Evaluating and Improving Patient Education Materials (PEMs) Readability Using Validated Readability Metrics and a Constrained AI-Prompt Framework

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INTRODUCTION

Health literacy is essential for patient understanding, adherence, and informed decision-making[12]. Organizations such as the American Medical Association and National Institutes of Health recommend patient education materials (PEMs) be written at a 6th–8th grade level[10].

However, dental materials, particularly informed consent documents, often exceed these recommendations due to complex terminology, legal language, and dense structure[3 5 13]. This can reduce comprehension and increase caregiver burden, especially in pediatric settings.

Large language models (LLMs) show promise for simplifying healthcare communication, but current approaches rely on single prompts, limiting consistency and scalability[14]. The impact of AI prompt design on readability remains unclear.

Our objective was to quantitatively compare AI prompt variants to identify which prompt structure produces the largest reduction in FKGL and SMOG while preserving clinical and legal meaning.

MATERIALS

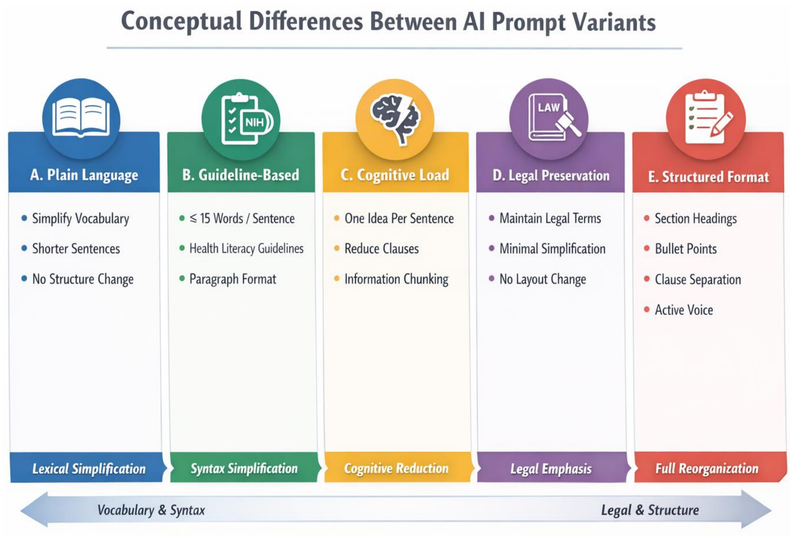
This study did not involve human subjects, as all analyses were conducted on existing patient education materials.

This study used a repeated-measures design to evaluate AI-assisted readability optimization of pediatric dental patient education materials.

Three documents were analyzed: post-operative instructions, an oral sedation consent, and a general consent. Baseline readability was assessed using Flesch–Kincaid Grade Level (FKGL) and SMOG.

Each document was rewritten using five AI prompt strategies targeting plain language, health literacy guidelines, cognitive load reduction, legal clarity, and structured formatting (15 total outputs). All revisions were generated within the same AI environment to ensure consistency.

Post-rewrite readability was reassessed, and changes in FKGL and SMOG were compared across prompt types to identify the most effective strategy.



RESULTS

Baseline readability analysis demonstrated substantial variation across document types. Instructional materials showed moderate complexity, while both consent forms exhibited high readability levels exceeding AMA/NIH recommendations (FKGL and SMOG > 13). AI-assisted rewriting improved readability across all prompt variants. However, the magnitude of improvement differed considerably by prompt architecture.

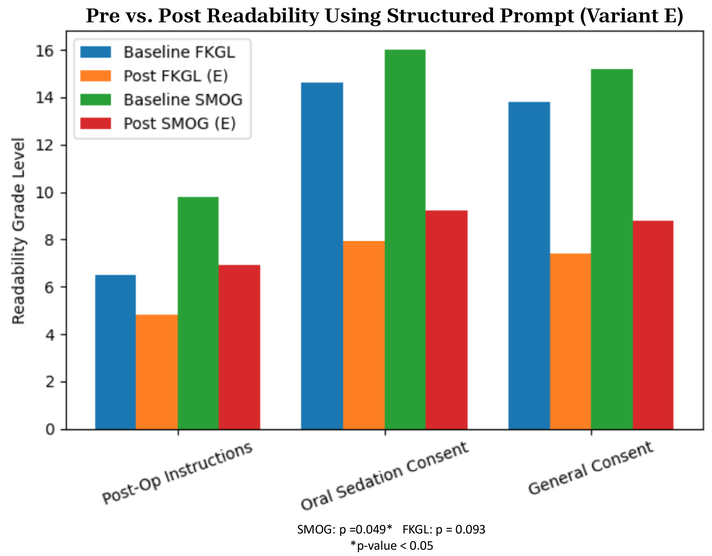
All AI prompt styles reduced FKGL and SMOG scores. Structured formatting (Variant E) produced the largest and most consistent reductions across all documents. Consent forms demonstrated the greatest absolute readability improvement. Only Variant E reduced FKGL into the recommended 6–8 range for all documents.

Initial Readability Scores

Document	FKGL	SMOG	Meets Guidelines?
Post-Op Instructions	6.5	9.8	Partial
Oral Sedation Consent	14.6	16.0	No
General Consent	13.8	15.2	No

Highest-Performing Strategy (Variant E)

Document	Baseline FKGL	After AI	Baseline SMOG	After AI
Post-Op Instructions	6.5	4.8	9.8	6.9
Oral Sedation Consent	14.6	7.9	16.0	9.2
General Consent	13.8	7.4	15.2	8.8



These findings indicate that structural reorganization (section headers + bullet formatting) produced greater readability gains than vocabulary simplification alone.

DISCUSSION

AI-assisted rewriting improved readability across pediatric dental patient education materials; however, the degree of improvement was strongly influenced by prompt architecture. While all prompt variants reduced FKGL and SMOG scores, structured formatting prompts consistently produced the largest readability gains.

Structural reorganization (section headers and bullet formatting) was more effective than vocabulary simplification alone. Consent forms showed the greatest absolute improvement, suggesting that layout and sentence restructuring can meaningfully reduce complexity even in legally dense documents. Reductions in sentence length and clause density likely drove improvements in readability metrics[9 12]. Notably, SMOG reductions reached statistical significance ($p = 0.049$), while FKGL improvements demonstrated a strong trend but did not reach significance ($p = 0.093$).

AI tools may offer a scalable approach for improving health literacy in dental PEMs. Standardized prompting strategies could help institutions systematically improve patient-facing materials. Readability improvements were achieved without removing essential legal or clinical content[14].

Evaluate patient comprehension outcomes following AI-optimized materials. Validate results across larger datasets and multiple institutions. Explore integration of structured AI prompting into clinical document workflows.

CONCLUSION

AI-assisted rewriting improved the readability of pediatric dental patient education materials. Prompt architecture was a major determinant of performance, with structured formatting prompts producing the greatest and most consistent reductions in FKGL and SMOG scores. SMOG improvements were statistically significant ($p = 0.049$), while FKGL reductions showed a non-significant trend ($p = 0.093$), likely due to limited sample size.

These findings suggest that AI-guided structural reorganization, including section headers and bullet formatting, may provide a scalable, generalizable approach to improving health literacy while preserving essential clinical and legal content. Structured AI prompting may represent a practical strategy for standardizing readability improvement in clinical patient materials.

REFERENCES

1. Kim H, Xie B. Health literacy in the eHealth era: A systematic review of the literature. *Patient Educ Couns.* 2017;100(6):1073-1082. doi:10.1016/j.pec.2017.01.015
2. Carayannopoulos A, Han A. Readability of patient education materials in physical medicine and rehabilitation: A comparative cross-sectional study. *PM R.* 2020;12(4):368-373. doi:10.1002/pmrj.12230
3. Nattam A, Vithala T, Wu TC, et al. Assessing the readability of online patient education materials in obstetrics and gynecology using traditional measures. *J Med Internet Res.* 2023;25:e46346. doi:10.2196/46346
4. Szmuda T, et al. Readability of online patient education materials regarding COVID-19. *Public Health.* 2020.
5. Cheng BT, Kim AB, Tanna AP. Readability of online patient education materials for glaucoma. *J Glaucoma.* 2022;31(6):438-442. doi:10.1097/IJG.0000000000002012
6. Singh SP, Qureshi FM, Borthwick KG, et al. Comprehension profile of patient education materials in endocrine care. *Kans J Med.* 2022;15:247-252.
7. Armstrong VL, Grabeel KL, Heidel RE, et al. Patient educational materials for pheochromocytoma exceed recommended readability level. *J Cancer Educ.* 2025. doi:10.1007/s13187-025-02666-3
8. Rodler S, Maruccia S, Abreu A, et al. Readability assessment of patient education materials on uro-oncological diseases. *Eur Urol Focus.* 2024;10(6):1055-1061. doi:10.1016/j.euf.2024.06.012
9. Okuhara T, Furukawa E, Okada H, et al. Readability of written information for patients across 30 years: A systematic review of systematic reviews. *Patient Educ Couns.* 2025;135:108656. doi:10.1016/j.pec.2025.108656
10. Mac O, Ayre J, Bell K, et al. Comparison of readability scores for written health information across formulas. *JAMA Netw Open.* 2022;5(12):e2246051. doi:10.1001/jamanetworkopen.2022.46051
11. Jiang C, Xu W. MedReadMe: Fine-grained sentence readability in the medical domain. *EMNLP.* 2024.
12. Friedman DB, Hoffman-Goetz L. A systematic review of readability and comprehension instruments. *Health Educ Behav.* 2006;33(3):352-373. doi:10.1177/1090198105277329
13. Kang E, Fields HW, Cornett S, Beck FM. Evaluation of pediatric dental patient education materials. *Pediatr Dent.* 2005;27(5):409-413.
14. Kaplan TT, Akyol GE. The role of large language models in dental communication: A systematic review. *Jpn Dent Sci Rev.* 2026;62:57-67. doi:10.1016/j.jdsr.2026.01.002