with individual preferences and needs. Indirect approaches via examinations of variations in prevalence of procedures, prescriptions, and intensity of care, however, suggest that high-income countries face high rates of overuse across a wide range of services and prescriptions.[1,2] Overuse can detrimentally impact patients' health, both physically and psychologically, and strain the healthcare system by squandering resources and funds that could be more effectively allocated elsewhere.

Past research indicates that physicians' level of medical risk literacy,[3-10] and, as a variant of risk literacy, their numeracy,[11-13] can considerably influence their recommendations and decisions. Medical risk literacy refers to the cognitive ability to understand and interpret numerical statistical information (e.g., relative vs. absolute risk) related to medical interventions. While these studies provide important insights into the role of these cognitive abilities on physicians' judgments and decisions, their significance is limited due to the fact that they usually employ hypothetical scenarios and do not investigate real-world behavior. Little is known about how risk literacy impacts physicians' real-world prescribing practices, especially in the context of potentially hazardous drugs like antibiotics, opioids, gabapentin, and benzodiazepines. In Europe, a prescription from a physician, typically a general practitioner (GP), is mandatory for each of these drugs, as they carry significant risks to patient safety and health when not used appropriately.

Our study sought to determine the association between GPs' level of risk literacy and their real-world prescribing of antibiotics, opioids, gabapentin, and benzodiazepines in England. Acknowledging that factors such as conflicts of interest[14,15] and perceptions of benefit–harm balance in low-value prescribing scenarios[16] can influence prescription patterns as well, we also investigated whether these factors independently contribute to GPs' prescriptions of these potentially hazardous drugs.

## METHODS

### *Study design*

The study reported herein is of an explorative, cross-sectional design. We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for our reporting. This study was approved by the Institutional Review Board (IRB) of [name of institution]. Written informed consent, granted by the Institutional Ethics Review Board of [name of institution], was obtained online from all participants at the study outset.

### *Participants and recruitment*

A cross-sectional national convenience sample of 304 English GPs, which approximates the distribution in years of profession of the general population of GPs in England (**Supplement 1**), was drawn from an established internet physician panel maintained by [name of survey sampling institute] (city, country) between June and October 2023. The panel contains about 7,500 verified English GPs out of approximately 45,000 actively practicing GPs and is representative in terms of age, gender, and years in profession. Physicians are recruited to the panel via a multichannel recruitment strategy that includes email marketing, online campaigns, live events, recommendations from other physicians, and classic partnership marketing. Before being accepted to the panel, physicians undergo a rigorous identification check that includes verification as a licensed physician and identity validation.

To accurately gauge the potential impact of risk literacy on the entirety of prescribing volume variation, we sought to balance the proportion of GPs falling into the categories of “low,” “medium,” and “high” prescribers. We therefore applied a multiplestep procedure. In March 2023, we gathered National Health Service (NHS) data on the prescribing volumes of antibiotics, opioids, gabapentin, and benzodiazepines for the period between July and December 2022 from OpenPrescribing.net, encompassing all active English practices during that timeframe. We then computed the monthly average prescribing volume, adjusted for patient numbers in each practice, and z-standardized the data while addressing outliers. Z-standardized data were used to create a composite score that informed the creation of three prescription quotas (low, medium, high). [Name of survey sampling institute] was commissioned to sample about 100 GPs for each of the three prescription quotas. To match GPs with the quota and their prescribing data, [name of survey sampling institute] required participants to enter their NHS practice code or their address as included in the OpenPrescribing.net dataset. If participants matched to one of the quotas and consented to participate, they proceeded to the online questionnaire.

***Survey questionnaire***

To measure treatment-specific risk literacy, we asked GPs seven multiple-choice questions retrieved from two validated questionnaires by Caverly and colleagues (2015)[17] and Anderson and colleagues (2014)[18] (survey, **Supplement 1**). First, we retrieved only the items from the two questionnaires that were generalizable across medical disciplines (e.g., we excluded items in the questionnaire by Anderson and colleagues that were specific to obstetricians and gynecologists). Next, we aligned the response options of the items by formatting the questions into a single choice format that presented a choice between four options: the correct answer, two incorrect answers, and one ‘don’t know’ option. The questions evaluated GPs’ interpretation of treatment effectiveness when expressed in various statistical formats such as number needed to treat, absolute risk, and relative risk. To avoid order effects, questions and response options were presented in a randomized order among participants. To evaluate GPs’ conflicts of interest, participants answered five questions from a questionnaire by Lieb and colleagues[14] that covered topics such as frequency of visits from pharmaceutical representatives, perceived influence of pharmaceutical representatives on prescribing behavior, and trustworthiness of received drug-related information. To investigate GPs' perceptions of benefit–harm balance in low-value prescribing scenarios, participants were presented with three scenarios where evidence suggests an unfavorable benefit–harm ratio of prescribing: antibiotics for otitis media, long-term strong opioids for chronic noncancer pain),[19,20] and benzodiazepines for insomnia. After each scenario, GPs were queried on their perception of the benefit–harm balance of prescribing using a 5-point scale ("The benefits clearly outweigh the harms," "The benefits somewhat outweigh the harms," "Benefits and harms are balanced," "The harms somewhat outweigh the benefits," "The harms clearly outweigh the benefits").

***Primary and secondary endpoint measures***

The primary outcome was the absolute prescribing volume (details, **Supplement 1**) per drug (antibiotics, opioids, gabapentin, benzodiazepines) per practice over 6 months per 1,000 patients, adjusted to the individual proportion of the drug-specific prescribing volume per drug for the period between July and December 2022. Secondary outcomes were associations between risk literacy, conflicts of interest, and benefit–harm assessments of nonevidence-based prescription scenarios.

***Data handling***

Risk literacy, conflicts of interest, and assessment of benefit–harm balance all yielded ordinal data. To better explore and illustrate the potential absolute effect between prescribing volumes and independent variables (e.g., risk literacy), we binarized the range of the potential scores for risk literacy, conflicts of interest, and the assessment of benefit–harm balance in the middle of their respective score distribution. That is, for risk literacy, with a score distribution of zero to seven correct responses, we categorized 0 to 3 correct answers as 'low risk literacy' and 4 to 7 correct answers as 'high risk literacy.' For conflicts of interest, we binarized each of the five questions into 'low' and 'high,' created a sum score across the five questions (minimum: 0, maximum: 5), and split that score in the middle of the distribution by classifying values of 0 to 2 as 'low conflicts of interest' and of 3 to 5 as 'high conflicts of interest.' For GPs' perception of the benefit–harm balance in low-value prescribing scenarios, responses incorrectly assuming a benefit were coded 0 and correctly assuming a harm were coded 1. We created a sum score across the three questions (minimum: 0, maximum: 3), and split that score in the middle of the distribution by classifying 0 to 1 as 'incorrectly assuming more benefits' and 2 to 3 as 'correctly assuming more harm.'

### *Analysis*

To ensure that effects are robust and independent of the cut-off criteria for the split scores, all associations for the primary analyses were analyzed with Kendall's Tau rank correlation (correlation coefficient $\tau$) for the continuous, nonparametric data (details and analyses, **Supplement 2**). To better understand and illustrate how medical risk literacy affected absolute prescribing volumes, we tested differences in individual prescribing volumes per drug between low and high risk literacy groups with a two-sample *t*-test and used Cohen's *d* (the difference between the pooled standard deviations from both groups) as a measure of effect size. If a Levene's test for homogeneity of variance was at least marginally significant ($P \leq 0.10$), we used the more robust Welch two-sample *t*-test instead. The same analysis strategy was pursued for testing the effects of low versus high conflicts of interest on prescribing behavior. Drug-specific prescribing behavior (e.g., antibiotics) was tested against GPs' drug-specific perception of the benefit–harm balance in low-value prescribing scenarios (e.g., antibiotics for otitis media) with a *t*-test. Chi-square tests were used to test the associations between the split scores of risk literacy, conflicts of interest, and benefit–harm perception. Wilcoxon rank sum tests were used to determine whether the numbers of patients per practice and years of experience differed between practitioners with high and low scores in risk literacy, conflicts of interest, and benefit–harm assessment of low-value care. $P$ values were two-sided, with statistical significance set at $P < 0.05$. All data were stored and analyzed utilizing R basic software and the packages effectsize, DescTools, psych, and car.

## RESULTS

Table 1 shows demographic characteristics of our sample of 304 GPs. The largest group ($n$ = 119; 39.1%) reported working in a practice with 6–10 GPs and had been practising for 10–19 years ($n$ = 116; 38.2%).

[Insert Table 1 about here]

### *Risk literacy and prescribing behavior*

GPs' risk literacy was significantly associated with prescribing volumes for opioids ($\tau$ = –0.14, $P < 0.001$), gabapentin ($\tau$ = –0.11, $P < 0.01$), and benzodiazepine ($\tau$ = –0.14, $P <$ 0.001), but not for antibiotics ($\tau$ = –0.06, $P$ = 0.131). Binarizing medical risk literacy across the sample, we observed that 38.8% of GPs ($n$ = 116) demonstrated low risk literacy and 61.8% ($n$ = 188) demonstrated high risk literacy (overall distribution of scores, **Supplements 1 & 2**). Compared with GPs with low risk literacy (Figure 1A), GPs with high risk literacy prescribed lower volumes of opioids (mean [*M*]: 60.60 vs. 43.88 per 1,000 patients over 6 months; $P$ = 0.016, $d$ = 0.31), lower volumes of gabapentin (*M*: 23.84 vs. 18.34/1,000 patients/6 months; $P$ = 0.023, $d$ = 0.27), lower volumes of benzodiazepines (*M*: 17.23 vs. 13.58/1,000 patients/6 months; $P$ = 0.037, $d$ = 0.25), and comparable volumes of antibiotics (*M*: 48.84 vs 40.61/1,000 patients/6 months; $P$ = 0.076, $d$ = 0.23).

[Insert Figure 1 about here]

### *Conflicts of interest and prescribing behavior*

Most GPs (91.4%; *n* = 278) reported taking no gifts from pharmaceutical representatives, not giving paid interviews (95.1%; *n* = 289), and seeing a pharmaceutical representative less than once a month to never (76.3%; *n* = 232). Just over half (54.9%; *n* = 167), however, regarded themselves as 'frequently to always' receiving adequate and accurate information from their pharmaceutical representatives, and 35.9% (*n* = 109) reported that their prescribing behavior is 'frequently to always' influenced by pharmaceutical representatives' advice. Differences in the level of conflicts of interest were not associated with differences in the prescribed volumes of any of the four drug types (antibiotics: *P* = 0.489; opioids: *P* = 0.873; gabapentin: *P* = 0.942, benzodiazepines: *P* = 0.197; Figure 1B).

***Perceptions of benefit–harm balance for low-value prescriptions and prescribing behavior***

For the low-value prescription of antibiotics to patients presenting with otitis media, most GPs (79.3%; *n* = 241) believed that antibiotics would have more benefits than harms. Differences in that assessment were not associated with differences in GPs' prescribed volumes of antibiotics (*P* = 0.369). For prescribing strong opioids long-term to patients presenting with chronic noncancer pain, the majority of GPs (62.8%; *n* = 191) knew that the harms outweighed the benefits. These differences were not associated with GPs' prescribed volume of opioids (*P* = 0.557). The low-value prescription of benzodiazepines for insomnia was also perceived as more harmful than beneficial by most GPs (71.4%; *n* = 217), with no association with prescribing volumes of benzodiazepines (*P* = 0.567; see Figure 1C).

***Other associations***

GPs' risk literacy was also associated with their conflicts of interest (τ = –0.11, *P* = 0.013) and their perceptions of the benefit–harm balance for low-value prescriptions (τ = 0.17, *P*

< 0.001). Compared with GPs with low risk literacy, GPs with high risk literacy more often had low conflicts of interest ($\chi^2(1) = 4.63$, $\phi = 0.12$, $P = 0.031$) and more often perceived that the harms outweighed the benefits in the low-value prescription scenarios ($\chi^2(1) = 7.36$, $\phi = 0.16$, $P = 0.007$). Similarly, compared with GPs with high conflicts of interest, GPs with low conflicts of interest were more likely to believe that the harms outweighed the benefits in the low-value prescription scenarios ($\chi^2(1) = 5.00$, $\phi = 0.13$, $P = 0.025$). GPs' risk literacy and their benefit–harm perceptions were not associated with the number of colleagues working in their practice ($P_{RiskLiteracy} = 0.261$; $P_{COI} = 0.322$; $P_{Assessment} = 0.653$) or their years of experience ($P_{RiskLiteracy} = 0.260$; $P_{Assessment} = 0.566$). However, there was an association between GPs' conflicts of interest and their years of experience: GPs with ≤19 years of experience were significantly less likely to report conflicts of interest than those with ≥20 years of experience ($\chi^2(1) = 6.45$, $\phi = 0.15$, $P = 0.011$).

## DISCUSSION

Doing too much in medicine constitutes a significant concern in healthcare systems worldwide.[1,21,22] Excessive prescriptions of drugs and administration of medical services can lead to unnecessary healthcare costs, adverse effects, and harm to patients, particularly in the case of high-risk drugs. In this cross-sectional study of 304 English GPs, we observed that those with low risk literacy were significantly more inclined than those with high risk literacy to prescribe more opioids, gabapentin, and benzodiazepines. These findings demonstrate the impact that physicians' comprehension and integration of medical statistics can have on prescription practices and unwarranted variation of care.[23] Our results are consistent with prior research highlighting inadequate levels of risk literacy among certain numbers of physicians.[3-4,6-10] They also reinforce earlier studies, primarily employing hypothetical scenarios, which underscore the substantial influence of physicians' risk literacy and numeracy on communication with patients,[12] screening recommendations,[3,5-11,24] and treatment evaluation.[4,18,25]

We did not detect a similar effect of risk literacy on prescribing antibiotics, and we can only speculate on why this was the case. One reason might be that for over a decade now the NHS has invested in numerous educational and awareness campaigns aimed at reducing unnecessary antibiotic prescriptions in response to the escalating concern over antibiotic resistance. These broad efforts, targeting both healthcare professionals and the public, have led to a widespread awareness of antibiotic resistance that may have fostered a collective effort by both physicians and patients to curtail unnecessary antibiotic prescriptions. While the NHS and other health organizations have recently also been promoting safe prescribing practices for opioids, these initiatives are less prominent and widespread as those for antibiotics. Another reason might be that antibiotics are commonly prescribed preemptively (‘delayed prescription’) to patients with mild symptoms as a precautionary measure due to challenges in accessing healthcare promptly, allowing patients to fill the prescription if their symptoms rapidly worsen rather than wait for another appointment. Healthcare systems that cannot ensure timely care may offset the potential impact of GPs’ risk literacy on their prescribing practices.

We did not find an independent association between GPs’ reported conflicts of interest and their prescriptions, which contrasts with the findings of some other studies.[14,15,26] The study by Lieb and colleagues[14] that established such a relationship among German GPs found a considerably higher level of conflicts of interest than in our English sample: While 98% of German GPs reported seeing their pharmaceutical representatives at least once a week and 69% reported frequently accepting gifts from pharmaceutical representatives, rates among the GPs in our sample were much lower (14.8% and 8.6%, respectively). DeJong and colleagues[15] also reported an association between pharmaceutical industry-sponsored meals and physicians’ prescribing patterns of statins, beta-blockers, and other drugs for Medicare beneficiaries in the U.S. Their analyses were based on payment data from the Open Payment Program, which provided explicit information on whether a meal promoted a specific brand-name drug. Because we assessed only general sponsored dinner participation, which does not allow for establishing a direct link between a dinner invitation and a particular drug, we may have underestimated the effect of conflicts of interest on prescribing behavior. However, we found an association between GPs' conflicts of interest and their risk literacy: GPs who were better at interpreting medical statistics appeared to be less likely to obtain information from and form relationships with pharmaceutical representatives.

Our study also suggests that GPs' understanding of medical statistics heightens their awareness of potential harms associated with low-value prescribing practices. It is worth noting, however, that although unnecessary antibiotic use is one of the best-documented instances of medication overuse worldwide[1,2] and has been the focus of numerous educational campaigns, a majority of GPs in our sample believed that the benefits of prescribing antibiotics in the low-value prescribing scenario outweighed the harms, which is in line with findings from other studies.[27,28] The unwarranted positive assessment of low-value antibiotic prescription contrasts with the scenarios involving low-value prescribing for opioids and benzodiazepines, where the majority of GPs correctly perceived the harms of these drugs to outweigh the benefits.

***Limitations***

Our study has limitations. First, the generalizability of our results may be limited by our sample, which consisted of a convenience sample of GPs in England. Second, our study was explorative and thus does not establish causality between risk literacy and prescribing behavior. Third, while we observed significant associations between prescriptions for opioids, gabapentin, and benzodiazepines, it is noteworthy that correlations and effect sizes are small, implying the influence of additional factors on

GPs' prescribing behavior. Fourth, while prescribing more rather than fewer drugs can be an indicator of overuse,[1] it does not constitute definitive proof of overuse or nonevidence-based practice. Fifth, we had no NHS information for specific therapeutic group age–sex related prescribing units (STAR-PU) for opioids, gabapentin, and benzodiazepines, which may influence prescribing volumes. Primary analyses for antibiotic prescriptions that applied and did not apply the antibiotic-specific STAR-PU, however, left findings on the direction and size of effects unchanged.

### *Implications for policy and practice*

Our findings have significant implications for policy and practice. In light of evidence demonstrating the effectiveness of brief and low-cost lessons in enhancing medical risk literacy,[29-31] we advocate for efforts to incorporate instruction on understanding evidence, particularly health statistics, into medical training and continuing medical education (CME). These easily implementable interventions have the potential to mitigate unnecessary prescribing. Additionally, ample evidence supports the use of transparent risk formats and visualization decision aids[7,27,31-33] to help physicians accurately judge the benefits and harms associated with drugs and other medical interventions. Adding visualization aids to medical guidelines and educational materials would provide busy physicians with quick, comprehensive insights into a drug's expected outcomes, thereby fostering a safer allocation of care.

### *Conclusion*

Physicians worldwide provide low-value care for numerous reasons.[22] Our study suggests a new and previously unexplored dimension to the problem of overuse and low-value care: physicians' ability to correctly understand and deal with medical statistics. Given the devastating effects that unnecessary prescriptions of potentially hazardous drugs can have on patients' health and safety, further studies are needed to investigate the generalizability of our findings in other healthcare settings and delve deeper into associations with other contributing factors (e.g., barriers to timely health care access) in order to better understand what undermines the practice of evidence-based prescribing.

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**Table 1.** Summary of demographics of English general practitioners assessed in the study

| | Total | Lower risk literacy | Higher risk literacy | *P* value [a] |
|---|---|---|---|---|
| **Sample size (%)** | 304 | 116 (38.2) | 188 (61.8) | |
| **Years of experience, *n* (%)[b]** | | | | **0.386** |
| < 10 years | 63 (20.7) | 23 (19.8) | 40 (21.3) | |
| 10–19 years | 116 (38.2) | 42 (36.2) | 74 (39.4) | |
| 20–29 years | 75 (24.7) | 26 (22.4) | 49 (26.1) | |
| 30–39 years | 40 (13.2) | 19 (16.3) | 21 (11.2) | |
| ≥ 40 years | 10 (3.3) | 6 (5.2) | 4 (2.1) | |
| **Size of practice, *n* (%)[b]** | | | | **0.093** |
| 1 practitioner | 3 (1.0) | 2 (1.7) | 1 (0.5) | |
| 2–3 practitioners | 17 (5.6) | 7 (6.0) | 10 (5.3) | |
| 4–5 practitioners | 80 (26.3) | 21 (18.1) | 59 (31.4) | |
| 6–10 practitioners | 119 (39.1) | 53 (45.7) | 66 (35.1) | |
| > 10 practitioners | 85 (28.0) | 33 (28.4) | 52 (27.7) | |
| **Patient list size, *M* (*SD*)** | | | | **0.320** |
| | 13,215 (9,972) | 12,491 (8,827) | 13,663 (10,615) | |
| **Conflicts of interests, *n* (%)[b]** | | | | **0.031** |
| Low | 249 (81.9) | 88 (75.9) | 161 (85.6) | |
| High | 55 (18.1) | 28 (24.1) | 27 (14.4) | |
| **Perception of benefit–harm ratio across all scenarios, *n* (%)[b]** | | | | **0.007** |
| More benefits than harms | 125 (41.1) | 59 (50.9) | 66 (35.1) | |

| | | | | |
|---|---|---|---|---|
| More harms than benefits | 179 (58.9) | 57 (49.1) | 122 (64.9) | |

[a] $\chi^2$ tests for differences between risk literacy groups. [b] Percentages are rounded and may not add up to 100.

**Figure 1:** Mean differences in GPs' NHS-recorded prescribing volumes of antibiotics, opioids, gabapentin, and benzodiazepines, measured over 6 months, adjusted by patient size of GPs' practice and their individual proportion of drug-specific prescriptions in association to their (A) level of risk literacy, (B) level of conflicts of interest, and (C) perception of harms in drug-specific low-value prescription scenarios (excluding gabapentin). Error bars show standard errors (SE) of the means.

*two-sided significance at $P < 0.05$.