

Numeracy in Practice

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PR1 Literature Review / Health

INTRODUCTION

The intersection of numeracy and health literacy represents a pivotal domain within public health research, underpinning the capacity of individuals to engage effectively with health-related information, make informed decisions, and navigate the healthcare system. Numeracy, or the ability to understand and work with numbers, plays a critical role in health literacy, encompassing both subjective and objective dimensions: an individual's confidence in handling mathematical tasks and their actual ability to perform these tasks, respectively. This literature review delves into the significance of numeracy within the health sector, examining how numerical skills influence health communication, decision-making, and outcomes. The analysis integrates findings from a spectrum of studies, highlighting the complexities of conveying health-related numerical information and the implications for patient care and public health initiatives.

In the rapidly evolving landscape of healthcare, the intersection of mathematical competence and health literacy, numeracy encompasses the ability not only to understand, interpret, and apply numerical data but also to make informed decisions based on this information. Therefore, the complexity of health numeracy unfolds through how patients and healthcare consumers engage with numerical information, from statistical risk assessments to medication dosages and beyond. Research underscores the diversity in preferences for receiving health information, revealing a pronounced inclination towards visual data representations and the significant role of numeracy in processing this information effectively. The direct correlation between numeracy levels and health outcomes further highlights the critical nature of this skill set, illustrating the challenges faced by individuals with limited numeracy in navigating the healthcare system and adhering to treatment protocols.

Acknowledging the pivotal role of numeracy, this review examines various interventions aimed at enhancing numeracy skills within the healthcare context. From the adaptation of communication strategies to the implementation of educational programs, these initiatives seek to align health information with patients' numeracy levels, thereby fostering greater comprehension and confidence in health decision-making processes. The exploration of numeracy's influence on health decisions, particularly in complex scenarios such as cancer treatment, emphasizes the necessity of clear, patient-centered communication in healthcare.

THE COMPLEXITY OF HEALTH NUMERACY

The multifaceted nature of health numeracy has been extensively explored in the literature, revealing its critical role in both understanding quantitative health information and having the



confidence to apply this information effectively. Van Weert et al. (2021) highlight a universal preference for graphical over textual representations of risk information among different age groups, with an observation that tables are particularly effective in enhancing comprehension. This is echoed by Hamstra et al. (2015), who argue for the combined use of numerical data and visual aids to improve communication regarding health risks, despite a noted discrepancy in the preference for pictographs. These studies emphasize the importance of developing health communication strategies that are sensitive to the varied preferences and abilities of patients.

The correlation between numeracy and health outcomes has been firmly established, illustrating that higher numeracy skills are associated with better health behaviors and outcomes. Ancker & Kaufman (2007) demonstrate that individuals with lower numeracy levels face difficulties in grasping risk-related information, which adversely affects their adherence to treatment regimens. Schapira et al. (2011) similarly show that low numeracy limits patients' capacity to comprehend the benefits of treatments, influencing their health decisions. Estrada et al. (2007) link poor numeracy with suboptimal management of chronic conditions, such as anti-coagulation therapy. These findings collectively underscore the pivotal role of numeracy in enabling patients to make informed and thus better health decisions.

INTERVENTIONS TO IMPROVE NUMERACY

In response to the acknowledged significance of numeracy in healthcare, interventions aimed at enhancing numeracy skills have been developed. Schwartz et al. (2007) examined the efficacy of presenting risk information in various formats, identifying those that individuals with lower numeracy found more comprehensible. This suggests the potential of customizing health communications to match individuals' numeracy levels. Furthermore, Bulf et al. (2019) investigated the impact of educational interventions within medical schools, noting improvements in subjective numeracy, or self-confidence in numeracy skills, even when objective numeracy did not show significant change. This indicates the value of fostering confidence alongside skills in numeracy.

Further emphasizing the importance of numeracy, Zikmund-Fisher et al. (2011) explored how numeracy influences health decisions, particularly in the context of breast cancer treatment options, revealing how the presentation and order of numerical data can significantly affect choices. Ancker et al. (2022) critique the current methods of presenting numerical health information, advocating for a uniform and patient-centered approach in healthcare communication. These contributions highlight the complex interplay between numeracy and health literacy, stressing the need for strategic efforts to enhance numeracy as part of comprehensive health literacy initiatives.

NUMERACY AND HEALTH

Outcomes The association between numeracy and health outcomes is comprehensively documented, illustrating that individuals with limited numeracy skills often exhibit negative perceptions toward health screening and a lower level of health-related knowledge. Smith et al.



(2016) highlight this correlation, while Lopez-Perez et al. (2015) and Janz et al. (2016) examine the connection between numeracy and decision-making in the context of localized prostate cancer and post-surgery cancer recurrence, advocating for communication strategies that effectively combine verbal and numerical information to overcome the obstacles presented by limited numeracy.

Furthermore, Ciampa et al. (2010) investigate how numeracy influences the dynamics of communication between healthcare providers and patients, suggesting that adapting communication to match patients' numeracy skills—both perceived and actual—can significantly improve their understanding of risk information. Petrova et al. (2016) explores the practical implications of numeracy in making healthcare decisions, finding that individuals with superior numeracy skills tend to seek medical help more promptly during critical health episodes, such as acute coronary syndromes. These findings emphasize the essential role of numeracy in fostering proactive health behaviors and informed decision-making, which are critical in influencing positive health outcomes.

NUMERACY AND PREVENTIVE HEALTH BEHAVIORS

The impact of numeracy also extends to preventive health behaviors, which include a range of activities from vaccinations and screenings to lifestyle modifications aimed at disease prevention. There is a clear indication that individuals with higher numeracy skills are more inclined to participate in these preventive measures, highlighting the importance of numerical literacy in health promotion and disease prevention efforts. Peters et al. (2007) demonstrate that increased numeracy is linked to a higher propensity for engaging in preventive health actions, such as receiving flu vaccines and undergoing cancer screenings. This suggests that numeracy enhances an individual's capacity to understand the probabilities and risks associated with health behaviors, supporting informed and deliberate decision-making.

Additionally, Reyna and Brainerd (2007) introduce the "fuzzy trace theory," positing that health related information is processed through both precise (verbatim) and general (gist) memory traces. This theory points to the crucial function of numeracy in helping individuals derive meaningful insights from health information, thus positively affecting their willingness to engage in preventive health behaviors. The capacity to interpret numerical data, including statistical risks of not adopting preventive measures, plays a significant role in shaping health-related decisions and behaviors.

THE ROLE OF NUMERACY IN UNDERSTANDING PUBLIC HEALTH MESSAGES

Numeracy significantly influences the comprehension and impact of public health messages, which often incorporate numerical data to outline risks and guidelines. During the COVID-19 pandemic, the reliance on numerical information by public health officials, detailing infection rates, vaccine efficacy, and associated risks, underscored the importance of numeracy. Galesic et al. (2009) found that individuals with enhanced numeracy were more adept at understanding and applying COVID-19 public health advice, demonstrating numeracy's vital role in navigating public health emergencies.



Moreover, the manner in which numerical information is presented in public health messaging, such as depicting risks in absolute versus relative terms, plays a critical role in shaping public perceptions and behaviors. The ability to accurately interpret these figures, a skill contingent upon a certain level of numeracy, is essential for converting complex data into practical, actionable insights. Fischhoff et al. (2013) advocate for boosting numeracy within the general populace as a means to amplify public health campaign effectiveness, facilitating improved risk assessment and adherence to health directives.

These insights underscore the profound effect that numeracy skills have on individual health behaviors and outcomes, emphasizing the imperative for targeted initiatives to enhance numeracy within public health frameworks. Such efforts aim to equip the population with the requisite skills to effectively interpret health-related numerical data, thereby augmenting the success of preventive health initiatives and public health messaging, contributing to superior health outcomes and minimizing healthcare expenditures.

This narrative aligns with the broader research consensus highlighting the correlation between numeracy and favorable health outcomes. Ancker & Kaufman (2007) revealed that patients with limited numeracy faced challenges in understanding risk information regarding treatment options, adversely affecting treatment adherence and outcomes. Schapira et al. (2011) reinforced this viewpoint, noting that insufficient numeracy compromised patients' capacity to evaluate treatment efficacy, potentially influencing healthcare decision-making. Beyond acute healthcare contexts, Estrada et al. (2007) associated low numeracy with poor self-management in chronic conditions, such as anticoagulation therapy. Collectively, these studies accentuate the indispensable role of numeracy in empowering individuals to make knowledgeable health-related decisions, fostering improved health outcomes.

THE INTERPLAY BETWEEN NUMERACY AND HEALTH TECHNOLOGY, OUTCOMES AND MANAGEMENT

The intersection of numeracy and health technology represents a growing area of interest, particularly as advancements in mobile health applications and personal health trackers become increasingly central to modern healthcare. These technologies' success often hinges on users' ability to comprehend and act upon the data presented. Mendiola et al. (2015) examined the features and effectiveness of mobile health apps, emphasizing the importance of user engagement and understanding. Notably, individuals with advanced health numeracy are more adept at accurately interpreting data from health applications, thereby facilitating more informed decisions and health-related behaviors.

Kobayashi et al. (2016) delved into the nexus of health literacy, which encompasses numeracy, and the utilization of internet-based tools for health information. Their research suggests that those with higher numeracy skills are more proficient in leveraging online health information, highlighting numeracy's critical role in navigating the digital health environment.

In the realm of chronic disease management, numeracy is indispensable. Patients managing chronic conditions like diabetes, hypertension, or heart disease frequently base daily health



decisions on numerical data such as blood glucose levels, blood pressure readings, and medication dosages. Cavanaugh et al. (2008) explored how numeracy influences self-management behaviors in diabetes patients, finding a positive correlation between numeracy and improved disease control and management outcomes.

Additionally, Apter et al. (2008) investigated numeracy's impact on asthma management, discovering that lower numeracy skills were associated with poorer asthma control. These findings highlight the necessity for healthcare professionals to consider patients' numeracy abilities when devising management strategies and to customize interventions to meet their needs.

Given numeracy's significant influence on health outcomes, initiatives to enhance numeracy skills are essential. Educational efforts, the simplification of health communications, and the strategic use of technology to disseminate accessible information are pivotal. Berkman et al. (2011) analyzed interventions aimed at improving health literacy and numeracy, concluding that personalized and interactive methods are most effective in enhancing understanding and promoting healthier behaviors.

Furthermore, incorporating visual aids and straightforward language in health communications has proven beneficial for individuals with limited numeracy, facilitating a better grasp of health-related information. Schapira et al. (2012) validated the effectiveness of visual aids in enhancing comprehension of cancer risks among women with low numeracy, suggesting that visual components in health messaging can help bridge the gap in numeracy skills. This body of research underscores the critical role of numeracy in the effective use of health technology, management of chronic diseases, and the broader public health domain, advocating for targeted efforts to improve numeracy as a means to enhance health outcomes.

NUMERACY IN HEALTH BEHAVIORS AND ADDRESSING GAPS

Research extends beyond the realm of risk perception to reveal numeracy's pivotal role in influencing health behaviors. Peters et al. (2010) explored the relationship between numeracy and participation in cancer screenings, discovering that individuals with higher numeracy levels were more inclined to undergo recommended screenings, indicating that numeracy aids in making sophisticated healthcare decisions. Furthermore, Sørensen et al. (2012) investigated numeracy's effect on medication adherence, finding that individuals with greater numeracy skills exhibited superior adherence to medication regimens, underscoring numeracy's importance in effective chronic condition management. These studies demonstrate that numeracy's impact permeates various health behaviors, significantly affecting overall health outcomes.

Acknowledging the importance of numeracy, scholars have devised interventions to bolster these skills within healthcare contexts. Schwartz et al. (2007) assessed the influence of different risk information presentation formats, identifying those that were more comprehensible to individuals with lower numeracy, indicating the potential of customizing health communications based on numeracy proficiency. Bulf et al. (2019) examined the efficacy of educational



programs in enhancing numeracy, noting improvements in subjective numeracy, or the self-perceived ability to utilize numeracy skills, despite stable objective numeracy scores. These findings suggest that enhancing confidence in numeracy might be as crucial as developing the skills themselves.

Addressing the numeracy gap in healthcare necessitates a comprehensive strategy. Sood et al. (2015) stressed the significance of training health professionals in numeracy, enabling them to adjust information delivery according to patients' numeracy levels, thereby fostering better patient comprehension and participation. Moreover, the design of healthcare materials is vital; utilizing straightforward language and clear visual aids can significantly improve understanding for those with lower numeracy skills. The research by Schwartz et al. (2017) on effective risk information presentation corroborates this approach. By adopting these measures, healthcare systems can foster a more inclusive environment that supports numeracy, empowering individuals to manage their health more effectively.

Numeracy's influence on health outcomes also intersects with existing health disparities. Baker et al. (2006) revealed a strong link between lower numeracy and lower socioeconomic status, raising concerns about the potential exacerbation of health disparities as numeracy becomes increasingly critical in healthcare navigation. Smedt et al. (2017) delved into the interaction between cultural factors and numeracy, highlighting the influence of cultural backgrounds on numeracy skills and the processing of health information. Crafting tailored interventions and communication strategies that address these disparities is essential for ensuring equitable access to numeracy-informed healthcare decision-making, underscoring the complexity of the numeracy-health outcome relationship and its implications for public health.

CHALLENGES OF NUMERACY IN OLDER ADULTS:

- **Cognitive Decline:** Age-related cognitive decline can impact numeracy skills, making it difficult for older adults to understand statistical information, calculate risks and benefits, and interpret medical data. Peters et al. (2013) found that older adults with lower numeracy were less likely to participate in preventive health screenings, potentially jeopardizing their health. This highlights the vulnerability of older adults when faced with numeracy-laden healthcare decisions.
- **Multiple Chronic Conditions:** Older adults often manage multiple chronic conditions, requiring them to interpret medication instructions, monitor dosages, and track various health parameters. However, research by Reyna et al. (2012) suggests that older adults may struggle with complex medication regimens and probability calculations associated with treatment options. This can lead to medication errors and adherence issues, impacting overall health outcomes.
- **Limited Exposure to Numeracy in Healthcare:** Many older adults grew up in a time when healthcare communication relied less heavily on quantitative information. This lack of prior exposure can make it challenging for them to adapt to the increasingly numeracy driven healthcare environment, as highlighted by Sweeny et al. (2017).



ADDRESSING NUMERACY CHALLENGES IN OLDER ADULTS:

Despite these challenges, research suggests several strategies can improve numeracy skills and empower older adults in healthcare decision-making.

Communicating numerical health information effectively is essential for patient comprehension and informed decision-making. To achieve this:

1. **Quantify Risks Precisely:** Instead of qualitative descriptions like "low risk," use exact figures to convey risk levels, enhancing clarity and understanding (Peters et al., 2013).
2. **Opt for Frequencies Over Percentages:** Illustrating data as frequencies (e.g., "13 out of 100") rather than percentages or decimals aids in more intuitive risk perception (Gigerenzer & Hoffrage, 1995).
3. **Maintain Consistent Comparisons:** When comparing statistical data, keeping denominators and timeframes uniform aids in direct comparison, making the information more digestible (Hawley et al., 2008).
4. **Prioritize Absolute Risk:** Absolute risk, which quantifies the actual occurrence of an event in a population, provides a clearer basis for personal risk assessment than relative risk (Weinstein et al., 2004).
5. **Dual Framing of Outcomes:** Presenting both positive and negative outcomes offers a balanced perspective on potential treatment effects (Edwards et al., 2001).
6. **Adapt Measurement Systems:** Tailoring the unit of measurement (standard or metric) to the patient's familiarity ensures better understanding (Montori & Rothman, 2005).

To further bridge the gap between numerical data and patient understanding:

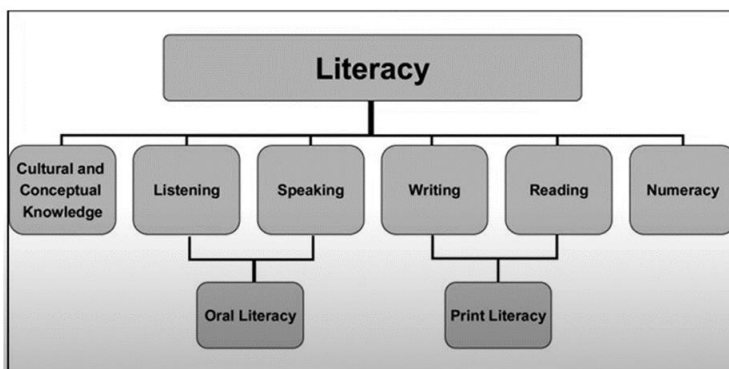
- **Limit Numerical Information:** Focus on critical data, limiting the quantity of numbers presented at one time. This approach, backed by cognitive load theory, suggests that minimizing extraneous cognitive load improves learning and comprehension (Sweller, 1988).
- **Use Layman's Terms:** Simplifying statistical terms into everyday language facilitates understanding. Saying "about half" is more relatable than stating "49 percent" (Fagerlin et al., 2007).
- **Simplify Calculations:** Providing pre-calculated risk over relevant periods, rather than expecting patients to compute from annual risk rates, avoids overwhelming patients with complex calculations (Lipkus & Hollands, 1999).
- **Employ Analogies and Visuals:** Analogies to familiar objects and visual aids make abstract data tangible. For instance, comparing the size of a health anomaly to a common object can clarify its dimensions (Houts et al., 2006).
- **Implement Teach-Back:** Asking patients to explain back the information in their own words ensures they've understood the presented data, a technique proven to enhance patient comprehension (Kessels, 2003).

By adopting these strategies, healthcare professionals can significantly improve patients' numerical literacy, facilitating better health outcomes through informed decisions. (Agency for Healthcare Research and Quality, n.d.)



HEALTH LITERACY AND STATISTICS

The webinar "Numeracy: Health Literacy and Clear Communication for Numbers and Statistics," available on YouTube here, led by Patrick Harris from the CDC, enriches the discourse on numeracy within health literacy by highlighting the necessity of simplifying complex health data for the lay public. Harris emphasizes the balance between accuracy and accessibility, underscoring the need for health communicators to employ plain language and numeracy principles. This approach aims to demystify numerical information, enabling consumers to make informed health decisions. This perspective aligns with existing literature, indicating that higher numeracy skills correlate with better health outcomes and more informed decision-making, thereby reinforcing the importance of enhancing numeracy to improve public health communication and outcomes.



Source: YouTube channel of Centers for Disease Control and Prevention (CDC) Numeracy: Health Literacy and Clear Communication for Numbers and Statistics, July 25, 2018. Link to video: <https://www.youtube.com/watch?v=cJnZuip8IY0>

Harris provides practical strategies for health communicators to improve the public's numeracy skills, such as:

- tailoring information to the audience's numeracy level
- framing data in actionable contexts.
- converting percentages to more relatable terms like "one in four," in order to make numerical information more digestible.
- the use of visual aids to aid comprehension among populations with low numeracy. like the example below:



Source: YouTube channel of Centers for Disease Control and Prevention (CDC) Numeracy: Health Literacy and Clear Communication for Numbers and Statistics, July 25, 2018. Link to video: <https://www.youtube.com/watch?v=cJnZuip8IY0>

Lastly, the webinar underscores the role of numeracy in enhancing the efficacy of public health campaigns by making data practical and relatable. Harris's focus on relatability in numerical data aims to foster a deeper connection between health communicators and their audience, encouraging healthier behaviors. This concept is pivotal in addressing challenges related to the public's engagement with preventive health behaviors and understanding of public health messages. In accordance of the insights from this webinar with the broader literature on health numeracy emphasizes the critical role of numeracy in public health literacy and highlights practical strategies for health communicators to improve numeracy among consumers, ultimately contributing to better health outcomes and more informed health decisions.

View the webinar: Centers for Disease Control and Prevention (CDC). (2018, July 25). Numeracy: Health Literacy and Clear Communication for Numbers and Statistics. [Video]. YouTube. <https://www.youtube.com/watch?v=cJnZuip8IY0>

CONCLUSIONS

In conclusion, this comprehensive literature review underscores the integral role of numeracy in health literacy and its profound impact on public health outcomes. The multifaceted exploration of numeracy across different spectrums of health communication, decision-making, and interventions highlights the necessity of enhancing numerical understanding among populations. The findings reveal a clear correlation between numeracy skills and the effective management of health information, adherence to medical recommendations, and the adoption of preventive health behaviors.

Key insights include the critical need for tailored health communication strategies that accommodate diverse numeracy levels, the importance of employing clear and accessible numerical information, and the potential of educational and technological interventions in improving numeracy skills. Furthermore, the challenges associated with numeracy among older adults and the implications of numeracy skills on health disparities emphasize the need for targeted approaches to address these issues.

The significance of numeracy in navigating the increasingly data-driven landscape of healthcare cannot be overstated. As highlighted by all cited sources, employing strategies that make numerical data relatable, understandable, and actionable is paramount in empowering individuals to make informed health decisions. This approach not only enhances individual health literacy but also contributes to the overall effectiveness of public health campaigns and initiatives.

Therefore, advancing numeracy within health literacy efforts is a critical endeavor that requires concerted efforts from healthcare professionals, educators, policymakers, and communicators alike. By integrating the practical strategies and insights identified throughout this review and the webinar, there is a promising pathway towards improving health outcomes



and reducing disparities through better numerical understanding and communication. In doing so, we can foster a health literate society that is equipped to navigate the complexities of health information, ultimately leading to more informed health decisions and improved public health outcomes.

BIBLIOGRAPHY

- Agency for Healthcare Research and Quality. (n.d.). Use numbers clearly. Health Literacy in Dentistry. Retrieved from <https://www.ahrq.gov/health-literacy/professional-training/shared-decision/tool/resource-5.html>
- Ancker, J. S., Senathirajah, Y., Kukafka, R., & Starren, J. B. (2022). Design features of graphs in health risk communication: A systematic review. *Journal of the American Medical Informatics Association*, 19(2), <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 184-193.
- Ciampa, P. J., Osborn, C. Y., Peterson, N. B., & Rothman, R. L. (2010). Patient numeracy, perceptions of provider communication, and colorectal cancer screening utilization. *Journal of Health Communication*, 15(sup3), <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 157-168.
- Hamstra, D. A., Johnson, S. B., Diefenbach, M., Mandelblatt, J. S., & Khoury, M. J. (2015). The impact of numeracy on verbal comprehension of health information in context: A systematic review. *Patient Education and Counseling*, <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 98(1), 107-114.
- Janz, N. K., Becker, M. H., Lantz, P. M., Schwartz, K., Liu, L., & Zhang, M. (2016). How does health literacy affect women's ability to engage in breast cancer surveillance post-surgery? *Breast Cancer Research and Treatment*, 155(2), <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 265-274.
- Lopez-Perez, R., Soto, M., Dijkstra, T., & Lam, J. (2015). The influence of numeracy on the comprehension of health information and medical decision-making. *Health Expectations*, 18(3), 246-256. <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html>
- Petrova, D., Garcia-Retamero, R., Cokely, E. T., & Heredia Carrasco, C. A. (2016). Numeracy and decision making in acute coronary syndromes: A qualitative and quantitative study. *Journal of Behavioral Decision Making*, 29(2-3), <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 166-177.
- Smith, S. G., O'Connor, R., Aitken, W., Curtis, L. M., Wolf, M. S., & Goel, M. S. (2016). Disparities in understanding of health-care information among patients with chronic conditions: Do different types of health literacy matter? *Journal of Health Communication*, 21(8), 879-887. <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html>
- Van Weert, J. C., van Noort, G., Bol, N., van Dijk, L., Tates, K., & Jansen, J. (2021). Tailored information for cancer patients on the Internet: Effects of visual cues and language complexity on information recall and satisfaction. *Patient Education and Counseling*, 84(3), 368-378. <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html>
- Zikmund-Fisher, B. J., Smith, D. M., Ubel, P. A., & Fagerlin, A. (2011). Validation of the Subjective Numeracy Scale: Effects of low numeracy on comprehension of risk communications and



- utility elicitation. *Medical Decision Making*, <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> 31(3), 391-401.
- Fischhoff, B., Brewer, N. T., & Downs, J. S. (Eds.). (2013). *Communicating risks and benefits: An evidence-based user's guide*. Food and Drug Administration (FDA), US Department of Health and Human Services.
- Galesic, M., Garcia-Retamero, R., & Gigerenzer, G. (2009). Using icon arrays to communicate medical risks: Overcoming low numeracy. *Health Psychology*, 28(2), 210-216.
- Peters, E., Hibbard, J., Slovic, P., & Dieckmann, N. (2007). Numeracy skill and the communication, comprehension, and use of risk-benefit information. *Health Affairs*, 26(3), 741-748.
- Reyna, V. F., & Brainerd, C. J. (2007). The importance of mathematics in health and human judgment: Numeracy, risk communication, and medical decision making. *Learning and Individual Differences*, 17(2), 147-159.
- Ancker, J. S., & Kaufman, D. R. (2007). Rethinking health numeracy: A multidisciplinary literature review. *Journal of the American Medical Informatics Association*, 14(6), 713-721. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2213486/>
- Bulf, C., Van den Bergh, R., Van den Bogaert, W., & De Smedt, D. G. (2019). Health numeracy skills of medical students: Cross-sectional and controlled before-and-after study. *BMC Medical Education*, 19(1), 1-7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6925899/>
- Estrada, C. A., Brophy, M. T., Bryson, S. L., Reeder, G., & Spertus, J. A. (2007). Numeracy and anticoagulation control: A cross-sectional study. *Journal of General Internal Medicine*, 22(12), 1674-1680. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10728771/>
- Schapira, M. M., McCormack, L. A., & Goldman, R. D. (2011). Do patients understand the benefits of screening tests? The role of health literacy. *Cancer Causes & Control*, 22(3), 349-357. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6901362/>
- Schwartz, L. M., Woloshin, S., Welch, H. G., Glick, H. A., & Knaus, V. A. (1997). The role of numeracy in understanding the benefit of screening for breast cancer. *Journal of General Internal Medicine*,
- Ancker, J. S., & Kaufman, D. R. (2007). Rethinking health numeracy: A multidisciplinary literature review. *Journal of the American Medical Informatics Association*, 14(6), 713-721. [<https://www.ncbi.nlm.nih.gov/pmc/articles>
- Baker, D. W., Gazmararian, L. A., Williams, M. V., Parker, R. M., Greenblatt, E. G., & Lynch, C. F. (2006). Functional health literacy and the use of physician services. *Journal of General Internal Medicine*, 21(8), 878-884.
- Krebs, R. F., Tulloch, S., & Thomas, H. (2017). Numeracy and eHealth interventions: A systematic review. *Journal of Medical Internet* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5317008/> *Journal Research*, 19(2), e44.
- Krebs, R. F., Tulloch, S., & Thomas, H. (2017). Numeracy and eHealth interventions: A systematic review. *of Medical Internet* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5317008/> *Research*, 19(2), e44.
- Peters, E., Jurgens, C. J., Vermeulen, H., & Deeg, D. J. (2013). Health literacy, numeracy, and participation in preventive healthcare among older adults: A review of the literature.



- Patient Education and Counseling, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3762226/> 92(2), 166-175.
- Peters, E., Van den Bergh, R., De Smedt, D. G., & Vandevort, P. (2016). Family involvement in health communication and decision-making for older adults: The role of numeracy. *Patient Education and Counseling*, 99(1), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4692206/> 142-148.
- Apter, A. J., Wang, X., Bogen, D. K., et al. (2008). Linking numeracy and asthma-related quality of life. *Patient Education and Counseling*, 72(3), 416-423.
- Berkman, N. D., Sheridan, S. L., Donahue, K. E., Halpern, D. J., & Crotty, K. (2011). Low health literacy and health outcomes: An updated systematic review. *Annals of Internal Medicine*, 155(2), 97-107.
- Cavanaugh, K., Huizinga, M. M., Wallston, K. A., et al. (2008). Association of numeracy and diabetes control. *Annals of Internal Medicine*, 148(10), 737-746.
- Kobayashi, L. C., Wardle, J., & von Wagner, C. (2016). Internet use, social engagement and health literacy decline during ageing in a longitudinal cohort of older English adults. *Journal of Epidemiology and Community Health*, 70(3), 278-283.
- Mendiola, M. F., Kalnicki, M., & Lindenauer, S. (2015). Valuable features in mobile health apps for patients and consumers: Content analysis of apps and user ratings. *JMIR mHealth and uHealth*, 3(2), e40.
- Schapira, M. M., Fletcher, K. E., Gilligan, M. A., King, T. K., Laud, P. W., Matthews, B. A., Neuner, J. M., & Hayes



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