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Effects of pharmacists' communication strategies and patients' numeracy skills on willingness to take medication

Akira Yoshida[1], Norimitsu Horii[1,2], Shinji Oshima[1,*], Shigeru Oshima[1,2], Daisuke Kobayashi[1,2]

[1]Faculty of Pharmacy and Pharmaceutical Sciences, Josai University, Saitama 350-0295, Japan
[2]Josai University Pharmacy, Saitama 350-0451, Japan

*Corresponding author. Faculty of Pharmacy and Pharmaceutical Sciences, 1-1 Keyakidai, Sakado-shi, Josai University, Saitama 350-0295, Japan.
E-mail: soshima@josai.ac.jp

Abstract

Objective: This study investigated whether providing numerical adverse event information and social norm nudging in medication counselling enhances patients' willingness to take medication differently, depending on their numeracy skills.

Methods: An online survey was conducted with 554 Japanese adults who were randomly assigned to one of four medication counselling scenarios, combining numerical and non-numerical adverse event information with or without a social norm nudge. After viewing counselling videos on a hypothetical diabetes drug, participants' willingness to take the medication and subjective numeracy skills were assessed.

Key findings: The results indicated that numerical adverse event information significantly improved medication willingness among more numerate participants, but had no significant effect on less numerate participants. In contrast, social norm nudging was more effective for less numerate individuals, whereas it had no significant effect on more numerate participants.

Conclusions: The findings underscore the importance of tailoring counselling strategies to patients' numeracy levels to optimize decision-making and improve adherence. As a practical implication, the findings suggest that brief numeracy screening before medication counselling may enable pharmacists to optimize their communication strategies. Moreover, the findings offer a foundation for pharmacists to implement numeracy-based communication strategies in clinical counselling to enhance patient-centred communication.

Keywords: adherence; patient behaviour; medication risk; patient safety; health promotion; pharmaceutical public health; decision aids; evidence-based practice

Introduction

In Japan, where the population is aging, many patients require long-term treatment for chronic diseases, such as hypertension and diabetes [1–3]. However, medication adherence remains low, partly because recognizable symptoms are lacking [4]. Approximately 50% of patients with chronic diseases fail to take their medications as prescribed [5], and 33%–69% of hospitalizations for worsening chronic diseases have been attributed to poor adherence [6]. In contrast, patients willing to initiate drug therapy tend to demonstrate better long-term adherence [7, 8]. Therefore, fostering patients' willingness to take medication at the start of treatment is essential for improving adherence over time. In Japan, pharmacists are responsible for both dispensing medications and providing medication counselling. Given this role, the present study regards pharmacists as potential implementers of communication strategies aimed at improving medication adherence in clinical practice.

In recent years, there has been growing interest in interventions aimed at increasing patients' medication willingness by providing numerical information in the field of risk communication. Accurate comprehension of the risks associated with medicines is crucial, as patients' risk perception of drug-related adverse events (AEs) significantly influences their willingness to take medication [9–11]. For example, presenting the likelihood of AEs as a numerical value, such as '5%', rather than a non-numerical descriptor like 'rarely', has been shown to increase willingness, whereas non-numerical formats tend to cause risk overestimation and reduce willingness [10]. Therefore, incorporating numerical information into medical communication is expected to enhance medication willingness by reducing the uncertainty surrounding treatment outcomes. However, patients with low numeracy—the ability to understand numerical data—are more likely to rely on non-numeric peripheral factors, such as the format of information or emotional cues [12, 13]. Thus, risk communication alone may be insufficient for patients with low numeracy skills.

Nudging, from behavioural economics, employs subtle adjustments to choice architecture to influence decision-making [14, 15]. A nudge is defined as 'any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives' [16]. Although nudging may infringe on a patient's autonomy, its use in

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health care is generally encouraged if it is ethically justifiable [15]. Common nudge techniques include framing, reminders, social modelling, and emphasizing social norms [17, 18]. For instance, a study involving patients with psoriasis found that a social norm nudge—conveyed through the statement, 'Tens of thousands of people are using this drug with great success'—induced a higher willingness to initiate biological treatments than other techniques, such as framing [19]. Similarly, a study on colorectal cancer screening in England found that statements emphasizing social norms, such as those including 'many people', increased screening intentions more effectively than presenting the actual uptake rate [20]. Furthermore, previous studies have shown that individuals with lower domain knowledge and numeracy are more affected by various nudges; conversely, the effects of nudges are attenuated in more numerate individuals [21, 22].

Given these contrasting approaches, risk communication may be less effective for individuals with low numeracy, whereas nudging may have limited benefits for those with high numeracy. However, an integrated study across these two fields is yet to be conducted. The present study examined whether these approaches differ in effectiveness depending on patients' numeracy to provide tailored interventions during medication counselling. A randomized online survey was conducted in which participants were assigned to one of four counselling scenarios, varying in numerical AE information and social norm nudging, followed by an assessment of their numeracy levels to examine differential effects across numeracy groups. Specifically, the following hypotheses were tested:

H1: In the more numerate group, numerical AE information will lead to a greater improvement in medication willingness than social norm nudging.

H2: In the less numerate group, social norm nudging will lead to a greater improvement in medication willingness than numerical AE information.

Methods

Participants

The market research firm, Rakuten Insight (Tokyo, Japan), conducted an online survey targeting Japanese adults aged 20–79 years. All participants were required to be nonmedical professionals. The number of survey responses was adjusted to reflect Japan's demographic structure, with quotas established for each sex and age group, representing Japan's population distribution.

Procedure

The study employed a survey method using a between-subjects design based on previous research [10, 11], which investigated medication counselling scenarios using audiovisual videos. The survey was conducted from 16 to 19 May 2022. Participants accessed the survey via their smartphones or tablets and completed the following steps: first, the participants indicated whether they had a history of diabetes ('yes'/'no') and their current health status on a seven-point Likert scale. Next, the participants read the following preliminary information: 'Imagine that you have been diagnosed with diabetes in a hospital. Diabetes requires treatment owing to the symptoms caused by high blood sugar levels, which can lead to serious complications, such as atherosclerosis and renal failure. Your doctor has prescribed a 30-day supply of diabetes medication for initial use. You bring your prescription to a pharmacy, where a pharmacist provides information about the medication'.

Before viewing the medication-counselling video, the participants were instructed to move to a quiet setting and enable audio on their device. Each participant was then randomly assigned to one of four medication counselling videos. After watching the video, the respondents indicated their willingness to take medication and completed the Subjective Numeracy Scale.

Medication counselling scenarios

The present study employed four medication counselling scenarios to investigate the effects of numerical AE information and social norm nudges on medication willingness. Participants were randomly assigned to one of the following scenarios: (i) non-numerical AE information without a social nudge (non-numeric/non-nudge), (ii) non-numerical AE information with a social nudge (non-numeric/nudge), (iii) numerical AE information without a social nudge (numeric/non-nudge), or (iv) numerical AE information with a social nudge (numeric/nudge). Each video was standardized to approximately 3 min.

In each scenario, a simplified patient information leaflet for a hypothetical diabetes drug was displayed on the screen, accompanied by an audio explanation provided by a male pharmacist in his forties. The pharmacist first provided basic instructions on how to administer the medication, including dosage, timing, and steps to follow if a dose was missed. This was followed by an explanation of the benefits of the medication, emphasizing its ability to lower blood glucose levels and reduce the risk of serious complications, such as atherosclerosis and renal failure. Finally, potential AEs were described. Figure 1 illustrates the screens displayed to participants during the AE explanation. In non-numeric scenarios, AEs were communicated qualitatively using terms such as 'occasionally' or 'rarely'. In numeric scenarios, AEs were presented quantitatively, with phrases such as '< 5%' or '< 0.01%'. For the nudge scenarios, the pharmacist concluded by highlighting social norms, stating, 'An increasing number of people in Japan are now being treated for diabetes, just like you. Many of them are taking this medicine'. In the non-nudge scenarios, blank screens and silence were presented for the same duration to maintain consistency.

Ethical approval

This study was approved by the Josai University Ethics Review Committee for Medical and Life Science Research on Human Subjects (approval number: 2022-01). Written informed consent was not obtained for the survey because all participants agreed to participate after reading the online information sheet. The data collected from the survey were anonymized and kept confidential according to Rakuten Insight's privacy policy.

Outcome measures

The study's primary outcome was the proportion of participants who were categorized as willing to take medication. Following the counselling videos, the participants completed an online questionnaire. Willingness and unwillingness (reverse-scored scale) were assessed using two 7-point Likert scales (1 = strongly disagree, 7 = strongly agree). Participants were categorized as willing if their willingness scores exceeded their unwillingness scores. The proportions of participants categorized as willing were compared across the scenarios.

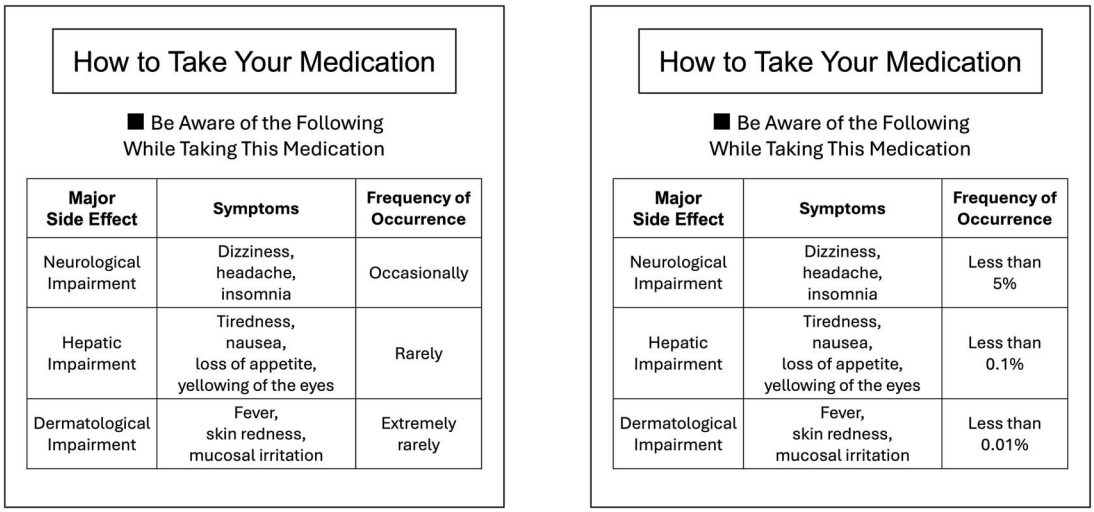

Figure 1. Medication counselling scenarios. Left is the video image in the non-numeric condition, and right is that in the numeric condition.

Measuring numeracy

Participants' numeracy was measured using the Subjective Numeracy Scale, a questionnaire-based psychological scale employing six-point Likert scales and consisting of two factors: cognitive abilities and preference for numbers [23]. The cognitive ability factor includes items such as calculating a tip ('How good are you at calculating a 15% tip?') [23], which may not be culturally appropriate for Japanese participants. Therefore, only the preference factor, which consists of culturally neutral items, was used in this study. The scales were translated from English into Japanese and back-translated by a native English speaker to ensure equivalence with the original items.

Data analyses

All statistical analyses were conducted using R software (version 4.1.2). Descriptive statistics were computed to summarize the participants' demographics, including age, sex, and subjective numeracy scores for each counselling scenario. Chi-squared tests and one-way ANOVA were performed to verify that random assignments produced comparable groups with no significant differences in categorical and continuous variables, respectively. The participants were subsequently divided into more and less numerate groups based on the mean numeracy score. The proportion of participants categorized as 'willing' was calculated for each numeracy group, and chi-squared tests were used to evaluate significant differences in willingness between the groups. Finally, to test the study hypotheses, logistic regression analyses were separately conducted for the more and less numerate groups to examine the effects of counselling scenarios on willingness to take medication, controlling for potential confounders, such as age and sex. The adjusted odds ratios and 95% confidence intervals (CIs) were used to interpret the results.

Results

The results supported both hypotheses, revealing a significant interaction between numeracy levels and the effectiveness of communication strategies. Specifically, numerical AE information enhanced willingness to take medication among more numerate participants, whereas social norm nudging was more effective among those with lower numeracy. No significant differences were found in demographic variables across the experimental conditions.

Participant demographics

Of the 600 respondents, 554 were included in the analysis; 46 with a history of diabetes were excluded. The demographic characteristics of the respondents are summarized in Table 1. Among the 554 participants, 47.1% were men, with scenario-specific proportions ranging from 46.4% to 48.2%. The mean age was 50.4 ($SD = 15.5$) years, the mean health status score (seven-point scale) was 5 ($SD = 1.3$), and the mean subjective numeracy score (six-point scale) was 4.3 ($SD = 0.7$). Statistical analyses revealed no significant differences in sex distribution, age, health status, or subjective numeracy across the four scenarios, indicating that the random assignments successfully ensured demographic comparability.

Willingness to take medication between the numeracy groups

Participants were divided into the more and less numerate groups using the overall mean subjective numeracy score. Among the 260 participants in the more numerate group, 59.6% (95% CI: 56.6%–62.7%) were classified as willing to take the medication. In contrast, 48% (95% CI: 45%–50.9%) of the 294 participants in the less numerate group were classified as willing. A chi-squared test confirmed that the proportion of willing participants was significantly greater in the more numerate group than in the less numerate group ($\chi^2 = 7.073$, $df = 1$, $P < .01$, Cramér's $V = 0.11$).

Willingness to take medication by scenarios

The proportion of participants categorized as willing to take medication varied by scenario and numeracy groups (Fig. 2). In the more numerate group, the highest willingness was observed in the numeric/non-nudge scenario (73.9%), followed by the non-numeric/nudge (58.1%) and numeric/nudge (54%) scenarios, with the lowest proportion in the non-numeric/non-nudge scenario (51.5%). In the less numerate group, willingness was highest in the numeric/nudge scenario (63%), followed by the non-numeric/nudge scenario (54.7%), whereas lower proportions were seen in the non-numeric/non-nudge (36%) and numeric/non-nudge (38%) scenarios.

Table 1. Demographics of the respondents.

	Overall	Non-numeric/Non-nudge	Non-numeric/Nudge	Numeric/Non-nudge	Numeric/Nudge
n	554	141	137	140	136
Number of male (%)	261 (47.1)	68 (48.2)	64 (46.7)	65 (46.4)	64 (47.1)
Average age (*SD*)	50.4 (15.5)	50.7 (15.5)	50.3 (15.8)	49.9 (15.4)	50.8 (15.4)
Average health status (*SD*)	5.0 (1.3)	4.8 (1.4)	5.1 (1.2)	5.0 (1.4)	5.0 (1.4)
Average subjective numeracy (*SD*)	4.3 (0.7)	4.4 (0.7)	4.3 (0.7)	4.4 (0.7)	4.3 (0.6)

Note: Health status was scored on a 7-point scale and subjective numeracy on a 6-point scale.

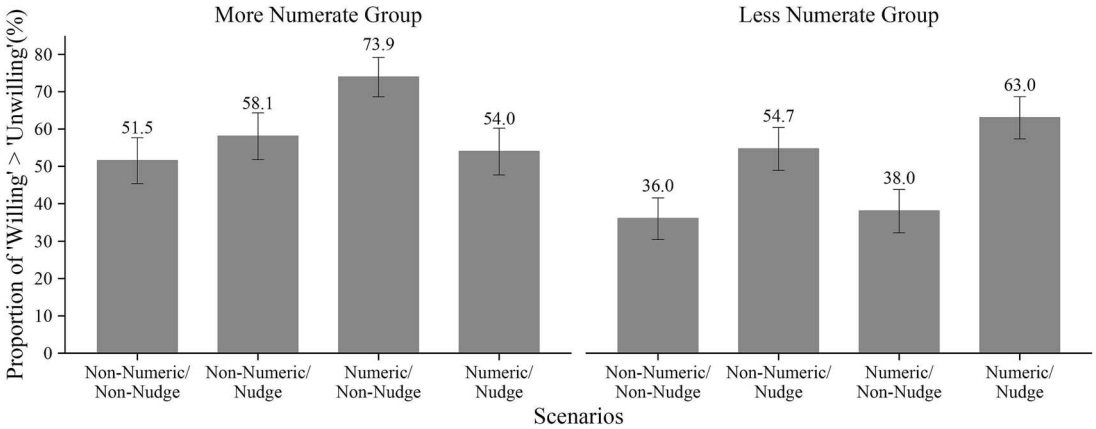

Figure 2. Proportion of willingness across scenarios by numeracy group. Error bars represent 95% confidence intervals.

Table 2. Logistic regression results for factors influencing medication willingness.

Group	Term	OR	95% CI (Lower–Upper)	*P*
More numerate	Numeric	2.64	1.29–5.52	<.01*
	Nudge	1.28	0.64–2.60	.488
	Male	0.78	0.63–2.56	.342
	Age	1.00	0.98–1.01	.786
	Health status	1.09	0.90–1.31	.373
	Numeric × Nudge	0.32	0.12–0.89	<.05*
Less numerate	Numeric	1.05	0.53–2.08	.882
	Nudge	2.06	1.07–4.02	<.05*
	Male	0.85	0.52–1.39	.514
	Age	1.00	0.98–1.01	.518
	Health status	1.21	1.01–1.45	<.05*
	Numeric × Nudge	1.37	0.53–3.57	.512

Note: 'Term' represents the explanatory variables in the model, 'OR' indicates the adjusted odds ratios, and '95% CI' shows the confidence intervals. The reference categories were non-numeric (for numeric), non-nudge (for nudge), and female (for male). *$P < .05$.

Logistic regression analyses were conducted to identify the factors influencing willingness in the more and less numerate groups (Table 2). In the more numerate group, numeric information significantly increased willingness [adjusted odds ratio (OR) = 2.64, 95% CI: 1.29%–5.52%, $P < .01$]. However, the interaction between numeric information and nudging showed a negative effect (OR = 0.32, 95% CI: 0.12%–0.89%, $P < .05$). In the less numerate group, nudging significantly enhanced willingness (OR = 2.06, 95% CI: 1.07%–4.02%, $P < .05$), and health status also had a positive effect (OR = 1.21, 95% CI: 1.01%–1.45%, $P < .05$). Other variables, including age and sex, were not significantly associated with willingness to take medication in either group.

Discussion

The present study found that numeracy moderated the effectiveness of communication strategies in medication counselling. Specifically, numerical information was more effective for more numerate individuals, whereas social norm nudging was more effective for less numerate individuals.

This study's findings suggest that numeracy plays an important role in how patients interpret medical information. It is conceptualized as a construct distinct from educational attainment or general intelligence and is regarded as a key factor in clinical decision-making [13]. A substantial proportion of adults lack basic numeracy skills, which can impair their ability to comprehend medical information and make informed treatment choices [24]. Furthermore, numeracy has been shown to influence the quality of decision-making by shaping the balance between emotional and intuitive responses to health-related information [22]. Accordingly, numeracy can be understood as the capacity to objectively evaluate provided information, and the present findings suggest that screening for this ability in advance may help optimize communication strategies regarding medical information.

This study had some limitations. First, as with most online surveys, the sampling process may have introduced selection bias, particularly related to variations in participants' digital literacy. This could limit the findings' generalizability. Second, the study's primary outcome was immediate willingness to take medication following a brief counselling session. Although this provides valuable insights into the initial decision-making processes, it does not directly assess long-term medication adherence or compliance. Future studies should examine the relationship between short-term willingness and sustained adherence over extended periods to evaluate the practical implications of these interventions. Third, this study relied on hypothetical scenarios of medication counselling rather than actual clinical settings. Although a controlled design ensures comparability across conditions, it may not capture the complexities of real-world interactions between patients and healthcare providers. Future studies should test these interventions in clinical environments to confirm their effectiveness and applicability in daily practice.

The more numerate group demonstrated an overall higher willingness to take medication than the less numerate group, and providing numerical AE information significantly enhanced their willingness. This result supports H1 and aligns with prior studies [9–11]. Numeracy skills are crucial for understanding risk–benefit information involving uncertainty, particularly when presented as probabilities or frequencies, and for making informed health-related decisions [12]. The present study's findings suggest that reducing uncertainty surrounding treatment outcomes enabled more numerate individuals to prioritize the long-term benefits of preventing diabetes progression over the short-term risks associated with medication. However, the combination of numerical information and social norm nudging resulted in a negative interaction effect that reduced willingness. This outcome may have occurred because the social norm nudge shifted attention away from numerical information, thereby diminishing its influence. For more numerate individuals who tend to base their decisions heavily on quantitative data, such a shift in focus may undermine the intended benefits of numerical information. Additionally, the order of information presentation may have exacerbated this effect, as prior research indicates that information presented last tends to receive greater attention [25]. In the present study, nudges, being the final component of the counselling videos, may have overshadowed the numerical information, diminishing its perceived impact. Alternatively, the combination of multiple informational cues may have increased cognitive load or reduced message coherence, thereby attenuating the individual components' effectiveness. Future research should investigate factors that interfere with the effectiveness of numerical information in such contexts.

Conversely, in the less numerate group, social norm nudging significantly enhanced medication willingness, thus supporting H2. This finding aligns with previous research suggesting that individuals with lower numeracy are less adept at processing numerical information and tend to rely more on non-numerical cues and emotional factors when making decisions [21, 22]. In contrast to the more numerate group, numerical information did not significantly increase willingness in the less numerate group, highlighting their limited ability to interpret and utilize quantitative data effectively. Furthermore, the less numerate group demonstrated overall lower medication willingness than the more numerate group, emphasizing the importance of prioritizing decision-making assistance for this group. By providing relatable behavioural cues, social norm nudges may have compensated for these limitations, reinforcing the perceived legitimacy of choices and supporting patients in their treatment decisions. However, as highlighted in prior research, social norm nudges can backfire when they unintentionally normalize undesirable behaviours, or when individuals perceive normative information as irrelevant or misaligned with their own context, underscoring the need for a precise and context-sensitive design [26, 27]. The social norm was presented in the survey because the hypothetical drug in the scenarios was assumed to be widely used in the initial treatment of diabetes; however, this nudge may not be contextually appropriate for rare diseases and treatments.

Future studies could explore not only real-world validation but also potential refinements of the intervention itself—such as optimizing the order, framing, or combination of numerical information and nudges—and tailoring these strategies to patient attributes, including medical conditions, sex, and age group. Furthermore, provider-related factors, such as the pharmacist's sex, age, and communicative style, may also influence intervention effectiveness and should be considered in future research.

Conclusion

The present study revealed an interaction between communication strategies and patients' numeracy in enhancing willingness to take medication. Numerical AE information was more effective at improving willingness among more numerate participants, whereas social norm nudging had a stronger impact on less numerate participants. These findings highlight the importance of tailoring medication counselling strategies according to patients' numeracy skill levels to optimize adherence. Given its brevity and feasibility, the numeracy screening approach used in this study may be readily integrated into pharmacy workflows with minimal burden, such as during patients' waiting time, thereby facilitating tailored communication in routine practice. As this study was based on a hypothetical scenario, future research should include piloting the intervention in community pharmacy settings to evaluate its feasibility and impact in real-world practice.

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Author contributions

Akira Yoshida (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing—original draft, Writing—review & editing), Shinji Oshima (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing—review & editing), Norimitsu Horii (Conceptualization, Investigation, Methodology, Project administration, Writing—review & editing), Shigeru Ohshima (Conceptualization, Investigation, Methodology, Project administration, Writing—review & editing), and Daisuke Kobayashi (Conceptualization, Investigation, Methodology, Project administration, Writing—review & editing).

Conflict of interest

The authors declare that there are no conflicts of interest.

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Data availability

All materials supporting the findings of the study are available from the corresponding author upon reasonable request.

Data access statement

All authors had complete access to the study data. Data collected through Rakuten Insight, excluding respondents' private information (e.g. names, addresses, and email addresses), were made available for browsing and analysis.

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