

# Welcome to FastFacts!

## Topic: Can Generative Artificial Intelligence (GenAI) Deliver Robust Research and Shorten the Healthcare Innovation Cycle?



### Today's Learning Objectives

|          |   |
|----------|---|
| <b>1</b> | Hear about how Generative Artificial Intelligence (GenAI) can make literature reviews and data synthesis more efficient |
| <b>2</b> | Discuss how a systems approach to GenAI including 'experts-in-the-loop' can increase accuracy and provide transparency. |



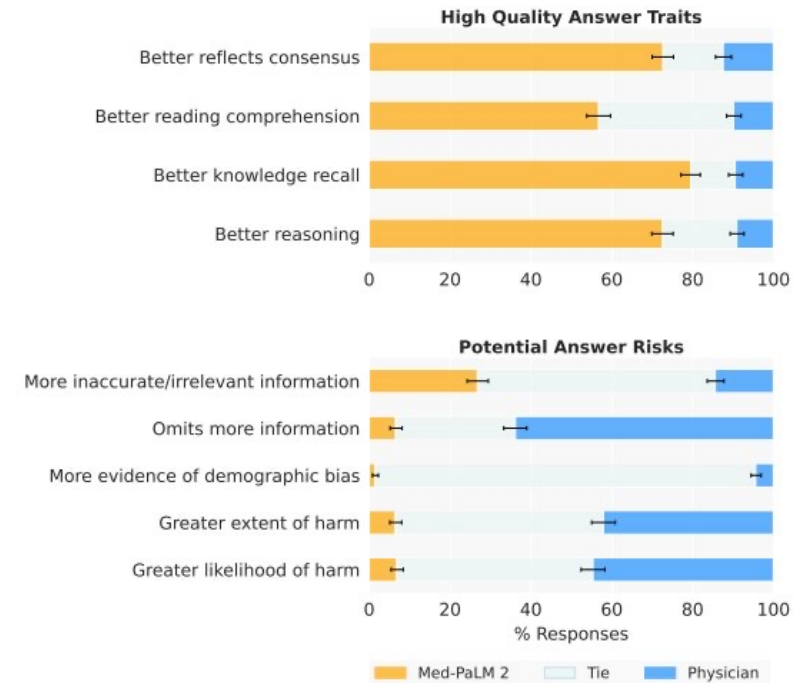
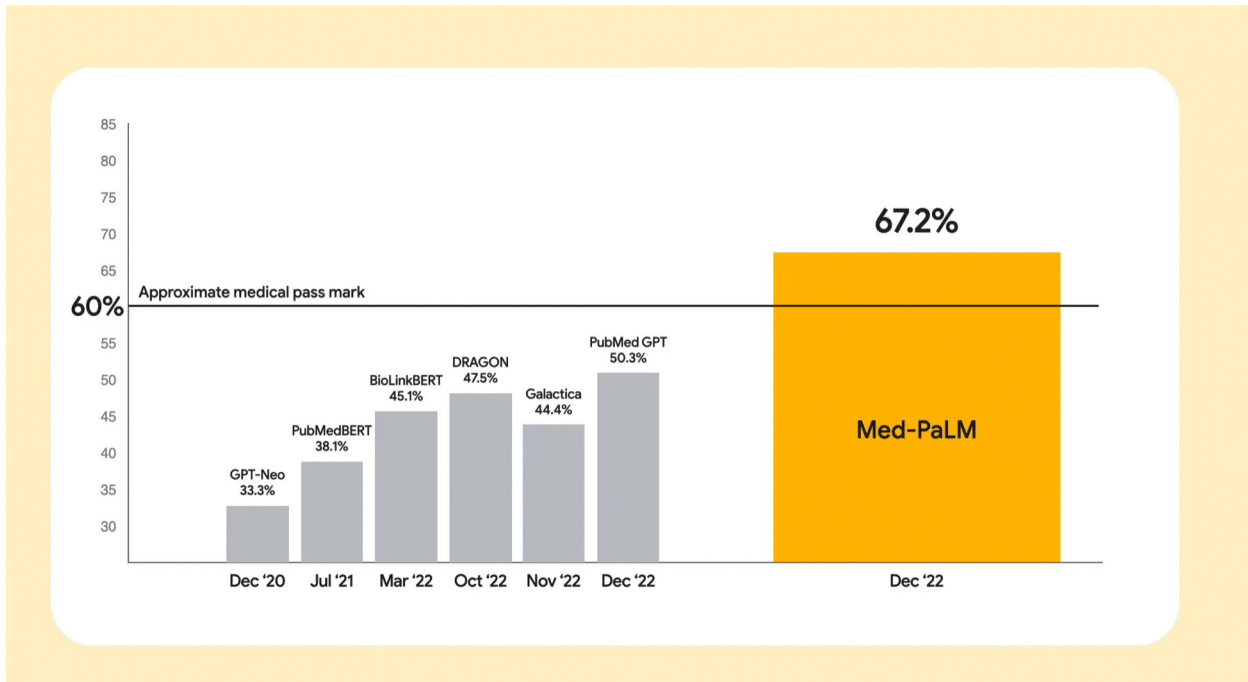
**John Hernandez, PhD**  
Head of Clinical Research & HEOR  
Google



**Lana Feng, PhD**  
CEO & Co-Founder  
Huma.AI

# Large Language Models for the Medical Domain

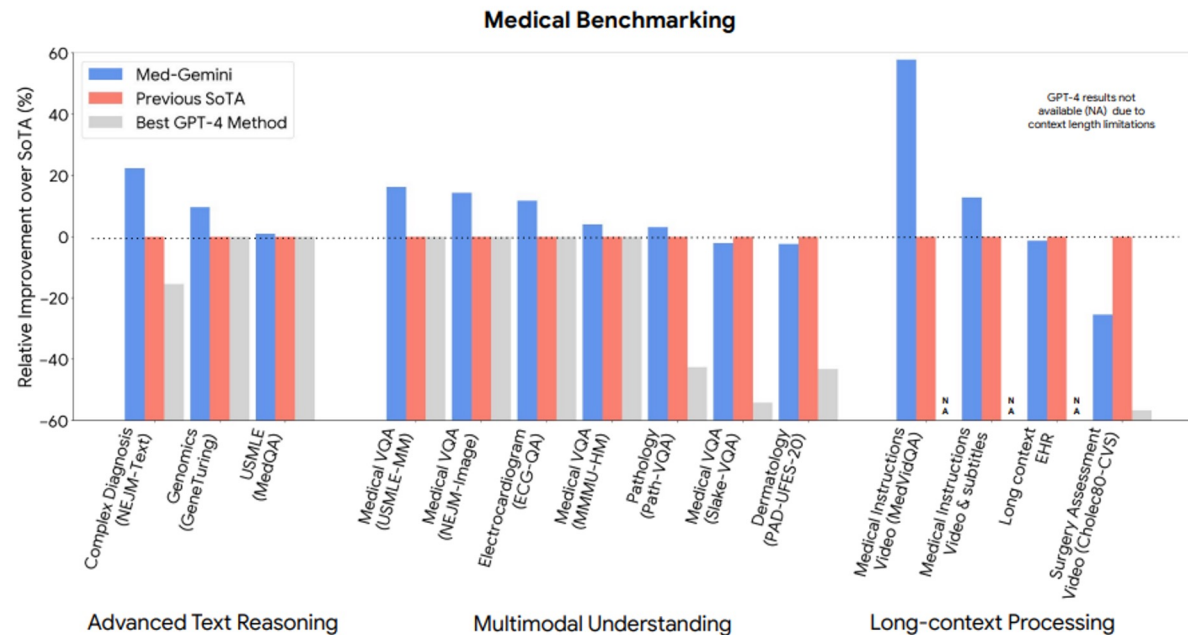
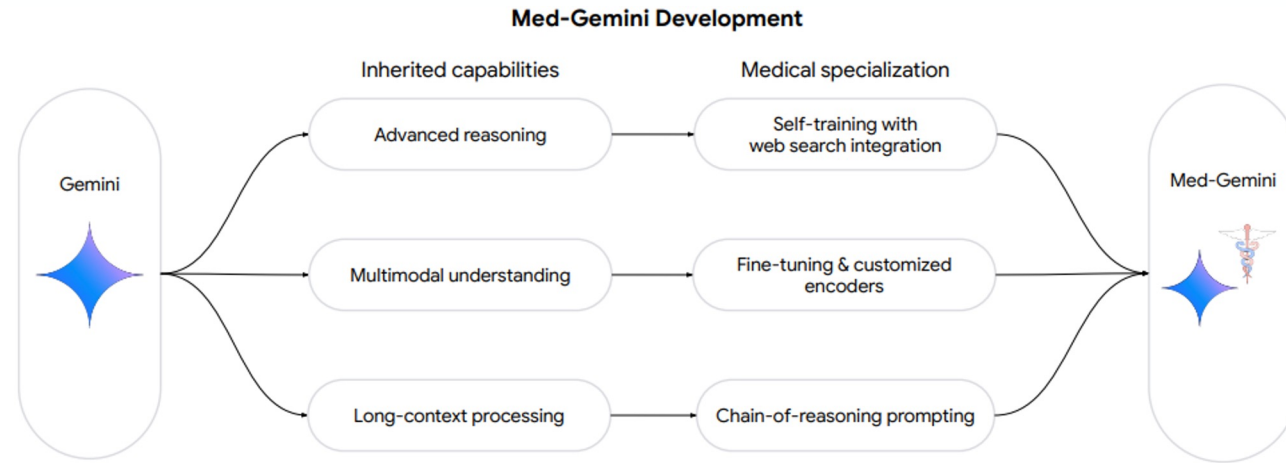
Med-PaLM is an AI system with expert clinician accuracy in answering medical questions. It is in research phase and we are exploring how we can build a safe, accurate, equitable, and useful tool



Singhal et al. [Large language models encode clinical knowledge.](#) *Nature*. July 2023

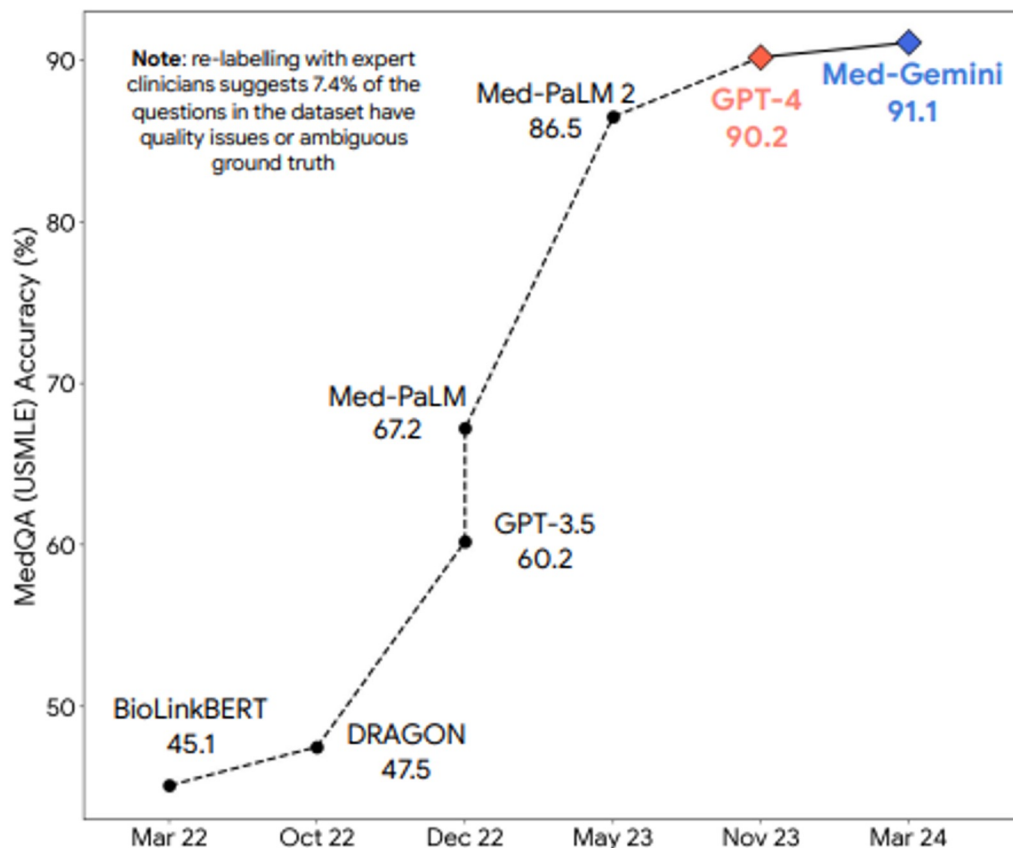
Singhal et al. [Towards expert-level medical QA with LLMs.](#) ArXiv May 2023.

# Med-Gemini is a family of medically-tuned multimodal models

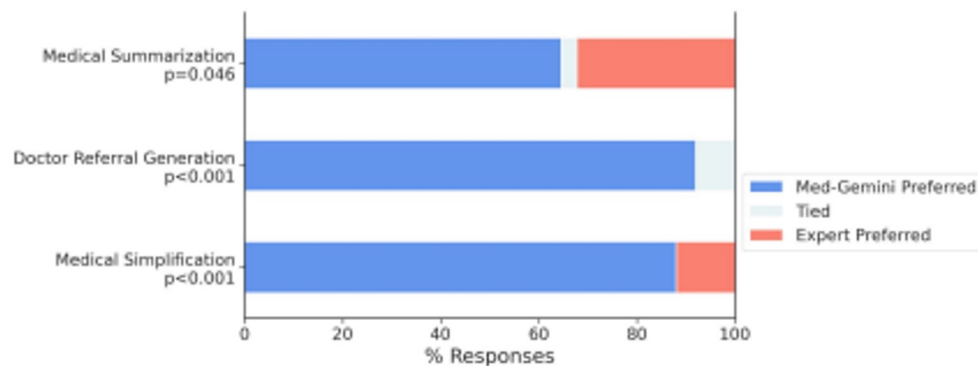


# Med-Gemini multimodal models advanced the state-of-the-art across medical applications with self-training and search tools

### SoTA on MedQA (USMLE)



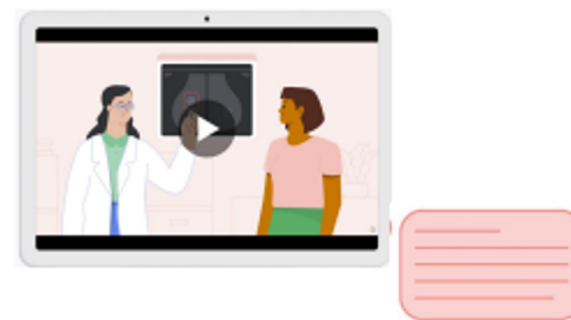
### Real-world Utility with Novel Applications



Clinical abstraction



Multimodal medical dialogue



Medical video QA

# GenAI for Lit Reviews

Research article | [Open access](#) | Published: 01 April 2022

## The landscape of GWAS validation; systematic review identifying 309 validated non-coding variants across 130 human diseases

Ammar J. Alsheikh , Sabrina Wollenhaupt, Emily A. King, Jonas Reeb, Sujana Ghosh, Lindsay R. Stolzenburg, Saleh Tamim, Jozef Lazar, J. Wade Davis & Howard J. Jacob

*BMC Medical Genomics* 15, Article number: 74 (2022) | [Cite this article](#)

| Publication Date | PMID     | Title                       | Validated Variant rsID | Chr   | Loc (hg38)  | Variant Class          | Target Gene |
|------------------|----------|-----------------------------|------------------------|-------|-------------|------------------------|-------------|
| 27/01/2007       | 17255560 | Association analysis of CC  | rs1883832              | chr20 | 46,118,343  | Promoter               | CD40        |
| 07/10/2008       | 18836445 | Disruption of an AP-2alph   | rs642961               | chr1  | 209,815,925 | Cis Regulatory Element | IRF6        |
| 06/11/2008       | 18984742 | A single-nucleotide polym   | rs573225               | chr2  | 168,901,031 | Promoter               | G6P2C       |
| 21/01/2009       | 19153072 | Fine mapping association    | rs10993994             | chr10 | 46,046,326  | Promoter               | MSMB        |
| 23/04/2009       | 19383797 | Fine mapping and functio    | rs10993994             | chr10 | 46,046,326  | Promoter               | MSMB        |
| 04/06/2009       | 19491260 | Genetic variants on chron   | rs6495309              | chr15 | 78,622,903  | Promoter               | CHRNA3      |
| 09/06/2009       | 19504470 | Functional characterizati   | rs449647               | chr19 | 44,905,307  | Promoter               | APOE        |
| 09/06/2009       | 19504470 | Functional characterizati   | rs405509               | chr19 | 44,905,579  | Promoter               | APOE        |
| 24/06/2009       | 19546342 | A common FADS2 promot       | rs968567               | chr11 | 61,828,092  | Promoter               | FADS2       |
| 30/06/2009       | 19561604 | The common colorectal c     | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 01/07/2009       | 19565498 | Functional analysis of the  | rs143383               | chr20 | 35,438,203  | Promoter               | GDF5        |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | ZPBP2       |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | GSDMB       |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | ORMDL3      |
| 10/11/2009       | 19897590 | A genome-wide associati     | rs1537415              | chr9  | 135,637,876 | Cis Regulatory Element | GLT6D1      |
| 07/01/2010       | 20051274 | Functional and associati    | rs2232157              | chr7  | 91,264,657  | Promoter               | FZD1        |
| 13/01/2010       | 20065031 | Upregulation of c-MYC in    | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 15/07/2010       | 20627891 | An 8q24 gene desert vari    | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 19/08/2010       | 20716579 | A functional variant in NK  | rs11781886             | chr8  | 23,682,904  | Promoter               | NKX3-1      |
| 09/09/2010       | 20822710 | Functional evaluation of 1  | rs6927172              | chr6  | 137,681,038 | Cis Regulatory Element | TNFAIP3     |
| 24/09/2010       | 20862326 | Allelic variation at the 8q | rs16888589             | chr8  | 116,623,363 | Cis Regulatory Element | EIF3H       |



Source: [DeepMind Gemini YouTube video](#)

```

FILTERING_PROMPT_TEMPLATE = '''\
You are a helpful biocuration assistant.

Your job is to read the following paper title and abstract, and tell me whether \
this paper talks about the experimental validation of a non-coding variant for a \
particular human disease.

Here are some things to keep in mind:
Sometimes a variant is also called a SNP or is referred to by rsID.
A functional variant or a regulatory variant is typically a non-coding variant.
Experimental validation can take many forms. Some assay methods use the \
following techniques or have the following names: CHIP, CRISPR-Cas9, MPRA, \
EMSA, TALEN, luciferase assay.
Experimental validation does not include statistical methods such as finemapping.

The paper details are as follows:
-----
{title}

{abstract}
-----

Does this paper talk about the experimental validation of a non-coding variant for a particular human disease?
'''
    
```

✓ # Evaluate a paper that we know is relevant to the study  
 compute\_relevance(pmid=INCLUDE\_PMID, prompt=FILTERING\_PROMPT\_TEMPLATE)

🔗 URL: <https://pubmed.ncbi.nlm.nih.gov/35264579/>

Title: An enhancer variant at 16q22.1 predisposes to hepatocellular carcinoma via regulating PRMT7 expression

Relevance: 99.954%

2. Extract new rows

```

[103] new_row = extract_data(pmid=INCLUDE_PMID)
new_row
    
```

|   | PMID     | Publication Date | Validated Variant rsID | Target Gene | Associated Disease       | Variant Class          |
|---|----------|------------------|------------------------|-------------|--------------------------|------------------------|
| 0 | 35264579 | 2022-3-9         | rs73613962             | PRMT7       | Hepatocellular Carcinoma | Cis Regulatory Element |

```

add_evidence(new_row)
    
```

|   | PMID     | Publication Date | Validated Variant rsID | Target Gene | Associated Disease       | Variant Class          |
|---|----------|------------------|------------------------|-------------|--------------------------|------------------------|
| 0 | 35264579 | 2022-3-9         | rs73613962             | PRMT7       | Hepatocellular Carcinoma | Cis Regulatory Element |

Gemini less confident Gemini more confident

# GenAI for Lit Reviews

Research article | [Open access](#) | Published: 01 April 2022

## The landscape of GWAS validation; systematic review identifying 309 validated non-coding variants across 130 human diseases

Ammar J. Alsheikh , Sabrina Wollenhaupt, Emily A. King, Jonas Reeb, Sujana Ghosh, Lindsay R. Stolzenburg, Saleh Tamim, Jozef Lazar, J. Wade Davis & Howard J. Jacob

*BMC Medical Genomics* 15, Article number: 74 (2022) | [Cite this article](#)

| Publication Date | PMID     | Title                       | Validated Variant rsID | Chr   | Loc (hg38)  | Variant Class          | Target Gene |
|------------------|----------|-----------------------------|------------------------|-------|-------------|------------------------|-------------|
| 27/01/2007       | 17255560 | Association analysis of CC  | rs1883832              | chr20 | 46,118,343  | Promoter               | CD40        |
| 07/10/2008       | 18836445 | Disruption of an AP-2alph   | rs642961               | chr1  | 209,815,925 | Cis Regulatory Element | IRF6        |
| 06/11/2008       | 18984742 | A single-nucleotide polym   | rs573225               | chr2  | 168,901,031 | Promoter               | G6PC2       |
| 21/01/2009       | 19153072 | Fine mapping associatio     | rs10993994             | chr10 | 46,046,326  | Promoter               | MSMB        |
| 23/04/2009       | 19383797 | Fine mapping and functio    | rs10993994             | chr10 | 46,046,326  | Promoter               | MSMB        |
| 04/06/2009       | 19491260 | Genetic variants on chron   | rs6495309              | chr15 | 78,622,903  | Promoter               | CHRNA3      |
| 09/06/2009       | 19504470 | Functional characterizati   | rs449647               | chr19 | 44,905,307  | Promoter               | APOE        |
| 09/06/2009       | 19504470 | Functional characterizati   | rs405509               | chr19 | 44,905,579  | Promoter               | APOE        |
| 24/06/2009       | 19546342 | A common FADS2 promot       | rs968567               | chr11 | 61,828,092  | Promoter               | FADS2       |
| 30/06/2009       | 19561604 | The common colorectal c     | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 01/07/2009       | 19565498 | Functional analysis of the  | rs143383               | chr20 | 35,438,203  | Promoter               | GDF5        |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | ZPBP2       |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | GSDMB       |
| 08/09/2009       | 19732864 | Allele-specific chromatin   | rs12936231             | chr17 | 39,872,867  | Cis Regulatory Element | ORMDL3      |
| 10/11/2009       | 19897590 | A genome-wide associati     | rs1537415              | chr9  | 135,637,876 | Cis Regulatory Element | GLTGD1      |
| 07/01/2010       | 20051274 | Functional and associati    | rs2232157              | chr7  | 91,264,657  | Promoter               | FZD1        |
| 13/01/2010       | 20065031 | Upregulation of c-MYC in    | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 15/07/2010       | 20627891 | An 8q24 gene desert vari    | rs6983267              | chr8  | 127,401,060 | Cis Regulatory Element | MYC         |
| 19/08/2010       | 20716579 | A functional variant in NK  | rs11781886             | chr8  | 23,682,904  | Promoter               | NKX3-1      |
| 09/09/2010       | 20822710 | Functional evaluation of 1  | rs6927172              | chr6  | 137,681,038 | Cis Regulatory Element | TNFAIP3     |
| 24/09/2010       | 20862326 | Allelic variation at the 8q | rs16888589             | chr8  | 116,623,363 | Cis Regulatory Element | EIF3H       |



load\_full\_data\_extraction\_with\_evidence()

|    | PMID     | Publication Date | Validated Variant rsID                      | Target Gene | Associated Disease            | Variant Class          |
|----|----------|------------------|---|-------------|-------------------------------|------------------------|
| 0  | 36977669 | 2023-3-28        | rs2238574                                   | ARID3A      | Cholangitis, Primary Biliary  | Cis Regulatory Element |
| 1  | 36286273 | 2022-9-23        | rs1165649373                                | CITED2      | Atrial Septal Defect          | Promoter               |
| 2  | 33972609 | 2021-5-10        | rs7107223                                   | ANKK1       | Parkinson Disease             | Cis Regulatory Element |
| 3  | 35264579 | 2022-3-9         | rs73613962                                  | PRMT7       | Hepatocellular Carcinoma      | Cis Regulatory Element |
| 4  | 35741778 | 2022-6-05        | rs6705628                                   | DGUOK       | Lupus Erythematosus, Systemic | Cis Regulatory Element |
| 5  | 34852650 | 2021-12-2        | rs4284742                                   | SIGLEC5     | Periodontitis                 | Cis Regulatory Element |
| 6  | 35168626 | 2022-2-16        | rs6781790                                   | GPX1        | Parkinson Disease             | Cis Regulatory Element |
| 7  | 34230488 | 2021-7-6         | rs4911178                                   | GDF5        | Hip Dysplasia                 | Cis Regulatory Element |
| 8  | 36675087 | 2023-1-13        | No validated variant provided in the paper. | PAX6        | Aniridia                      | non-coding RNA         |
| 9  | 33420081 | 2021-1-8         | rs2431697                                   | MIR146A     | Systemic Lupus Erythematosus  | Cis Regulatory Element |
| 10 | 35547258 | 2022-4-25        | No validated variant provided in the paper. | FBN1        | Marfan Syndrome               | non Coding RNA         |
| 11 | 34445492 | 2021-8-16        | rs684232                                    | VPS53       | Prostate Cancer               | Cis Regulatory Element |
| 12 | 34889888 | 2021-10-26       | rs4808611                                   | NR2F6       | Breast Neoplasms              | Cis Regulatory Element |
| 13 | 37345431 | 2023-6-22        | rs6475604                                   | CDKN2A      | Glaucoma                      | Cis Regulatory Element |
| 14 | 34475398 | 2021-9-2         | rs6983267                                   | MYC         | Colorectal Neoplasms          | Cis Regulatory Element |
| 15 | 34552866 | 2021-9-06        | rs6983267                                   | MYC         | Colorectal Neoplasms          | Cis Regulatory Element |
| 16 | 35433465 | 2022-3-31        | rs2278176                                   | GSTA2       | Colorectal Neoplasms          | non-coding RNA         |

So, now we have a refreshed version of that dataset.


Source: [DeepMind Gemini YouTube video](#)

# Med-Gemini synthesis of scientific literature

## Prompt

**Task:** Given the provided [Research Articles], what is the mechanism linking locus FTO with disease Obesity?

**Instructions:** Provide the main variants involved, the chain of molecular events linking the variant to the phenotype, and the experimental support for your statement.

 [Research Articles ]:

|   |   |  |
|---|---|--|
| <p>BMC Cell Biology</p> <p><b>Brain dystrophin-glycoprotein complex: persistent expression of <math>\beta</math>-dystroglycan, impaired oligomerization of Dp71 and up-regulation of utrophins in animal models of muscular dystrophy</b></p> <p>Culligan, K., Glover, L., Dowling, P., &amp; Ohlendeck, K.</p> | <p>International Journal of Biological Sciences</p> <p><b>Complex relationship between obesity and the fat mass and obesity locus.</b></p> <p>Yang, Q., Xiao, T., Guo, J., &amp; Su, Z.</p>   | <p>Frontiers in Endocrinology</p> <p><b>Critical enzymatic functions of FTO in obesity and cancer</b></p> <p>Deng, X., Su, R., Stanford, S., &amp; Chen, J.</p>  |
| <p>Current Diabetes Reports</p> <p><b>FTO and obesity: mechanisms of association.</b></p> <p>Zhao, X., Yang, Y., Sun, B. F., Zhao, Y. L., &amp; Yang, Y. G.</p>   | <p>The American Journal of Clinical Nutrition</p> <p><b>FTO genotype impacts food intake and corticolimbic activation</b></p> <p>Melhorn, S. J., Askren, M. K., Chung, W. K., Kratz, M., Bosch, T. A., Tyagi, V., ... &amp; Schur, E. A.</p>                  | <p>New England Journal of Medicine</p> <p><b>FTO obesity variant circuitry and adipocyte browning in humans.</b><br/><i>New England Journal of Medicine</i></p> <p>Claussnitzer, M., Dankel, S. N., Kim, K. H., Quon, G., Meuleman, W., Haugen, C., ... &amp; Kellis, M.</p> |
| <p>Obesity</p> <p><b>Genetics of obesity: what we have learned over decades of research</b></p> <p>Bouchard, C.</p>   | <p>Science Advances</p> <p><b>Linking the FTO obesity rs1421085 variant circuitry to cellular, metabolic, and organismal phenotypes in vivo</b></p> <p>Laber, S., Forcisi, S., Bentley, L., Petzold, J., Moritz, F., Smirnov, K. S., ... &amp; Cox, R. D.</p> | <p>Nature Communications</p> <p><b>Multiple novel gene-by-environment interactions modify the effect of FTO variants on body mass index</b></p> <p>Young, A. I., Wauthier, F., &amp; Donnelly, P.</p>  |
| <p>Cell Metabolism</p> <p><b>Obesity and FTO: changing focus at a complex locus</b></p> <p>Tung, Y. L., Yeo, G. S., O'Rahilly, S., &amp; Coll, A. P.</p>  | <p>Obesity</p> <p><b>The fat mass-and obesity-associated (FTO) gene to obesity: lessons from mouse models</b></p> <p>Chang, J. Y., Park, J. H., Park, S. E., Shon, J., &amp; Park, Y. J.</p>  | <p>Nature Reviews Genetics</p> <p><b>The genetics of obesity: from discovery to biology.</b></p> <p>Loos, R. J., &amp; Yeo, G. S.</p>  |

## Response

**Mechanism linking the FTO locus with Obesity:**

**Variants Involved:** The primary variant is the single-nucleotide polymorphism (SNP) rs1421085, a T-to-C substitution. This SNP is located in the first intron of the FTO gene and is strongly associated with an increased risk of obesity.

**Molecular Chain of Events:**

- ARID5B Binding Disruption:** In individuals with the non-risk T allele, the transcription repressor ARID5B binds to the region containing rs1421085, effectively repressing enhancer activity.
  - The T-to-C substitution (risk allele) disrupts a critical motif necessary for ARID5B binding. This leads to a loss of repression and a gain of enhancer activity.
- Increased IRX3 and IRX5 Expression:** The increased enhancer activity results in the upregulation of two nearby genes, IRX3 and IRX5, during the early stages of adipocyte differentiation. This is particularly notable in subcutaneous (inguinal) white adipose tissue (iWAT).
  - This upregulation is specific to adipocyte progenitor cells and is not observed in mature adipocytes or other tissues like the brain.
- Adipocyte Fate Switch:** IRX3 and IRX5 promote a shift in the developmental fate of adipocytes. Instead of differentiating into energy-dissipating beige (brite) adipocytes, the progenitors are more likely to become energy-storing white adipocytes.
  - Beige adipocytes are characterized by high mitochondrial content and the expression of uncoupling protein 1 (UCP1), which allows them to burn energy and produce heat.
  - White adipocytes, on the other hand, are primarily involved in lipid storage.
- Reduced Thermogenesis and Increased Lipid Storage:** The decrease in beige adipocytes leads to reduced thermogenesis and increased lipid storage, contributing to weight gain and obesity.

**Experimental Support:**

- Mouse Models:** CRISPR-Cas9 was used to create a mouse model with a deletion of the rs1421085-conserved cis-regulatory module (CRM). Mice homozygous for this deletion exhibited reduced body weight and fat mass when fed a high-fat diet, consistent with the human phenotype. These mice also showed increased mitochondrial activity and thermogenesis marker expression in adipose tissue, as well as decreased lipid storage marker expression and smaller adipocytes.
- Human Adipocytes:** CRISPR-Cas9 editing of rs1421085 in primary human adipocytes from a patient with the risk allele restored IRX3 and IRX5 repression and activated browning expression programs and thermogenesis.
- Gene Expression and Chromatin Conformation:** Studies have shown that the risk allele is associated with increased IRX3 and IRX5 expression in human adipocyte progenitor cells. Additionally, 3D fluorescence in situ hybridization experiments in mice demonstrated that the risk allele disrupts the interaction between the enhancer and the *Irx3* promoter, providing further evidence for the proposed mechanism.
- Metabolomic Studies:** Untargeted metabolomic analysis of adipose tissue and blood plasma from mice and humans revealed an rs1421085-specific disruption of steroidal metabolic homeostasis, with a decrease in acyl steroids in risk allele carriers. This suggests that the FTO obesity variant may also exert its effects through a genetically determined metabolotype.

# Responsible AI for Healthcare and Life Sciences

## Concerns



- **Privacy and Security:** ChatGPT and private data

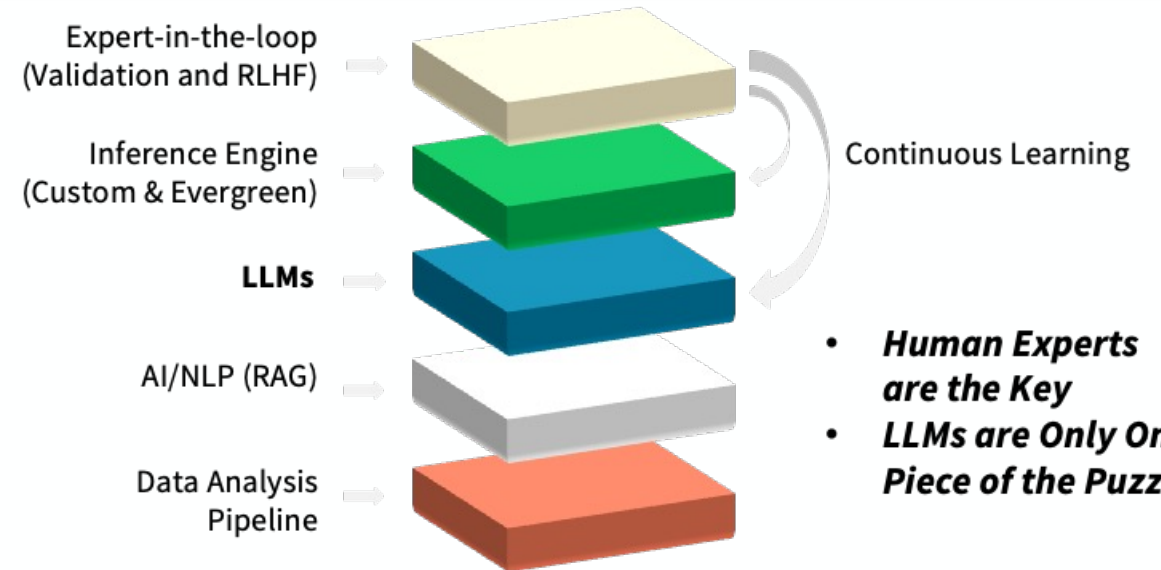


- **Accuracy:** Hallucinations and fake citations



- **Transparency:** Blackbox. Difficult to verify and validate

## Platform Approach to Achieve Responsible AI





# AI Solution Saves Time: From Days/Weeks to Minutes

Customize Queries and Prompts

suggest literature analysis health and economic outcomes for breast cancer

Here are some suggestions:

1. Literature analysis for query: "(health outcomes OR clinical outcomes OR patient outcomes) AND (economic outcomes OR economic impact OR healthcare costs) AND (breast cancer OR mammary carcinoma)" PubMed doc count 41
2. Literature analysis for query: "(treatment outcomes OR survival rates OR quality of life) AND (cost analysis OR economic evaluation OR cost-effectiveness) AND (breast neoplasm OR breast tumors)" PubMed doc count 5
3. Literature analysis for query: "(patient well-being OR therapy effectiveness OR disease management) AND (financial outcomes OR budget impact OR economic burden) AND (breast cancer OR breast carcinoma)" PubMed doc count 6

**user prompt:** Analyze the content to delineate how health and economic outcomes are interconnected in the context of breast cancer. Focus on summarizing the key findings regarding patient outcomes, economic impacts, and overall healthcare costs associated with the treatment and management of breast cancer. Highlight any emerging trends or variations in outcomes across different demographics or treatment modalities.

Refine Query If Needed

suggest literature analysis health or economic outcomes for breast cancer

Here are some suggestions:

1. Literature analysis for query: "(health outcomes OR clinical outcomes OR patient outcomes) AND (breast cancer OR mammary carcinoma)" PubMed doc count 6063
2. Literature analysis for query: "(economic outcomes OR economic impact OR cost analysis) AND (breast cancer OR breast neoplasms)" PubMed doc count 898
3. Literature analysis for query: "(healthcare costs OR financial burden) AND (breast cancer OR breast carcinoma)" PubMed doc count 363

**user prompt:** Evaluate how health and economic outcomes are reported in studies on breast cancer. Synthesize findings on the impact of breast cancer on patient health, healthcare costs, and economic factors. Consider variations in outcomes between studies, and identify any notable correlations or trends.

Literature analysis for query: "(health outcomes OR clinical outcomes OR patient outcomes) AND (breast cancer OR mammary carcinoma)" user prompt: Evaluate how health and economic outcomes are reported in studies on breast cancer. Synthesize findings on the impact of breast cancer on patient health, healthcare costs, and economic factors. Consider variations in outcomes between studies, and identify any notable correlations or trends.

Utterance Processed

Processing Step 2 of 23

# AI Solution Saves Time: From Days/Weeks to Minutes

Literature analysis using query: "(health outcomes OR clinical outcomes OR patient outcomes) AND (economic impacts OR healthcare costs) AND (breast cancer OR mammary carcinoma)" using prompt: "Analyze the content to delineate how health and economic outcomes are interconnected in the context of breast cancer. Focus on summarizing the key findings regarding patient outcomes, economic impacts, and overall healthcare costs associated with the treatment modalities in outcomes across different demographics or treatment modalities." [Edit Query](#)

## Summary

Literature Analysis for using query: "(health outcomes OR clinical outcomes OR patient outcomes) AND (economic impacts OR healthcare costs) AND (breast cancer OR mammary carcinoma)" Total documents found from query on PMC: 3000, Total documents found with matching data, relevant based on the query on PMC: 913, Total documents found from ... [Read more](#)



Search 167 records... 167 out of 167 records

| Epubdate   | Article   | Summary   | Takeaway  | Abstract   | Datasource ↑ | Article Index |
|------------|---|---|---|--|--------------|---------------|
| 2023-07-30 | <a href="#">Evaluation of health and economic effects of United States school meal standards consistent with the 2020–2025 dietary guidelines for Americans</a>   | The study analyzed cause-specific mortality rates for breast cancer, stratifying the data by age, sex, and race/ethnicity, acknowledging the variability in outcomes and economic impacts across different demographic groups. It highlighted the potential for improved dietary habits, particularly those established through school meal programs, to reduce the incidence of breast cancer and other diseases. While the study did not provide specific figures for breast cancer, it suggested that better nutrition standards in schools could lead to long-term health benefits and economic savings by decreasing direct medical costs and lost productivity associated with breast cancer. The overall model predicts significant reductions in disease burden and healthcare costs, implying that such preventative measures could have a substantial impact on both patient outcomes and economic factors related to breast cancer treatment and management. The study underscores the importance of considering demographic variations in breast cancer outcomes and the potential for policy interventions in nutrition to improve long-term health and economic outcomes. | Cause-specific mortality rates, including breast cancer, were modeled separately and stratified by age, sex, and race/ethnicity, indicating an understanding that breast cancer outcomes and economic impacts may vary across different demographic groups.<br><br>The economic impacts of improved dietary habits formed in school, which could potentially reduce the incidence of breast cancer among other diseases, were quantified in terms of both direct medical costs and lost productivity costs, although specific figures for breast cancer were not detailed in the excerpts.<br><br>The study suggests that implementing stronger school meal nutrition standards could lead to long-term reductions in disease burdens, including breast cancer, and associated healthcare costs. While specific numbers for breast cancer are not provided, the overall model estimates significant health benefits and economic savings. | Background<br>The current school meal nutrition standards, established in 2010, are not fully aligned with the 2020–2025 Dietary Guideline for Americans (DGA). This study evaluates the potential short-term and long-term health and economic benefits of strengthening the school meal standards on added sugars, sodium, and whole grains to be aligned with current guidelines.<br>Methods<br>We used comparative risk assessment frameworks based on nationally representative data incorporating current demographics, dietary habits, and risk factors of United States children aged 5–18 y from 3 cycles of the National Health and Nutrition Examination Survey (2013–2018). To estimate short-term impact, the model incorporated estimated dietary changes owing to potential new DGA-aligned school meal nutrition standards and the effect of these changes on childhood body mass index (in kg/m <sup>2</sup> ) and blood pressure. To estimate long-term impact, the model further incorporated data on the sustainability of childhood dietary changes into adulthood, and on demographics and risk factors of United States adults, diet-disease associations, and disease-specific national mortality.<br>Results<br>In a best-case scenario assuming full school compliance, implementing new DGA-aligned nutritional standards would lower elementary children's BMI by an average 0.14 (95% UI: 0.08–0.20) kg/m <sup>2</sup> and systolic blood pressure by 0.13 (95% UI: 0.06–0.19) (95% mm Hg. Later in life, the new standards were estimated to prevent 10,600 [95% uncertainty interval (UI): 4820–16,800] annual deaths from cardiovascular disease (CVD), diabetes, and cancer in adulthood; and save 355,000 (95% UI: 175,000–538,000) disability-adjusted life years and \$19.3 (95% UI: 9.35–30.3) B in direct and indirect medical costs each year. Accounting for plausible (incomplete) school compliance, implementation would save an estimated 9110 (95% UI: 2740–15,100) deaths, 302,000 (95% UI: 120,000–479,000) disability-adjusted life years, and \$15.9 (95% UI: 4.54–27.2) B in healthcare-related costs per year in later adulthood.<br>Conclusions<br>Stronger school meal nutrition standards on added sugars, sodium, and whole grains aligned with the 2020–2025 DGA recommendations may improve diet, childhood health, and future adult burdens of CVD, diabetes, cancer, and associated economic costs. | PMC          | 0             |
| 2023-09-12 | <a href="#">Comparison of the Efficacy of Longer versus Shorter Pulsed High Dose Dapsone Combination Therapy in the Treatment of Chronic Lyme Disease/Post Treatment Lyme Disease Syndrome with Bartonellosis and Associated Coinfections</a> | Recent research has identified a potential link between Bartonella species and breast cancer, which could influence the disease's etiology. This association is significant as it may affect patient outcomes and healthcare costs, underscoring the necessity for a precision medicine approach in treatment. The implication of Bartonella in breast cancer suggests an emerging trend that could alter current understanding and management of the disease. Understanding this connection is crucial for developing targeted therapies that could improve patient outcomes and potentially reduce healthcare expenses. Further investigation into this association is essential to confirm its impact and to adapt breast cancer treatment strategies accordingly.   | The association of Bartonella with breast cancer warrants further research due to its potential implications for both healthcare costs and patient outcomes, indicating a need for a precision medicine approach in treatment.  | Twenty-five patients with relapsing and remitting Borreliosis, Babesiosis, and bartonellosis despite extended anti-infective therapy were prescribed double-dose dapsone combination therapy (DDCT), followed by one or several courses of High Dose Dapsone Combination Therapy (HDDCT). A retrospective chart review of these 25 patients undergoing DDCT therapy and HDDCT demonstrated that 100% improved their tick-borne symptoms, and patients completing 6–7 day pulses of HDDCT had superior levels of improvement versus 4-day pulses if Bartonella was present. At the completion of treatment, 7/23 (30.5%) who completed 8 weeks of DDCT followed by a 5–7 day pulse of HDDCT remained in remission for 3–9 months, and 3/23 patients (13%) who recently finished treatment were 1 ½ months in full remission. In conclusion, DDCT followed by 6–7 day pulses of HDDCT could represent a novel, effective anti-infective strategy in chronic Lyme disease/Post Treatment Lyme Disease Syndrome (PTLDS) and associated co-infections, including Bartonella, especially in individuals who have failed standard antibiotic protocols.   | PMC          | 1             |

# AI Solution Saves Time: From Days/Weeks to Minutes

what are the biggest barriers in health and economic outcomes in breast cancer

## High-level Questions

### Overview of Barriers in Health and Economic Outcomes in Breast Cancer

Breast cancer remains a significant public health issue, with disparities in health and economic outcomes influenced by a variety of barriers. These barriers are particularly acute among African American women. This summary explores the major obstacles that hinder equitable health outcomes in breast cancer treatment and management.

#### Socioeconomic and Financial Barriers

Including poverty and financial difficulties, are pivotal in determining the timeliness and quality of breast cancer care. These conditions lead to delayed diagnoses and restricted treatment options, exacerbating health disparities among different populations[6][10]. African American women, in particular, face significant challenges due to economic inequalities, which impact not only the detection of breast cancer but also the quality and effectiveness of its management[9].

#### Insurance Coverage and Treatment Costs

The high costs associated with breast cancer treatment and the lack of adequate health insurance coverage are substantial barriers that prevent many patients from accessing necessary care[5][10]. Out-of-pocket expenses and the financial toxicity of cancer care can severely impact patients' quality of life and impede optimal treatment outcomes[5]. This issue is particularly acute among rural breast cancer patients and those from minority backgrounds, who often have less comprehensive insurance coverage[5].

#### Access to Advanced Treatments and Supportive Care

The availability of advanced cancer treatments and supportive care options like integrative oncology is often limited by socioeconomic status. African American women have reported difficulties in accessing such treatments due to financial constraints, which suggests broader issues of limited access to comprehensive care[4][7]. Virtual interventions and mindfulness-based programs have shown potential in overcoming some of these barriers by improving access to supportive care, although their application in breast cancer care specifically needs further exploration[9].

#### Impact of Socioeconomic Factors on Clinical Outcomes

#### Delayed Help-Seeking and Diagnosis

Socioeconomic status, including factors like education level and income, influences help-seeking behavior and attitudes towards breast cancer symptoms[8]. Delays in seeking help due to financial concerns or lack of knowledge about symptoms can lead to advanced disease stages at diagnosis, which are harder and more expensive to treat effectively[8].

#### Racial Disparities in Screening and Treatment

Racial disparities in breast cancer screening and treatment are well-documented, with African American women less likely to receive advanced screening technologies and more likely to experience delays in follow-up after abnormal mammograms[2]. These disparities contribute to poorer health outcomes and higher mortality rates in this population[9].

#### Addressing the Barriers

To mitigate these barriers, it is essential to develop targeted interventions and policies that consider the socioeconomic factors influencing breast cancer care. Enhancing patient education, improving insurance coverage, and increasing the affordability and accessibility of advanced treatments are critical steps towards reducing health disparities. Additionally, fostering trust in the medical system through community engagement and a diverse medical workforce can help improve health outcomes across all demographics[2].

#### Conclusion

The barriers to equitable health and economic outcomes in breast cancer are deeply rooted in socioeconomic and financial factors. Addressing these barriers requires a multifaceted approach that includes policy changes, community engagement, and innovations in healthcare delivery. By focusing on these areas, it is possible to improve access to care and reduce disparities in breast cancer outcomes.

#### References

- 1 - [ICIMH 2022 Abstracts](#), 2022-05-02.
- 2 - [The promise and challenges of multi-cancer early detection assays for reducing cancer disparities](#), 2024-03-08.
- 4 - [Abstracts](#), 2018-09-21.
- 5 - [Qualitative analysis of cancer care experiences among rural cancer survivors and caregivers](#), 2022-04-05.
- 6 - [Proceedings of the 15th Annual Conference on the Science of Dissemination and Implementation in Health](#), 2023-10-05.
- 7 - [Abstracts](#), 2018-09-21.
- 8 - [A Description of Theoretical Models for Health Service Utilization: A Scoping Review of the Literature](#), 2023-05-30.
- 9 - [ICIMH 2022 Abstracts](#), 2022-05-02.
- 10 - [Health system factors that influence diagnostic and treatment intervals in women with breast cancer in sub-Saharan Africa: a systematic review](#), 2021-07-06.

#### Rating

9 out of 10.

#### Answer Description

The answer is very relevant to the question and is of high quality.

## Citations

## 2<sup>nd</sup> Level of Transparency

# AI Solution Saves Time: From Days/Weeks to Minutes

what are the biggest barriers in health and economic outcomes in breast cancer. Please give as much as quantitative data as possible.

## Key Question

What are the biggest barriers in health and economic outcomes in breast cancer, with a focus on quantitative data?

### Overview of Barriers in Breast Cancer Outcomes

Breast cancer remains a significant public health issue, with disparities in health and economic outcomes influenced by a variety of barriers. These barriers can be broadly categorized into financial, socioeconomic, and healthcare access barriers, each playing a role in determining the timeliness and effectiveness of breast cancer diagnosis and treatment, which are critical for patient outcomes.

#### Financial Barriers

Financial constraints are one of the most significant obstacles affecting breast cancer outcomes. High treatment costs and inadequate health insurance coverage are primary financial barriers that hinder access to care. Out-of-pocket expenses can be prohibitively high, leading to delays in treatment and sometimes the complete inability to receive necessary care. For instance, rural breast cancer patients often face financial toxicity, which not only affects their quality of life but also impedes their ability to receive optimal care<sup>5</sup>. Additionally, African American women have reported difficulties in accessing supportive care like cannabis due to financial constraints, highlighting broader issues of limited access to treatments<sup>3</sup>.

#### Socioeconomic and Demographic Factors

Socioeconomic status, including factors like poverty and financial difficulties, significantly affects breast cancer diagnosis and outcomes. These factors often lead to late-stage diagnoses and delays in accessing treatment, contributing to higher mortality rates<sup>1</sup>. African American women, in particular, face health disparities with higher mortality and lower survival rates for breast cancer compared to other populations. These disparities are attributed to differences in access to and utilization of advanced cancer treatments<sup>4</sup>.

#### Healthcare Access Barriers

Access to healthcare is another critical determinant of breast cancer outcomes. Individuals who are underinsured or uninsured often experience late presentation and reduced prevention and care, leading to poorer health outcomes. Theoretical models suggest that help-seeking behavior, which is crucial for early diagnosis, is influenced by a combination of personal and systemic factors, including knowledge, symptom appraisal, and attitudes towards seeking help<sup>6</sup>.

#### Economic Conditions and Inequalities

Economic conditions and inequalities further exacerbate disparities in breast cancer care. For example, a systematic review highlighted that in sub-Saharan Africa, economic hardships significantly influence diagnostic and treatment intervals in women with breast cancer<sup>9</sup>. Similarly, in the United States, economic barriers hinder the effective management of breast cancer, with virtual interventions like Mindfulness-Based Stress Reduction programs suggested as potential solutions to overcome these obstacles<sup>4</sup>.

#### Conclusion

The biggest barriers in health and economic outcomes in breast cancer are primarily financial, socioeconomic, and related to healthcare access. These barriers lead to disparities in healthcare access and utilization, particularly among underrepresented and economically disadvantaged groups, resulting in delayed help-seeking behavior and potentially worse health outcomes. Addressing these barriers is crucial for improving breast cancer diagnosis and treatment across diverse populations.

#### References

- 1 - [2022 International Cancer Education Conference Late-Breaking Abstracts](#), 2023-04-18.
- 3 - [Abstracts](#), 2018-09-21.
- 4 - [ICIMH 2022 Abstracts](#), 2022-05-02.
- 5 - [Qualitative analysis of cancer care experiences among rural cancer survivors and caregivers](#), 2022-04-05.
- 6 - [A Description of Theoretical Models for Health Service Utilization: A Scoping Review of the Literature](#), 2023-05-30.
- 9 - [Health system factors that influence diagnostic and treatment intervals in women with breast cancer in sub-Saharan Africa: a systematic review](#), 2021-07-06.

#### Rating

8 out of 10. You can improve this answer with:

[Update training on my question](#)

Pick a training suggestion and run it. Once complete, rerun your question.

#### Answer Description

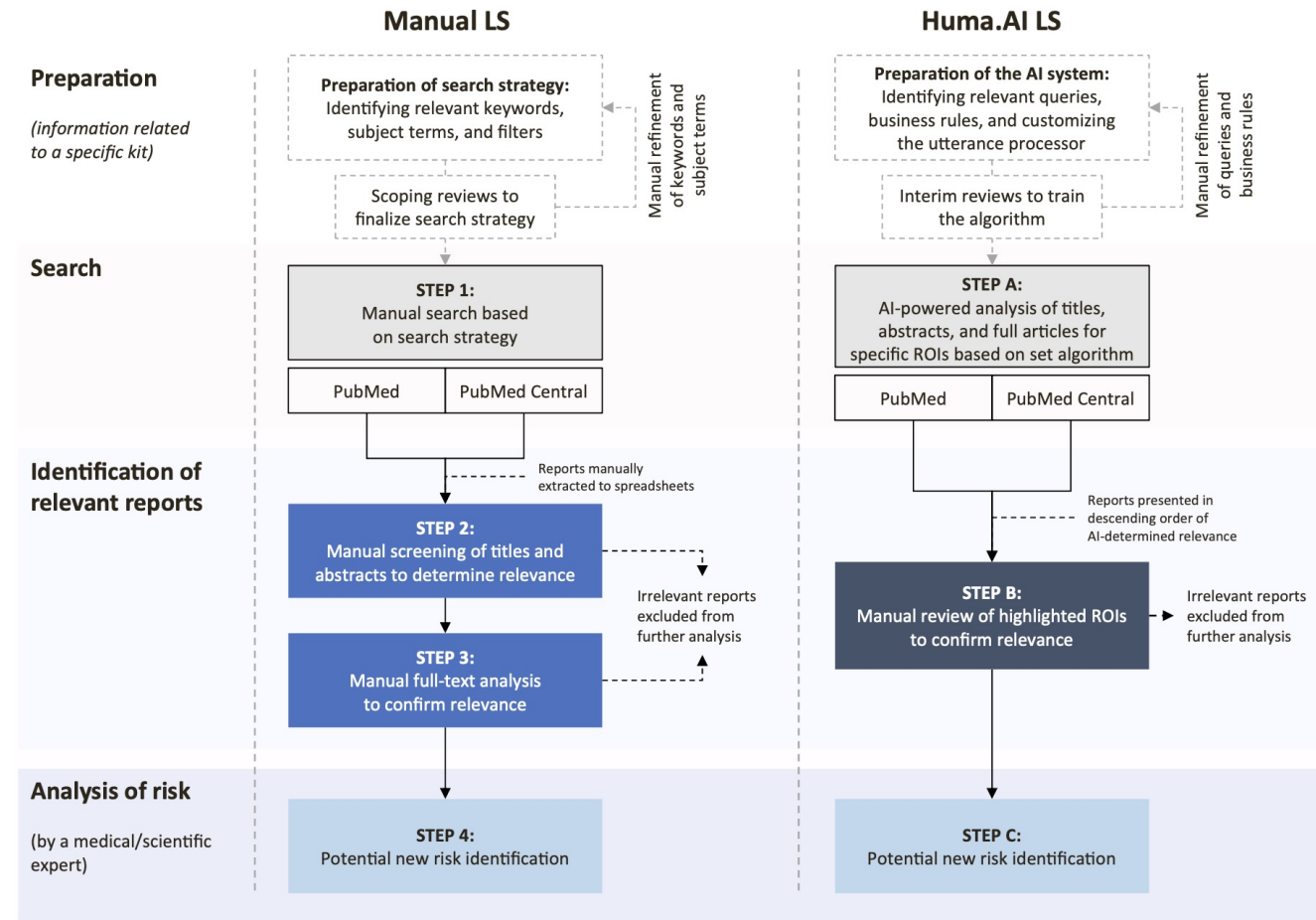
The answer is very relevant to the question and is of high quality.

Ask Iterative Questions

# Peer-Reviewed Manuscript: Systematic Lit Review Validation

J. Reniewicz et al.

New BIOTECHNOLOGY 79 (2024) 82–90

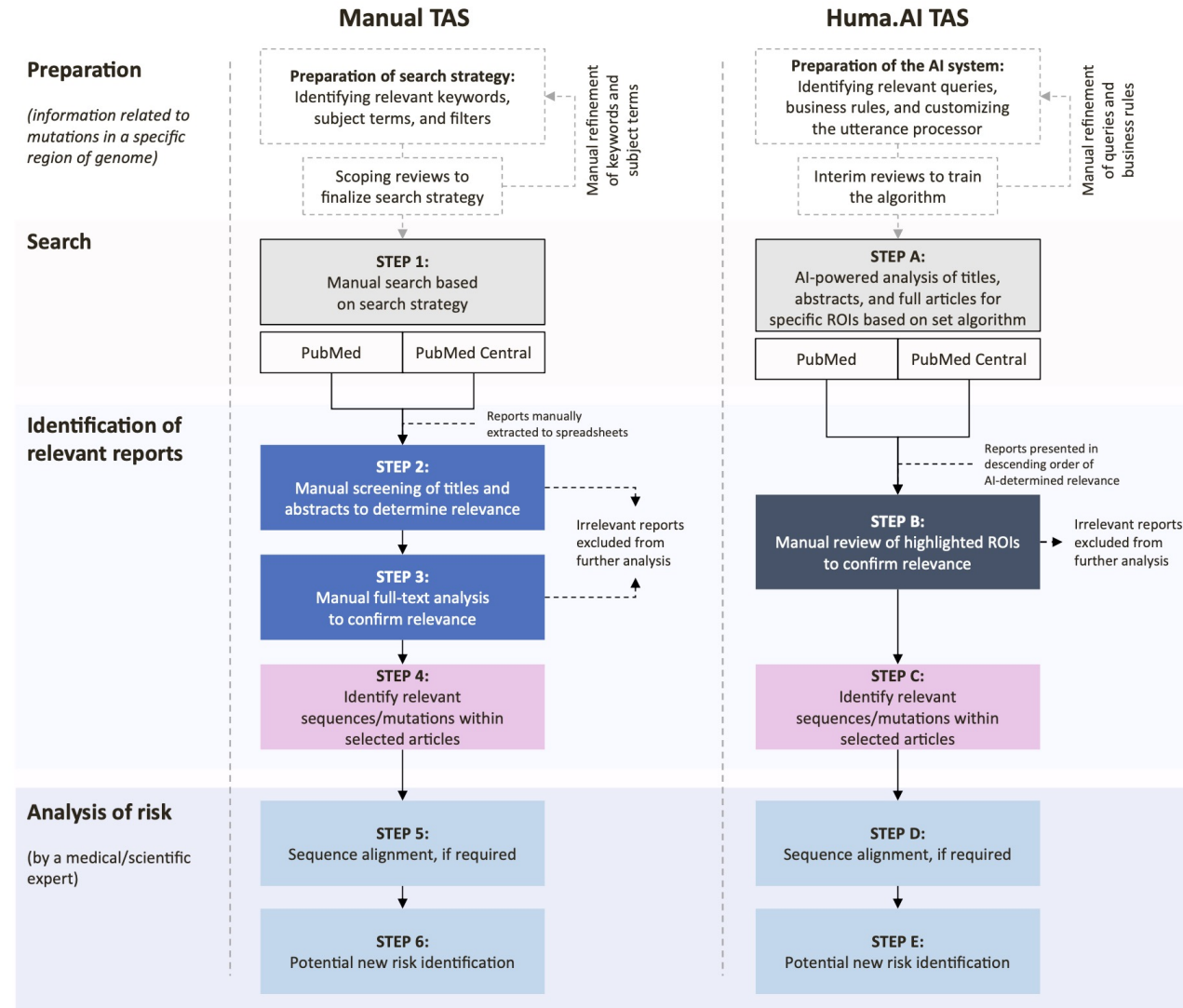


**Fig. 1.** Process for the manual and Huma.AI literature search. The Huma.AI workflow mirrors the manual search but simplifies the ‘identification of relevant reports’ stage by identifying potentially relevant articles and presenting the region of interest with each report. Relevant articles were those that referred explicitly to the evaluated product. Information related to the safety and/or performance from the relevant articles was then extracted by a medical/scientific expert for inclusion in a PMS report. AI, artificial intelligence; LS, literature search; PMS, post-market surveillance; ROI, region of interest.

# Peer-Reviewed Manuscript: Systematic Lit Review Validation

J. Reniewicz et al.

New BIOTECHNOLOGY 79 (2024) 82–90



# Peer-Reviewed Manuscript: Validation Results

J. Reniewicz et al.

New BIOTECHNOLOGY 79 (2024) 82–90

**Table 1**  
Comparison of manual versus Huma.AI literature search results.

| Assay                                | 2019                   |                        | 2020                   |                        | 2021                   |         | 2022   |         |
|--------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|---------|--------|---------|
|                                      | Manual                 | Huma.AI                | Manual                 | Huma.AI                | Manual                 | Huma.AI | Manual | Huma.AI |
| RGQ MDx                              | 6/11                   | 255/260                | 9/21                   | 329/335                | 10/22                  | 477/489 | n/a    | n/a     |
| Precision rate (%)                   | 54.55                  | 98.08                  | 42.86                  | 98.21                  | 45.45                  | 97.55   |        |         |
| digene HC2 DNA Collection Device     | No articles identified | 35/63                  | 1/1                    | 48/69                  | 3/4                    | 44/60   | n/a    | n/a     |
| Precision rate (%)                   | n/a                    | 55.56                  | 100                    | 69.57                  | 75                     | 73.33   |        |         |
| digene HC2 HPV DNA Test              | 4/4                    | 13/13                  | 2/3                    | 16/17                  | 3/6                    | 18/18   | n/a    | n/a     |
| Precision rate (%)                   | 100                    | 100                    | 66.67                  | 94.12                  | 50                     | 100     |        |         |
| therascreen BRAF                     | 0/1                    | No articles identified | 1/1                    | No articles identified | No articles identified | 3/4     | n/a    | n/a     |
| Precision rate (%)                   | 0                      | n/a                    | 100                    | n/a                    | n/a                    | 75      |        |         |
| ipsogen JAK2 kits                    | No articles identified | 2/3                    | No articles identified | 6/8                    | 0/1                    | 5/6     | n/a    | n/a     |
| Precision rate (%)                   | n/a                    | 66.67                  | n/a                    | 75                     | 0                      | 83.33   |        |         |
| ipsogen BCR-ABL1 kits                | 1/1                    | 3/3                    | 1/1                    | 2/2                    | No articles identified | 2/3     | n/a    | n/a     |
| Precision rate (%)                   | 100                    | 100                    | 100                    | 100                    | n/a                    | 66.67   |        |         |
| QuantiFERON-CMV Kit                  | 3/3                    | 7/9                    | 1/1                    | 14/14                  | 2/2                    | 11/12   | n/a    | n/a     |
| Precision rate (%)                   | 100                    | 77.78                  | 100                    | 100                    | 100                    | 91.67   |        |         |
| QIA Symphony DSP Virus/Pathogen      | No articles identified | 4/4                    | 1/2                    | 0/2                    | No articles identified | 2/2     | n/a    | n/a     |
| Precision rate (%)                   | n/a                    | 100                    | 50                     | 0                      | n/a                    | 100     |        |         |
| care HPV                             | 4/4                    | 9/9                    | 7/7                    | 12/14                  | 4/4                    | 12/15   | n/a    | n/a     |
| Precision rate (%)                   | 100                    | 100                    | 100                    | 85.71                  | 100                    | 80      |        |         |
| QuantiFERON SARS-CoV-2               | n/a                    | n/a                    | n/a                    | n/a                    | 6/12                   | 18/30   | 20/24  | 67/93   |
| Precision rate (%)                   |                        |                        |                        |                        | 50                     | 60      | 76.92  | 72.04   |
| QIAstat SARS-CoV-2 Respiratory Panel | n/a                    | n/a                    | n/a                    | n/a                    | 7/8                    | 56/57   | 6/6    | 32/35   |
| Precision rate (%)                   |                        |                        |                        |                        | 87.50                  | 98.24   | 100.00 | 91.43   |
| NeuMoDx SARS-CoV-2 Assay             | n/a                    | n/a                    | n/a                    | n/a                    | 2/2                    | 21/23   | 5/8    | 19/21   |
| Precision rate (%)                   |                        |                        |                        |                        | 100.00                 | 91.30   | 62.50  | 90.48   |

Results are shown as relevant articles / total articles identified. Precision rates are shown in percentages.

n/a, not applicable.

BCR-ABL1, breakpoint cluster region protein Abelson murine leukemia viral oncogene homolog 1; BRAF, serine/threonine-protein kinase B-raf; CMV, cytomegalovirus; DNA, deoxyribonucleic acid; DSP, diagnostic sample preparation; HC2, hybrid capture 2; HPV, human papillomavirus; JAK2, Janus kinase 2; RGQ, rotor-gene Q; SARS-CoV-2, severe acute respiratory syndrome coronavirus-2.

# FastFacts: Can Generative Artificial Intelligence (GenAI) Deliver Robust Research and Shorten the Healthcare Innovation Cycle?

## Takeaways

|   |  |
|---|--|
| 1 | Evidence requirements burden industry and delay patient access to healthcare innovation.                         |
| 2 | Promising Generative Artificial Intelligence (GenAI) applications include literature reviews and data synthesis. |
| 3 | GenAI may accelerate data evaluation and shorten the innovation cycle.   |
| 4 | Concerns linger regarding the accuracy and transparency of GenAI in technology assessment.                       |
| 5 | With appropriate boundaries and SOPs, we can trust GenAI not to "hallucinate"                                    |



**John Hernandez, PhD**  
Head of Clinical Research & HEOR  
Google



**Lana Feng, PhD**  
CEO & Co-Founder  
Huma.AI