Retrieval-Enhanced Large Language Models for Safer CBD Education for Older Adults: Evaluation Study A. Abedi, C. H. Chu, S. S. Khan. *Gerontechnology* 25(s)

Purpose Older adults increasingly use cannabidiol (CBD) to manage chronic pain, sleep disturbance, anxiety [1], and responsive behaviors associated with cognitive impairment [2]. Safe CBD use requires attention to dosing, titration, and potential interactions with other medications [3]. Many older adults manage multiple conditions and medications, and the information available online about CBD dosage and titration is often inconsistent, technical, or difficult to personalize [4]. Some older adults may also experience stigma or discomfort discussing cannabis use, which can further limit access to clear, trustworthy information about CBD [5]. Large language models (LLMs) [6], which are advanced AI systems trained to understand and generate natural language, offer new opportunities to provide clearer educational communication. Retrieval-enhanced LLMs, also called Retrieval-Augmented Generation (RAG) systems [7], build on an LLM by allowing it to look up information from trusted external documents. This helps the LLM provide answers that are more accurate, evidence-based, and better tailored to the user. This study aimed to develop and evaluate a retrieval-enhanced LLM framework designed to support safe and easy-to-understand CBD education for older adults, including those with cognitive impairment. **Method** A diverse set of sixty-four standardized scenarios was created to represent older adults with different symptom goals, administration preferences, cognitive abilities, health conditions, medication regimens, and levels of caregiver support. Each scenario was given to several state-of-the-art LLMs. For the retrieval-enhanced LLMs, each LLM was connected to a database created from thirty-two validated CBD education resources for older adults. When answering a scenario, the LLM automatically retrieved the most relevant passages and incorporated them into its response. An additional ensemble setup combined two retrieval-enhanced LLMs, with a third LLM acting as a tiebreaker to review both answers and produce a final, more balanced output. All LLMs were required to follow a predefined structured format, which helped reduce incorrect information, promote consistency, and ensure that key educational elements such as dosing guidance, titration steps, and safety considerations were clearly presented. Multiple automated evaluation methods were used to assess the safety, consistency, and clarity of the outputs generated by both the LLM and retrieval-enhanced systems. **Results and Discussion** Retrieval-enhanced LLMs produced the safest and most consistent CBD guidance. Their outputs were stable, cautious, and closely aligned with evidence from the curated resources. In contrast, standalone LLMs showed more variability and tended to give more permissive dosing suggestions. The evaluation methods showed that retrieval-enhanced LLMs adjusted recommendations appropriately when scenarios included factors such as older age, organ impairment, CBD-naive status, or cognitive impairment. The ensemble setup performed the best overall, benefiting from cross-review and a tiebreaker LLM. Compared to standalone LLMs, the retrieval-enhanced LLMs scored highest in safety, factual grounding, structure, and clarity. These findings show that retrieval-enhanced LLMs can provide safer, clearer, and more accessible CBD education for older adults, including those with cognitive impairment. By offering evidence-aligned guidance that supports self-management and helps caregivers, these systems may reinforce aging in place. Retrieval grounding may also reduce aspects of digital ageism [8] by ensuring AI outputs reflect older adults' needs rather than reproducing exclusionary assumptions.

References

1. Porter B, Marie BS, Milavetz G, Herr K. Cannabidiol (CBD) Use by Older Adults for Acute and Chronic Pain. J Gerontol Nurs. 2021 Jul;47(7):6–15.
2. Ortiz R, Rueda S, Di Ciano P. Use of cannabidiol (CBD) for the treatment of cognitive impairment in psychiatric and neurological illness: A narrative review. Exp Clin Psychopharmacol. 2023 Oct;31(5):978–88.
3. Graham M, Martin JH, Lucas CJ, Murnion B, Schneider J. Cannabidiol drug interaction considerations for prescribers and pharmacists. Expert Rev Clin Pharmacol. 2022 Dec;15(12):1383–97.
4. D'Souza DC, Gupta P, Schnakenberg Martin AM, Stevens MC, Pearlson GD. Cannabis, Aging and Cognition: An Urgent Need for Research. Cannabis Cannabinoid Res. 2025 Nov 6;
5. Dahlke S, Butler JI, Hunter KF, Toubiana M, Kalogirou MR, Shrestha S, et al. The Effects of Stigma: Older Persons and Medicinal Cannabis. Qual Health Res. 2024 Jul;34(8–9):717–31.
6. Huo B, Boyle A, Marfo N, Tangamornsuksan W, Steen JP, McKechnie T, et al. Large Language Models for Chatbot Health Advice Studies: A Systematic Review. JAMA Netw Open. 2025 Feb 3;8(2):e2457879.
7. Amugongo LM, Mascheroni P, Brooks S, Doering S, Seidel J. Retrieval augmented generation for large language models in healthcare: A systematic review. PLOS Digit Health. 2025 Jun;4(6):e0000877.
8. Chu CH, Nyrup R, Leslie K, Shi J, Bianchi A, Lyn A, et al. Digital ageism: challenges and opportunities in artificial intelligence for older adults. The Gerontologist. 2022;62(7):947–55.

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