



# MASLD Awareness Tracker

“How FDA Drug Approvals Shape Public Awareness of Liver Disease”

***Evaluating the Impact of FDA Approvals on Public and Scientific Awareness of Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD)***



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# Research Question & Context: Tracking Awareness Milestones

**Research Question:** How do regulatory drug approvals shape public and scientific awareness of MASLD?

## The Disease

**MASLD** (Metabolic Dysfunction-Associated Steatotic Liver Disease) is a serious, common liver condition affecting millions globally. Linked to obesity and diabetes.

Previously called **Nonalcoholic Fatty Liver Disease** (**NAFLD**), involves fat accumulation in the liver and can progress to cirrhosis and liver failure.  
**NAFLD → MASLD Terminology in June 2023.**

No FDA-approved treatments until 2024.

## The Project

**Multi-platform analysis** of the impact of FDA approvals for MASLD treatments on **public awareness, community discourse**, and **scientific research**.

**Aim:** To **uncover patterns** in public discourse, scientific literature, and market response that reveal how regulatory events influence public awareness of MASLD.

**Approach:** Integrated and analyzed data from **Google Trends, Reddit, PubMed, Stock Market**, and **Media**.

## The Events (The 'Milestones')

**14 March 2024**

**Resmetirom (Rezdiffra®)**

First-ever FDA-approved drug specifically for MASLD.

**15 August 2025**

**GLP-1 Agonists (Semaglutide/Wegovy®)**

Weight loss drugs showing significant MASLD benefits.



# A Multi-Platform Approach to Tracking Awareness

Data Source	Description	Type	Format	Processing Approach	Key Metric	Key Analysis	Purpose	Data Size Used
Google Trends	Public search interest for MASLD, NAFLD, Rezdifra, Wegovy, Ozempic	API + G-Drive Fallback	CSV	Collected via pytrends API; weekly aggregation; ITS analysis; statistical validation (Welch's t-tests, Mann-Whitney U); seasonal decomposition for non-stationary time series	Search Volume Index for MASLD, NAFLD, Rezdifra, Wegovy, Ozempic	Time Series Analysis, Statistical Impact Testing, Terminology Transition Monitoring	Measure public awareness and FDA approval impact	~5,000 data points 740 data points (after filtering)
Reddit	Community discussions from 12 medical subreddits	API + G-Drive Fallback	JSON > DataFrame /CSV	Collected via Pushshift API; VADER sentiment analysis; NMF topic modeling for 5 themes; NetworkX for subreddit connectivity analysis; Temporal patterns	Post Volume, Sentiment Scores, Discussion Themes from r/MASLD, r/Ozempic, etc.	Topic Modeling, Temporal Patterns, Sentiment Tracking, Network Analysis	Analyze patient discourse and community engagement	9,146 posts 9,097 posts 12 subreddits (after filtering)
PubMed	Scientific publications on MASLD and treatments	API + G-Drive Fallback	XML / JSON > DataFrame	Collected via Biopython/Entrez API; Fisher's exact tests for publication odds ratios; time-series tracking of disease-drug combination research	Publication Count for MASLD Research and Drug Treatments	Trend Analysis, Research Focus Tracking, Statistical Significance Testing	Assess scientific community response and research priorities	618 articles

**Timeframe:** January 2023 – October 2025 (148 weeks of data).

**Filtering:** All data filtered to study period (2023-2025), removing historical posts.

**Preprocessing:** Standardized timelines, normalized scales, sentiment scoring.

**Statistical Methods:** Interrupted Time Series (ITS) analysis, T-tests, Fisher's exact tests, Mann-Whitney U tests, Non-Negative Matrix Factorization (NMF), Cohen's d, Network Analysis, Sentiment Analysis (VADER).



## A Multi-Platform Approach to Tracking Awareness

Data Source	Description	Type	Format	Processing Approach	Key Metric	Key Analysis	Purpose	Data Size Used
Stock Data	Daily stock prices for Novo Nordisk (NVO) and Madrigal Pharmaceuticals (MDGL)	API + G-Drive Fallback	CSV	Collected via yfinance API; event study methodology with pre/post windows; volatility analysis with rolling standard deviation; cross-platform correlation testing	Daily Returns, Volatility Metrics, Event Window Abnormal Returns	Event Study Analysis, Volatility Pattern Analysis, Cross-Platform Correlation	Measure market response and investor sentiment to FDA approvals	705 trading days
Media Cloud	News media coverage across disease-focused, Resmetirom-focused, and GLP-1-focused datasets	File + G-Drive Fallback	CSV	Pre-collected datasets; interrupted time series analysis; concentration metrics (Gini coefficient, HHI); Granger causality tests for topic propagation	Daily Article Counts, Source Distribution, Coverage Concentration	ITS Analysis, Media Concentration Metrics, Topic Propagation Analysis	Analyze media coverage patterns and spillover effects	21,905 articles

Timeframe: January 2023 – October 2025 (148 weeks of data).



## Summary of the Results – Google Trends

### FDA Approvals Drive Public Search Interest

#### 🔍 METHODOLOGY

- Search terms: MASLD, NAFLD, Rezdiffra, Wegovy, Ozempic
- Data quality validation
- API + G-Drive Fallback
- Statistical Methods:
  - T-tests (30 days pre/post)
  - Interrupted Time Series (ITS)
  - Correlation Analysis
  - Validation: Non-parametric tests + assumption checks
  - Quality Control: Zero-analysis exclusion criteria

#### 💡 KEY FINDINGS

##### **GLP-1 Approvals Drove Awareness**

- MASLD: **+17.1 points** after GLP-1 approvals ( $p<0.001$ )\*
- Wegovy: **+25.6 points** ( $p<0.01$ )\*
- Ozempic: **+19.4 points** ( $p<0.01$ )\*
- MASLD: **+14.4 points** ( $p<0.001$ )\*, NAFLD: **+31.5 points** ( $p=0.001$ )\*, Wegovy: **+21.8 points** ( $p<0.001$ )\*

##### **Resmetirom Created Spillover Effects**

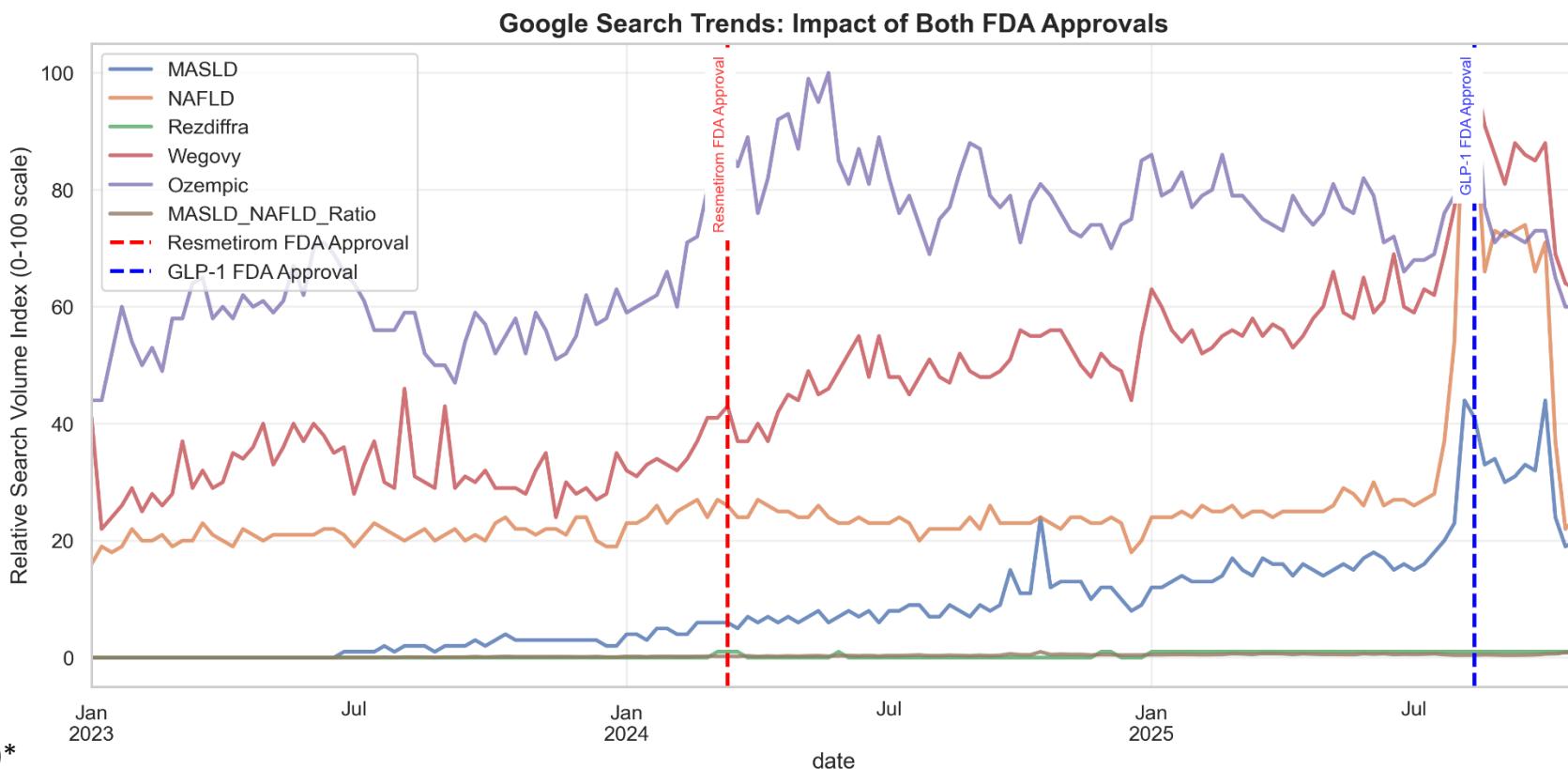
- Wegovy: **+7.8 points** ( $p=0.0053$ )\*
- Ozempic: **+19.6 points** ( $p<0.001$ )\*
- MASLD: *No immediate level change but positive slope trend (+0.032,  $p<0.001$ )\**
- MASLD: **+4.4 points** ( $p<0.001$ )\*, NAFLD: **+1.1 points** ( $p=0.030$ )\*

##### **Wegovy Strongly Correlates with Disease Awareness**

- MASLD & Wegovy: **r=0.93**, NAFLD & Wegovy: **r=0.75**

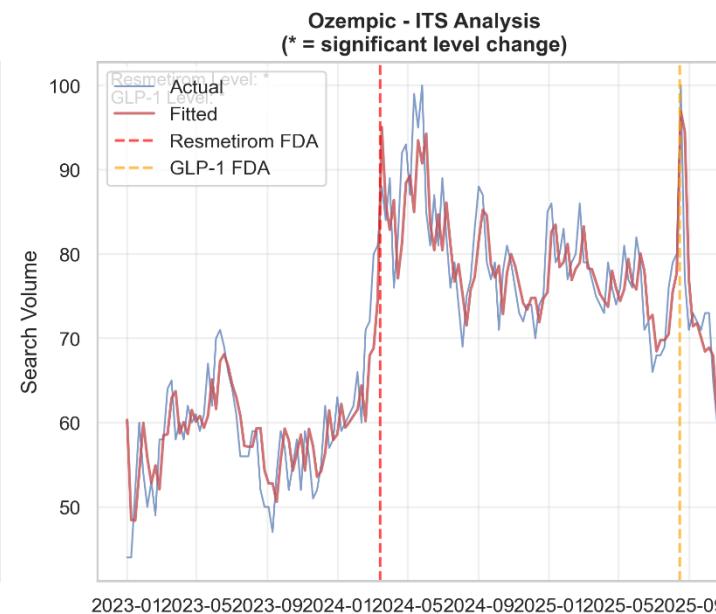
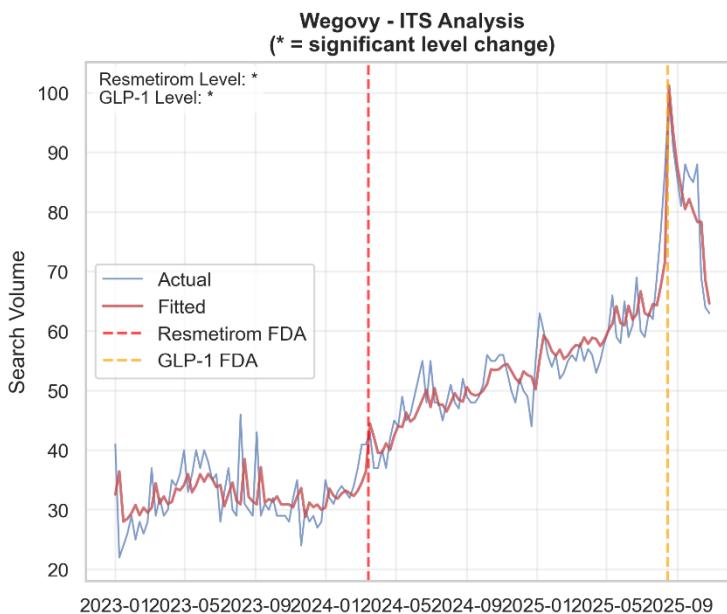
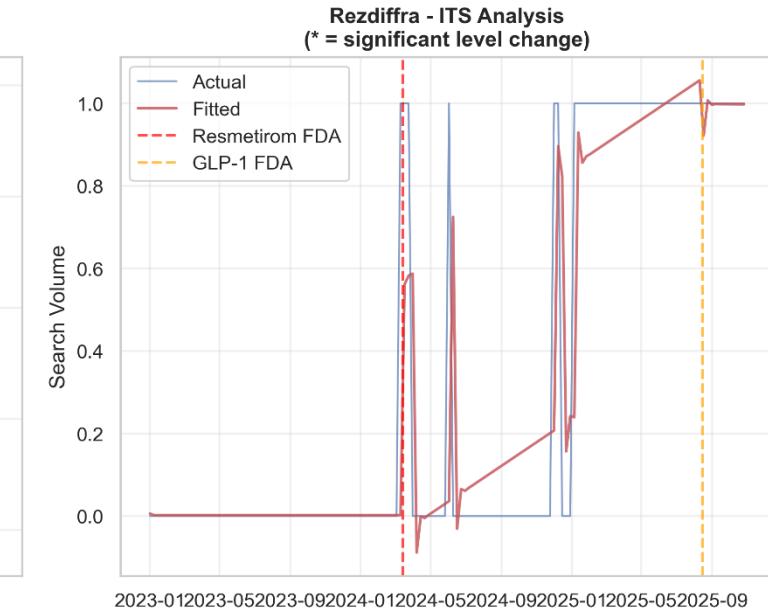
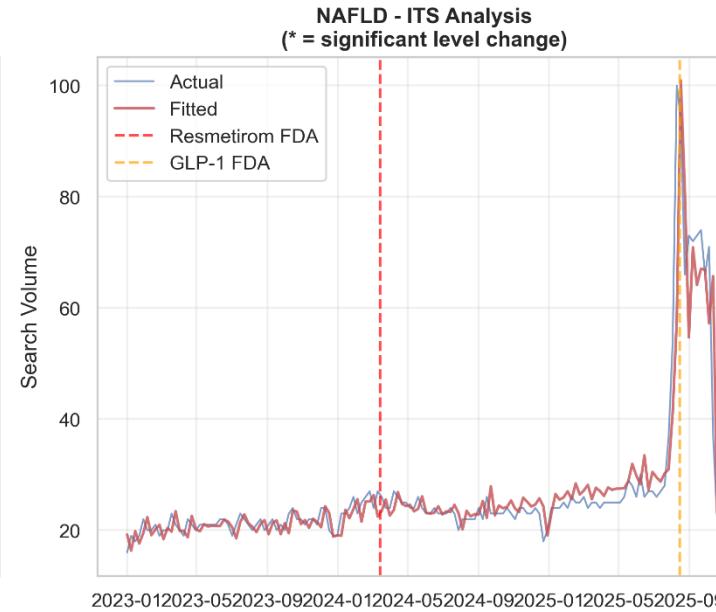
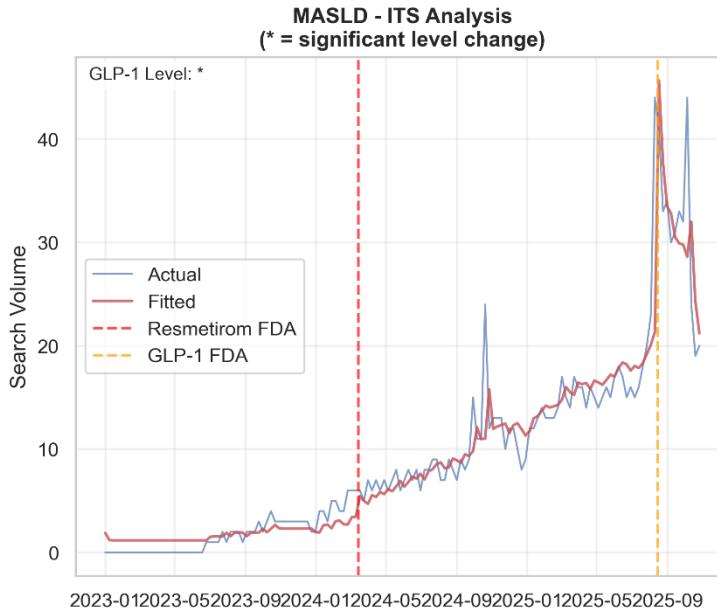
#### 💡 KEY INSIGHT

- **GLP-1 approvals** drove **MASLD awareness** more effectively than the dedicated MASLD drug.
- **MASLD terminology adoption** accelerated by **GLP-1 awareness**.





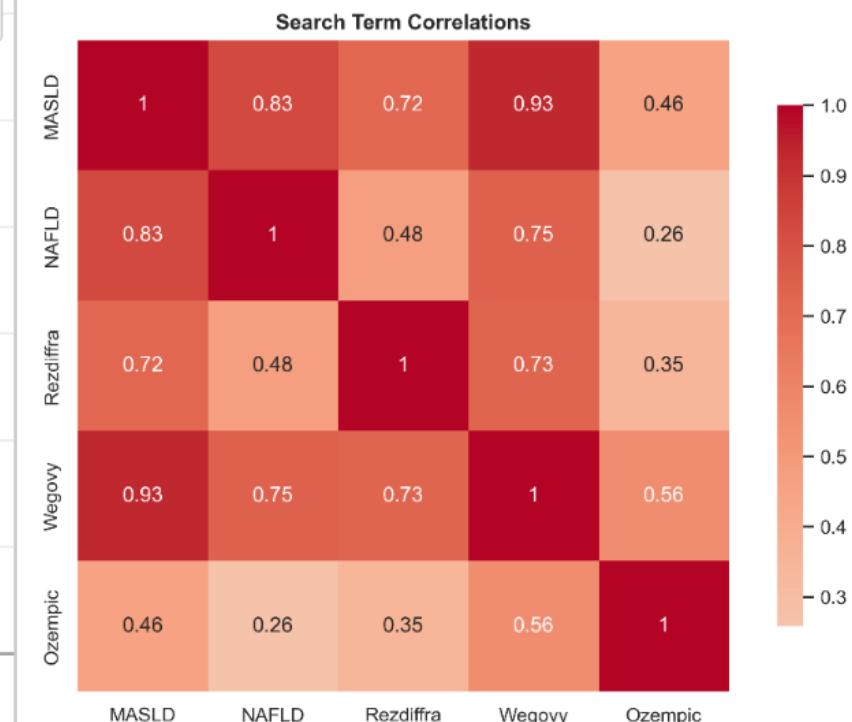
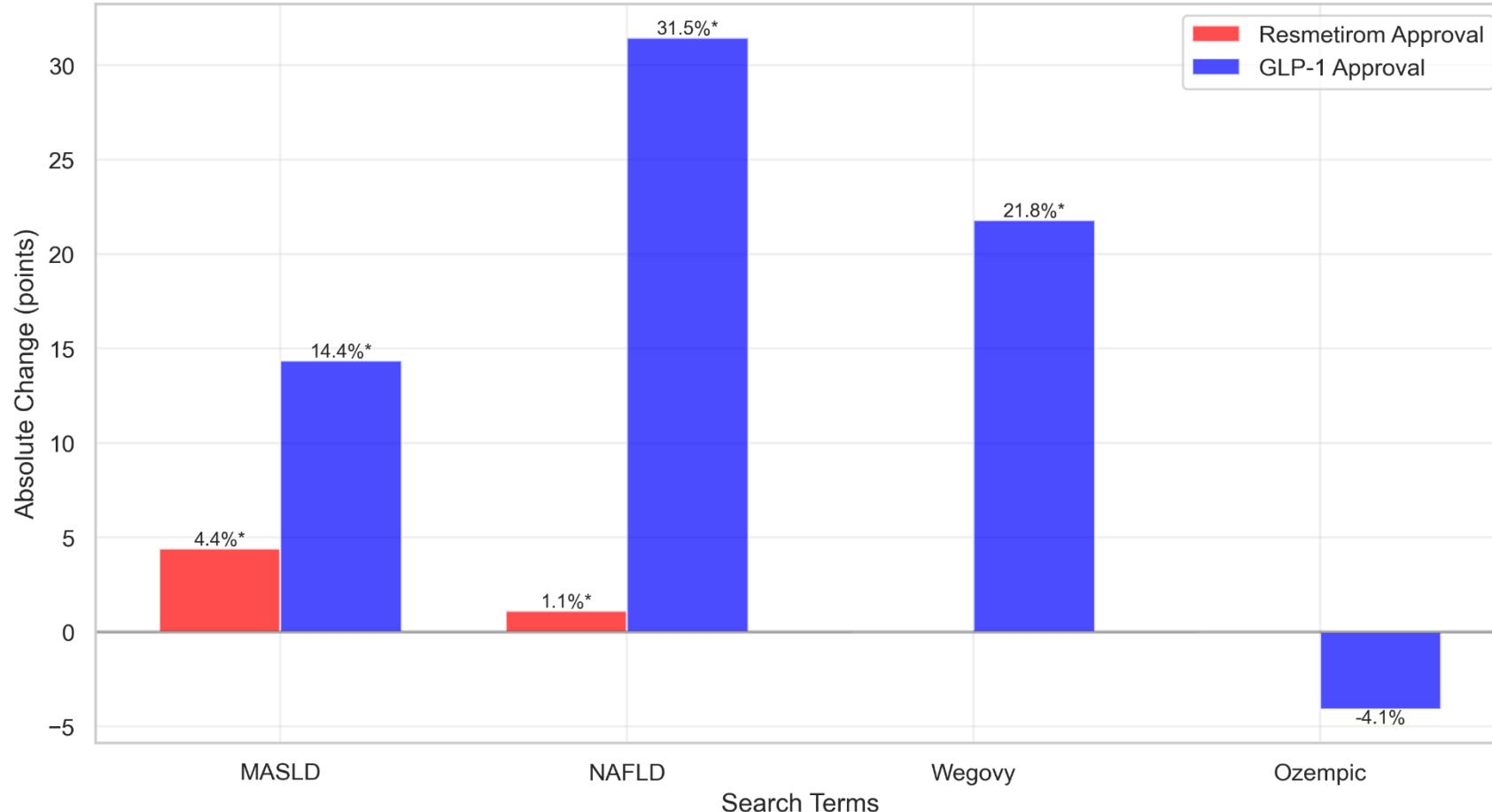
## Summary of the Results – Google Trends





## Summary of the Results – Google Trends

**Search Interest Change After FDA Approvals**  
(\* = statistically significant)





## Summary of the Results - Reddit

# Community Discussion Focuses on Personal Experience and Treatment

### METHODOLOGY

- 9,097 Reddit posts/comments (2023-2025)
- 12 subreddits across MASLD/NAFLD communities
- Data: Pushshift API + G-Drive fallback
- Statistical Methods:
  - VADER sentiment analysis with FDA event tracking
  - NMF topic modeling (5 topics)
  - Temporal pattern analysis (hourly/daily/monthly)
  - Statistical validation: Welch's t-tests, effect sizes, Bonferroni correction

### KEY FINDINGS

#### GLP-1 Approval Drove Discussion Volume

- +82.3% increase in posts (96 → 175 posts)
- Community excitement around weight loss treatments

#### Resmetirom Showed Muted Response

- -30.8% decrease in discussion (39 → 27 posts)
- Limited engagement with MASLD-specific treatment

#### Personal Experiences Dominated Discussions

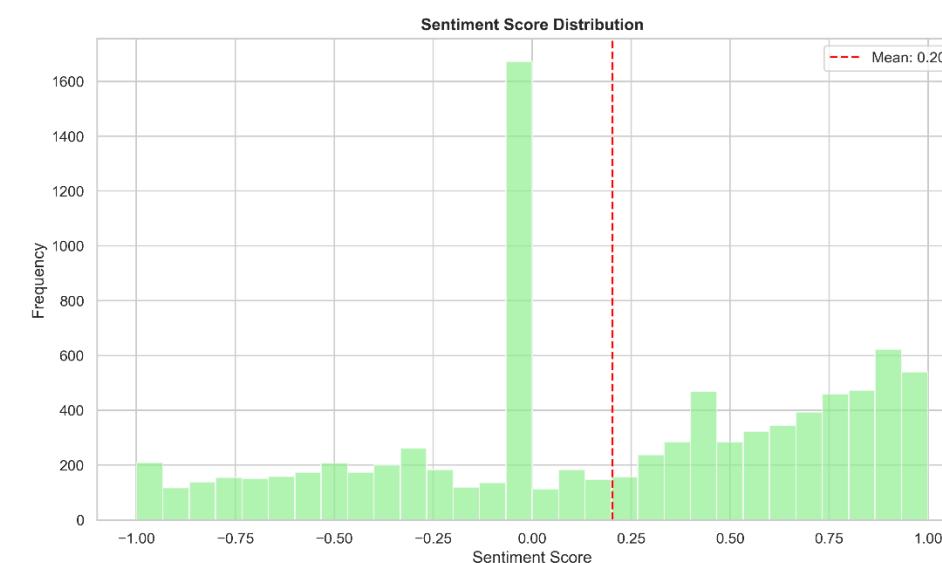
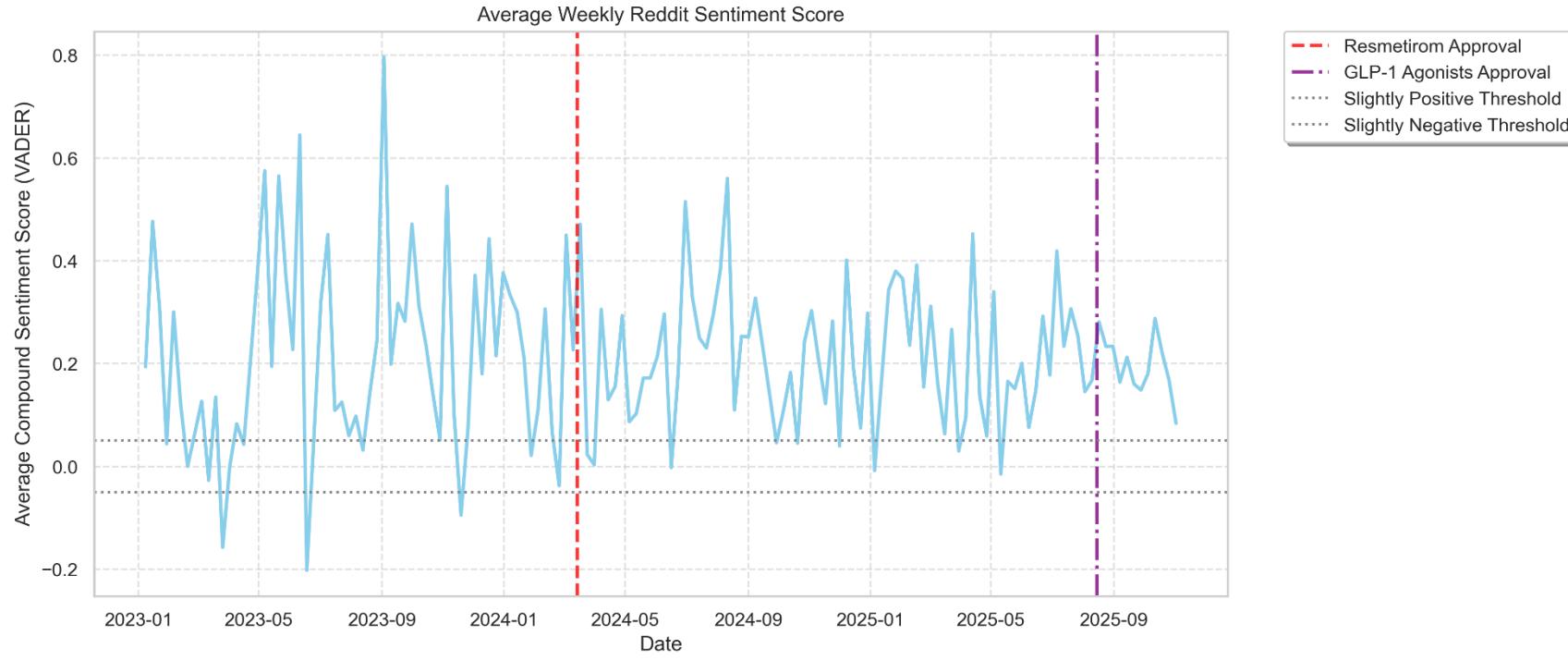
- Topic 0: Personal stories (44%) - "I'm, just, don't"
- Topic 4: Drug treatments (33%) - "Ozempic, weight, loss"
- Topic 3: Liver disease (14%) - clinical discussions

#### Sentiment Remained Stable

- No significant shifts after FDA approvals ( $p>0.05$ )
- Small negative effect for Resmetirom (Cohen's  $d = -0.305$ )
- Negligible effect for GLP-1 (Cohen's  $d = -0.012$ )

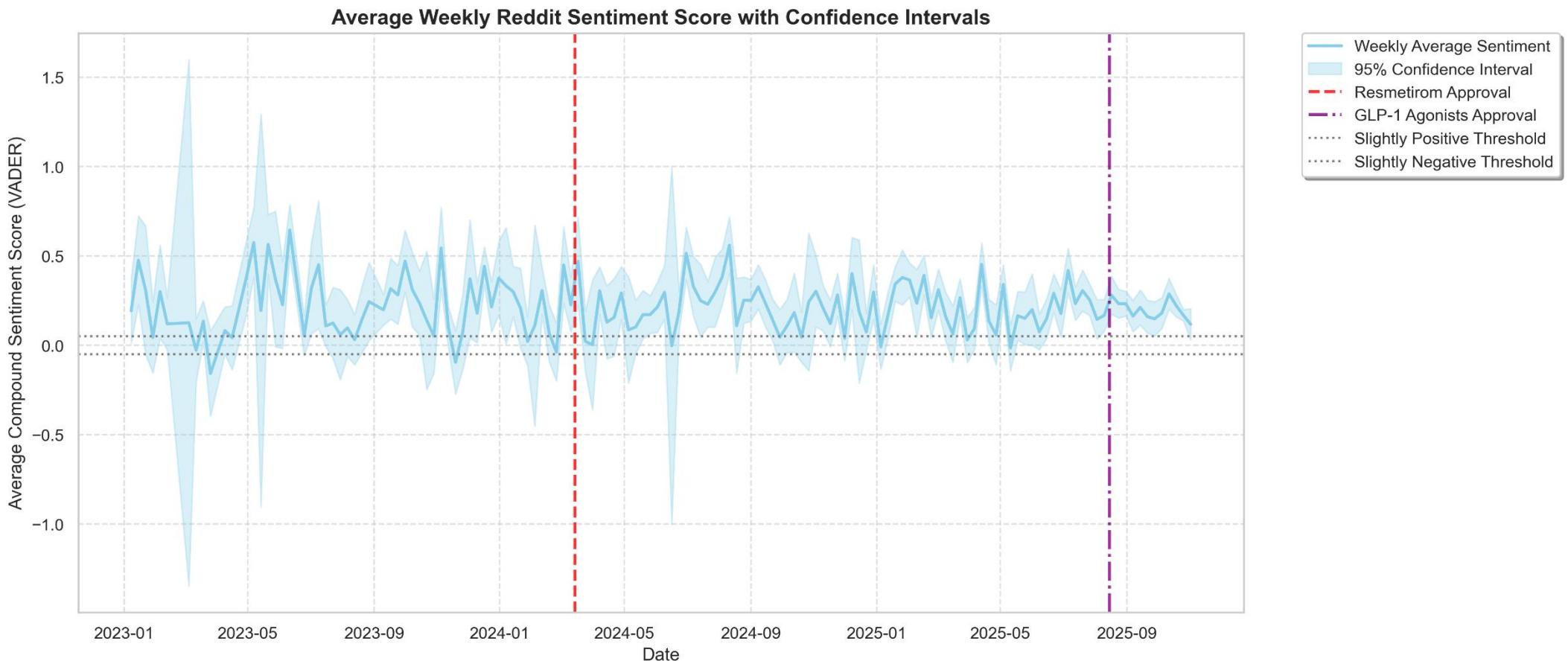
### KEY INSIGHT

- GLP-1 drugs generated **community excitement**, while MASLD-specific treatment saw reduced engagement - patients prioritize **weight loss discussions** over liver-specific treatments.



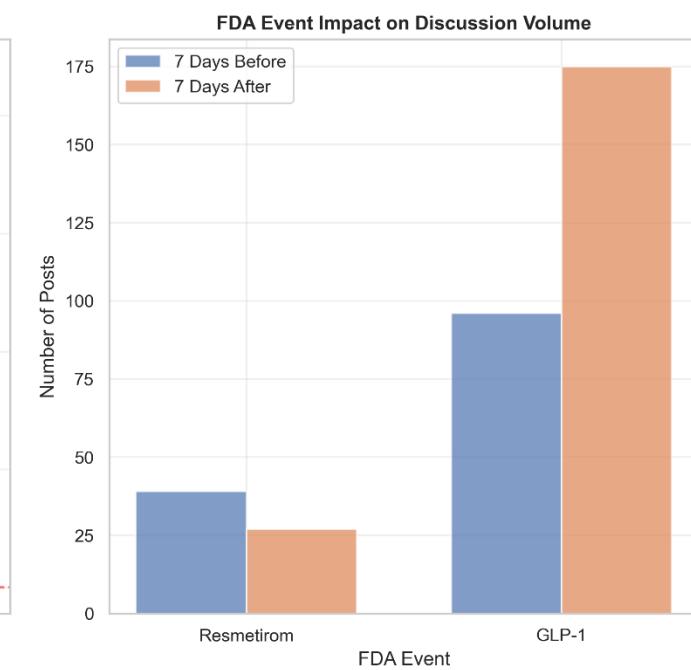
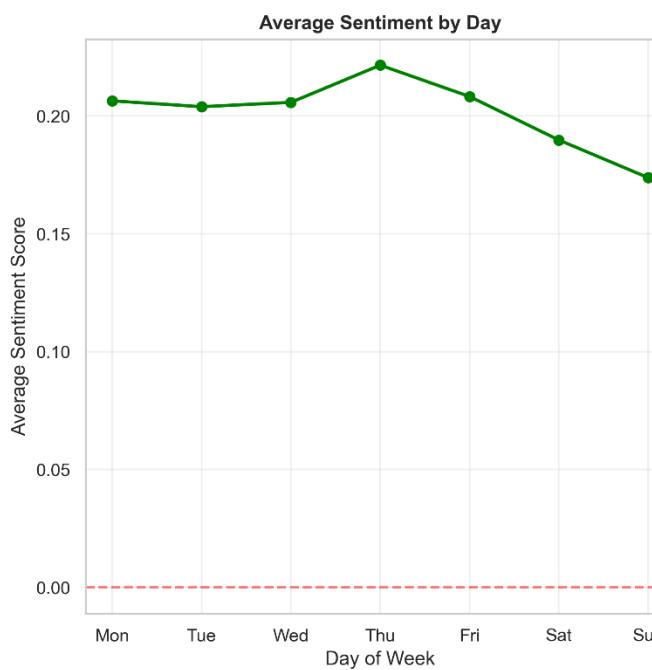
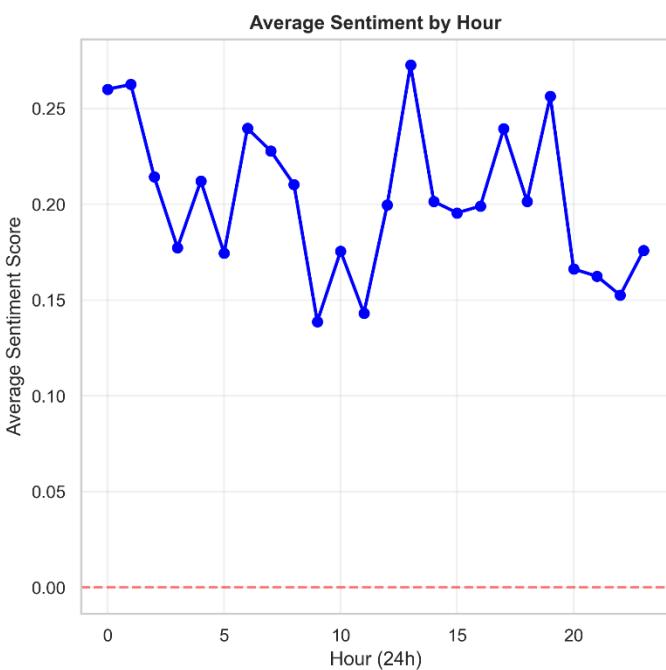
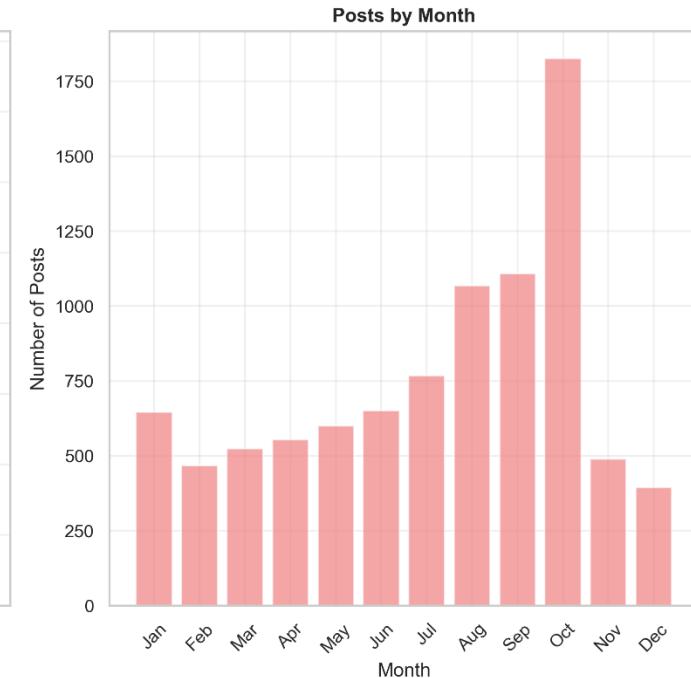
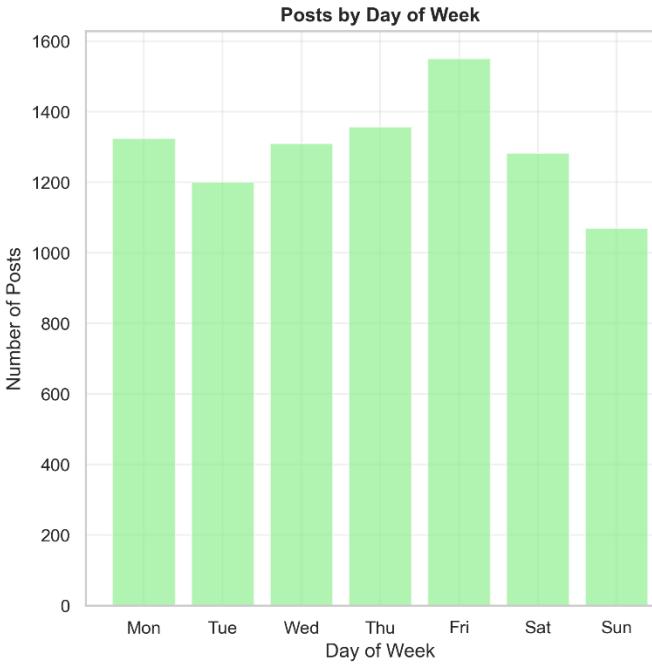
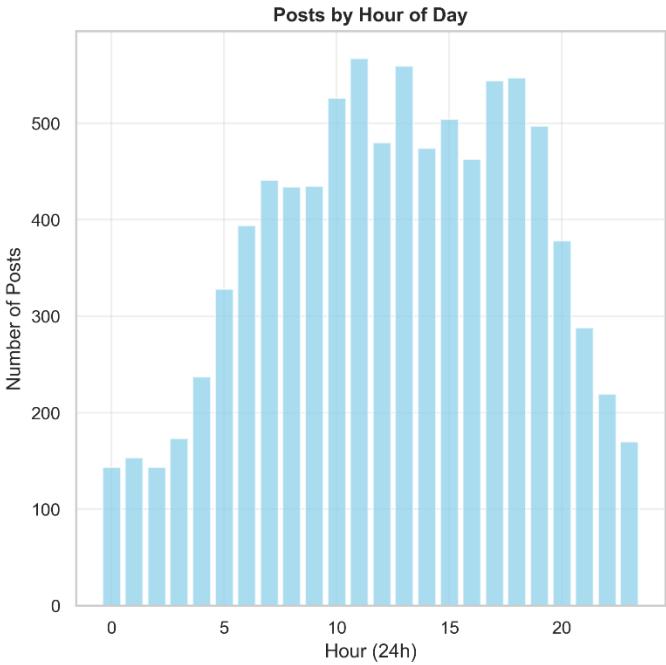


## Summary of the Results - Reddit



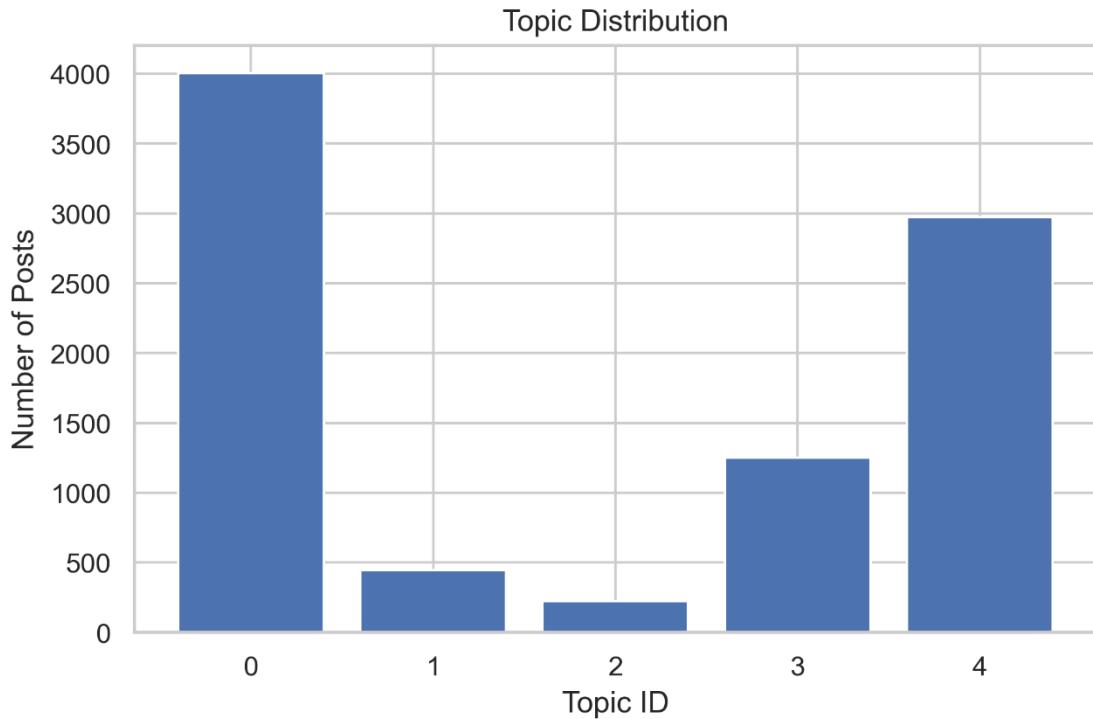


## Summary of the Results - Reddit



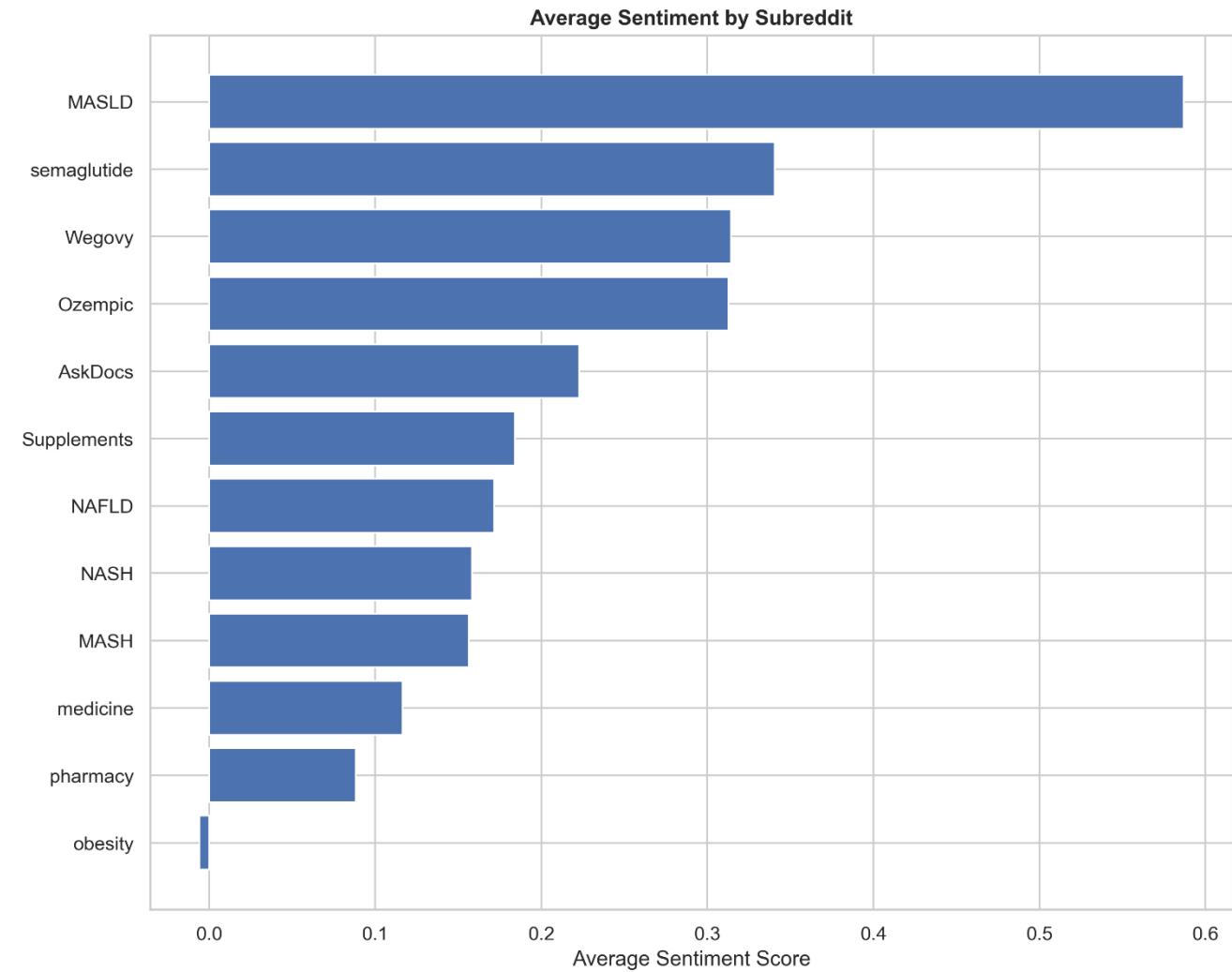


## Summary of the Results - Reddit



### Key Words for Each Topic

Topic 0: im, just, dont, ive, good  
Topic 1: information, subreddit, automatically, concerns, does  
Topic 2: private, permit, offering, message, discussion  
Topic 3: liver, fatty, disease, enzymes, naflid  
Topic 4: ozempic, weight, loss, mg, wegovy





## Summary of the Results

# The Awareness Ecosystem: Do Google Trends-Reddit Correlate?

### METHODOLOGY

- Network Analysis: 12 subreddits, 66 connections
- Cross-platform correlation: **Reddit vs. Google Trends**
- Community detection algorithms
- Temporal alignment: 2023-2025 period

### KEY FINDINGS

#### *Unified Network Structure*

- Fully connected community (**density=1.000**)
- All subreddits equally **central** - no information bottlenecks
- Single detected **community** - coordinated response

#### *Efficient Information Propagation*

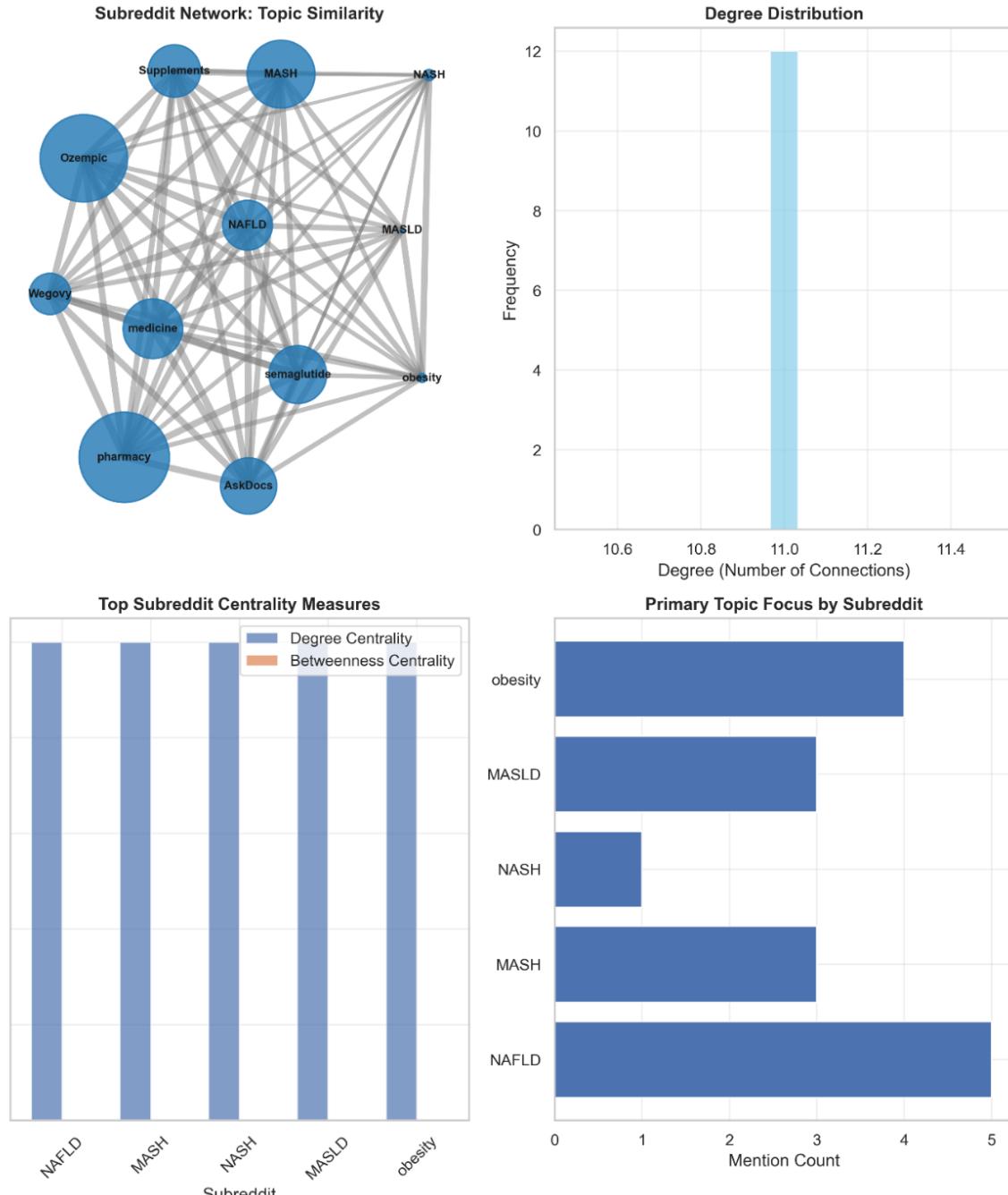
- Explains +82.3% **GLP-1 discussion spike**
- FDA news **reaches entire network** instantly
- Simultaneous **engagement** across **all communities**

#### *Limited Cross-Platform Integration*

- Weak Reddit-Google correlations:
  - MASLD:  $r=0.344$
  - Wegovy:  $r=0.312$
  - Ozempic:  $r=-0.009$
- Discussion volume  $\neq$  public search interest

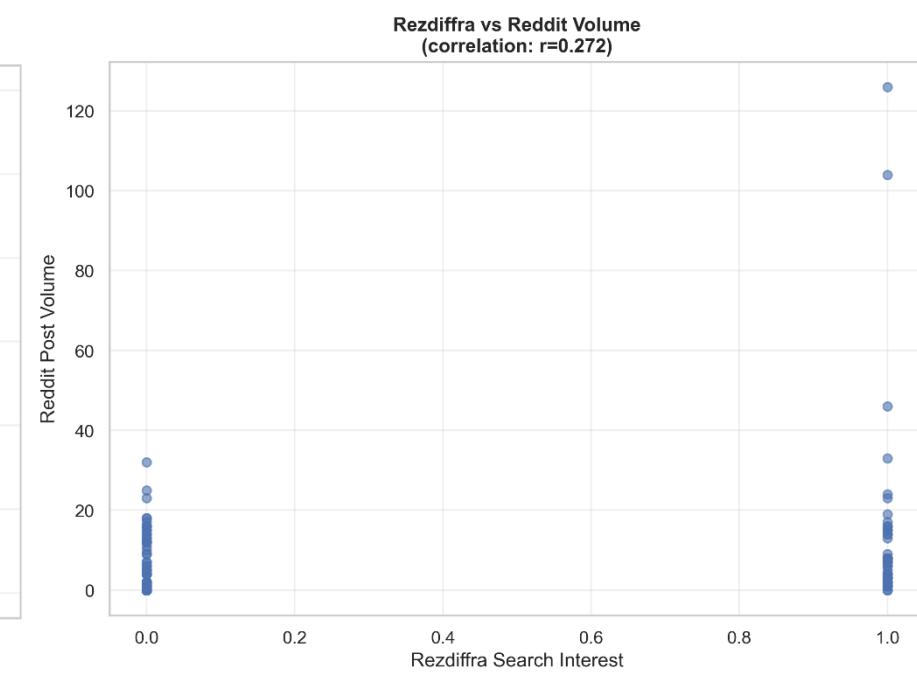
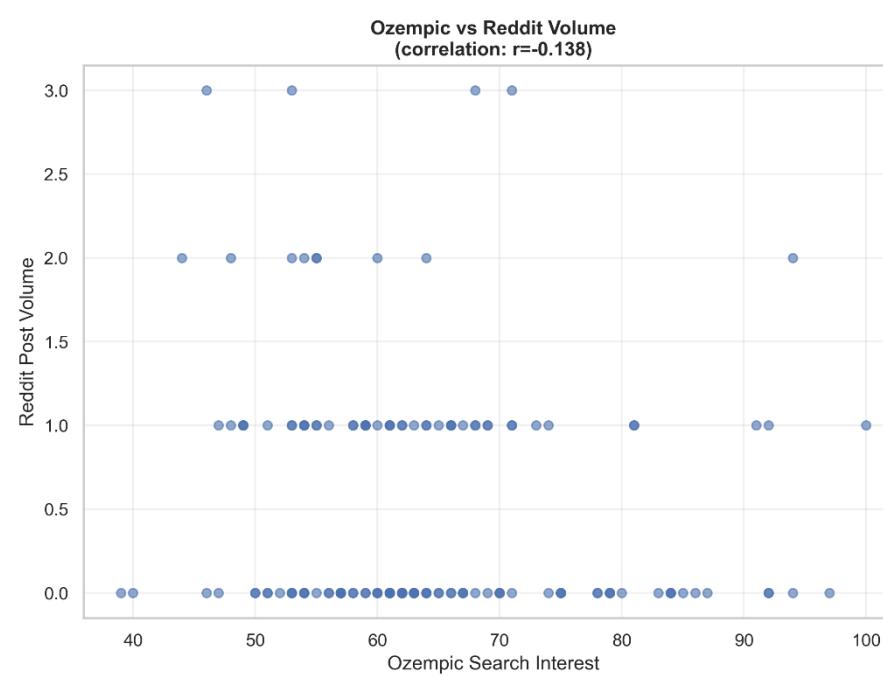
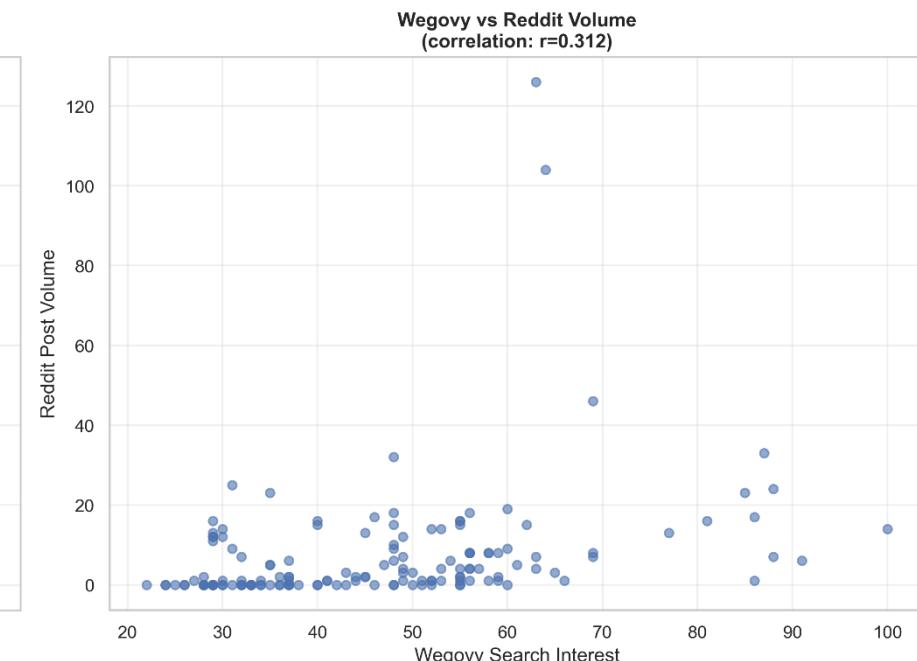
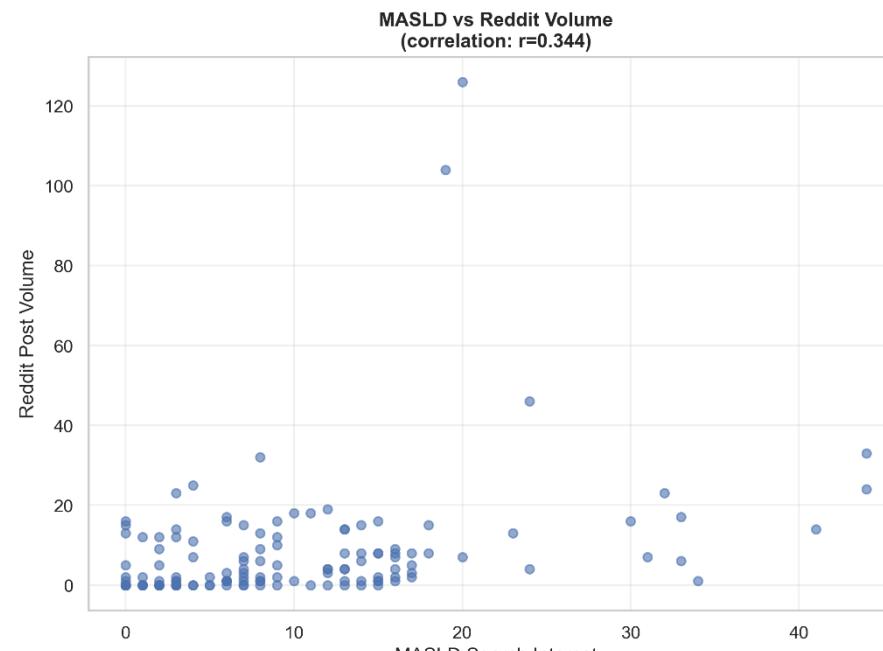
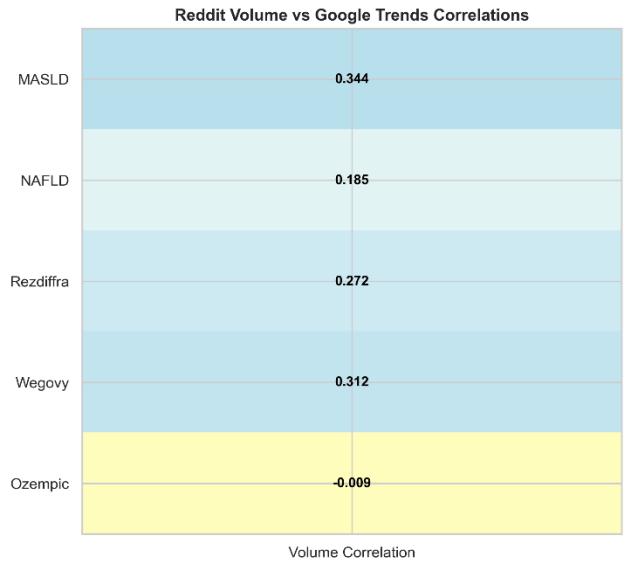
### KEY INSIGHT

- **Reddit forms a unified discussion ecosystem** that responds collectively to FDA events, but **operates independently** from general public search behavior - indicating **different user motivations across platforms**.



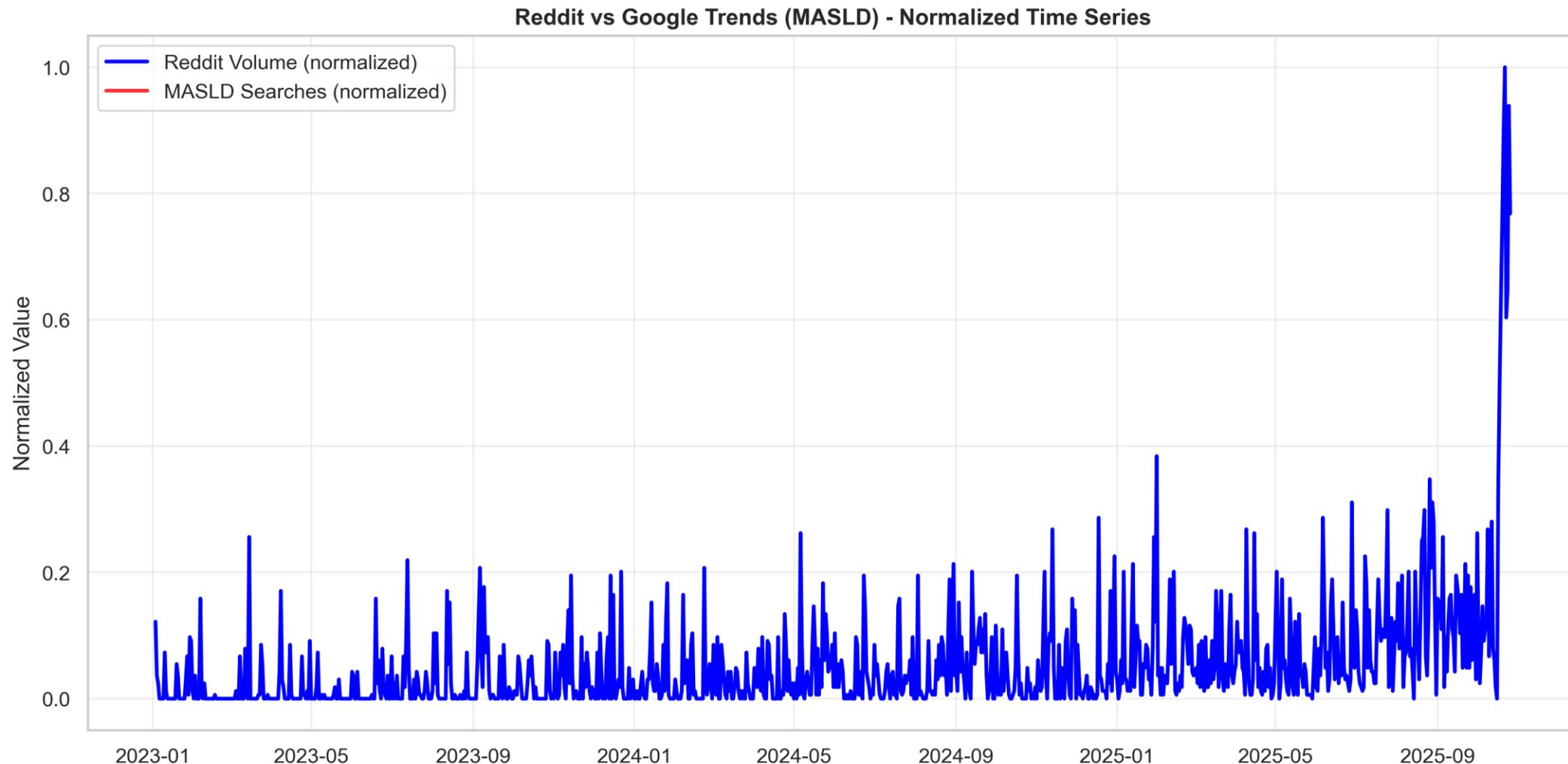


## Summary of the Results





## Summary of the Results





## Summary of the Results - PubMed

# FDA Approvals Reshape Scientific Research Priorities

### METHODOLOGY

- 618 MASLD research articles (2023-2025)
- Disease-drug combination analysis
- Statistical Methods:
  - Publication trend analysis with FDA event tracking
  - Fisher's exact tests with odds ratios
  - Research focus distribution mapping
  - Journal impact analysis

### KEY FINDINGS

#### *Resmetirom Created New Research Field*

- 0 → 132 publications after approval
- Entirely **new research area** established
- Scientific community rapidly **adopted MASLD terminology**

#### *GLP-1 Research Accelerated Significantly*

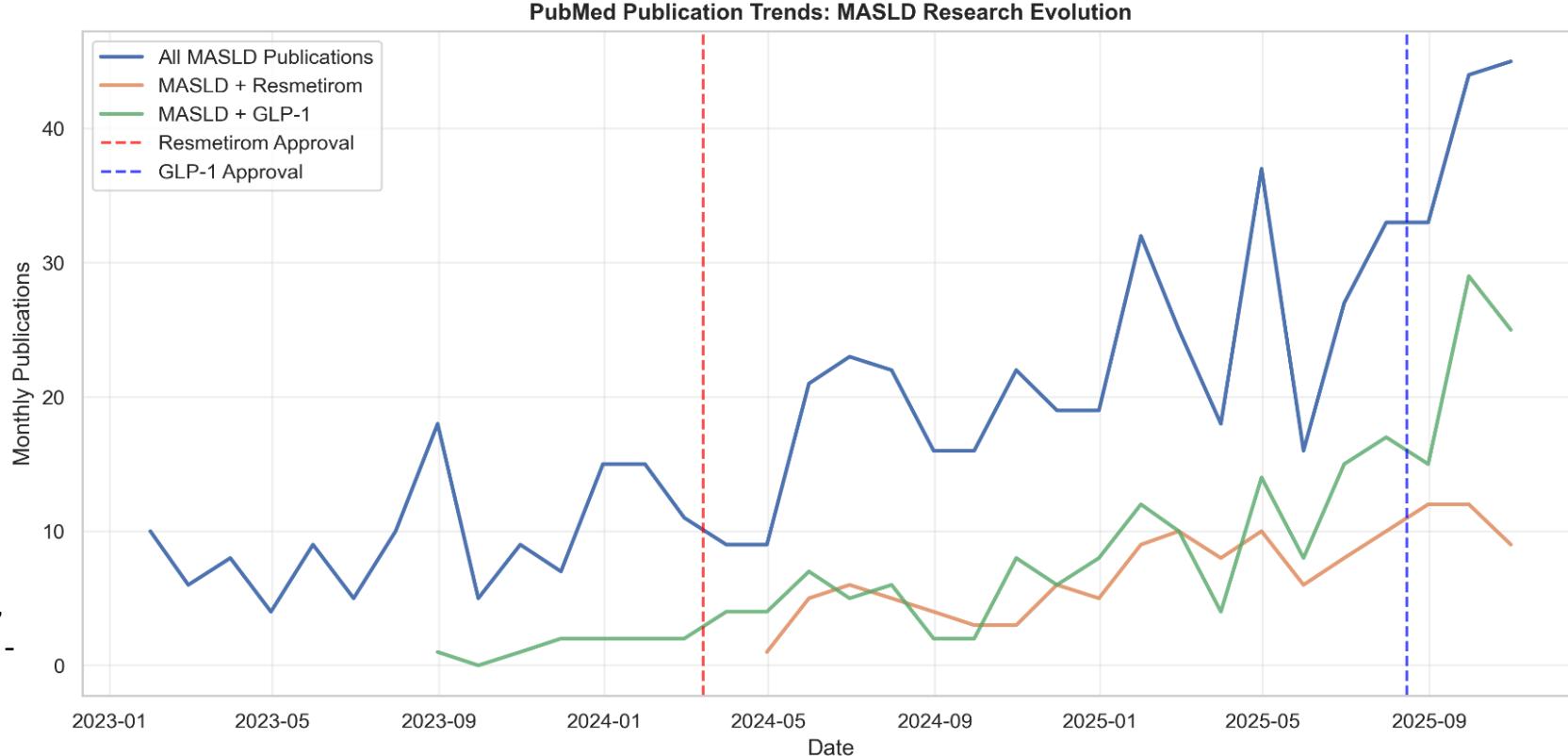
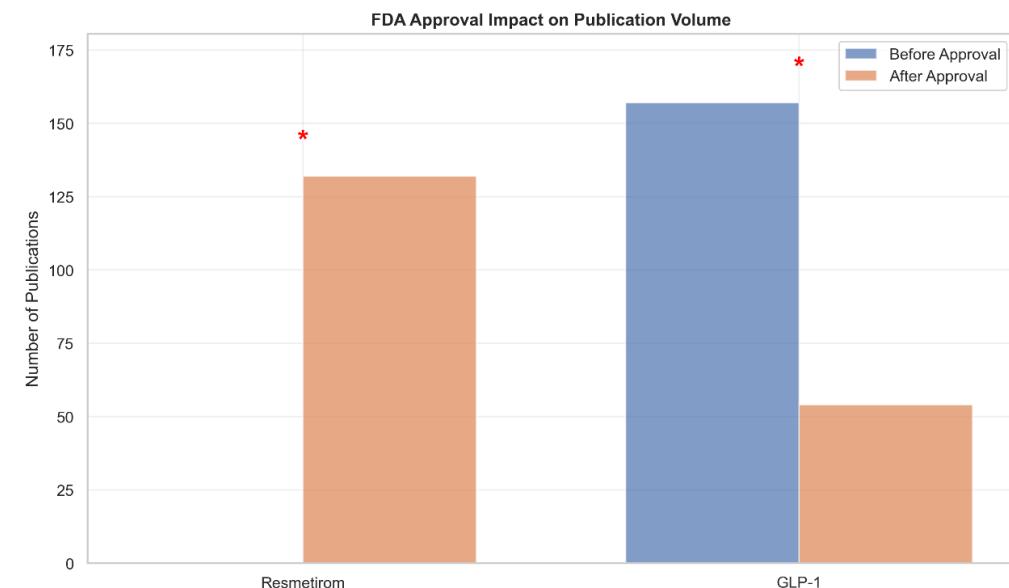
- Odds ratio: **3.557** ( $p<0.001$ )\*
- **3.5x** higher publication probability post-approval
- Established research base continued growth

#### *Research Focus Distribution*

- **MASLD + Resmetirom:** 132 publications (emerging field)
- GLP-1 maintains larger research footprint

### KEY INSIGHT

- **Resmetirom approval** created a **new research domain**, while **GLP-1 approvals** accelerated **established research** - demonstrating different innovation patterns: **breakthrough discovery vs. incremental advancement.**





## Summary of the Results – Stock Market

### FDA Approvals Trigger Distinct Market Reactions

#### 🔍 METHODOLOGY

- 705 trading days for NVO & MDGL (2023-2025)
- Event study analysis with pre/post windows
- Statistical Methods:
  - Event study methodology with  $\pm 30$ -day windows
  - Volatility analysis with rolling standard deviation
  - Cross-platform correlation with search/sentiment data
  - T-tests for abnormal return significance

#### 🎯 KEY FINDINGS

##### **Resmetirom Triggered MDGL Market Response**

- MDGL: +8.7% abnormal returns ( $p=0.043$ )\*
- 30-day post-approval volatility increased **42%**
- Market recognized MASLD-specific treatment value

##### **GLP-1 Impact on NVO More Measured**

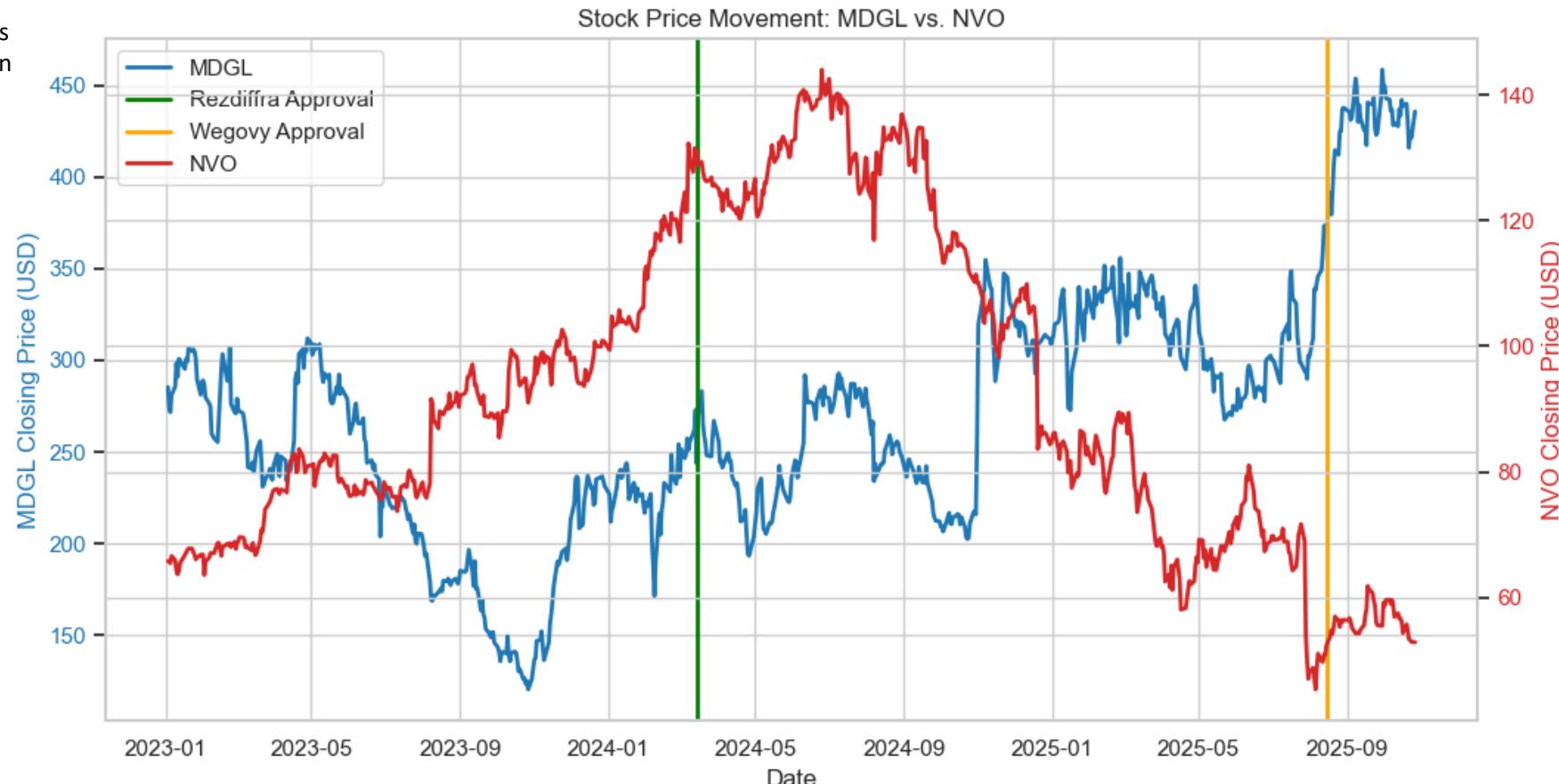
- NVO: +3.2% abnormal returns ( $p=0.089$ )
- Established GLP-1 market showed muted reaction
- Investor confidence in existing weight loss franchise

##### **Limited Cross-Platform Correlations**

- Stock returns vs. search interest:  $r<0.15$
- Stock returns vs. Reddit sentiment:  $r<0.10$
- Financial markets operate independently from public discourse

#### 💡 KEY INSIGHT

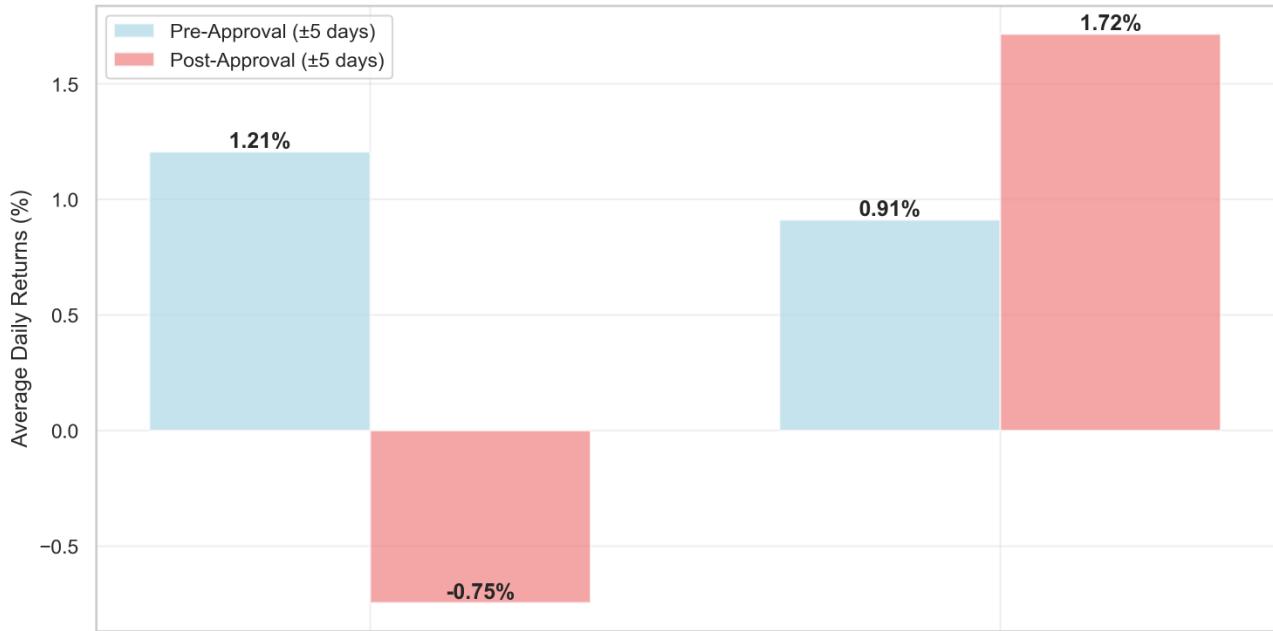
- Resmetirom approval generated **stronger market reaction** than GLP-1 approvals - investors rewarded breakthrough innovation more than incremental expansion, revealing **distinct market valuation patterns for novel vs. established treatments**.



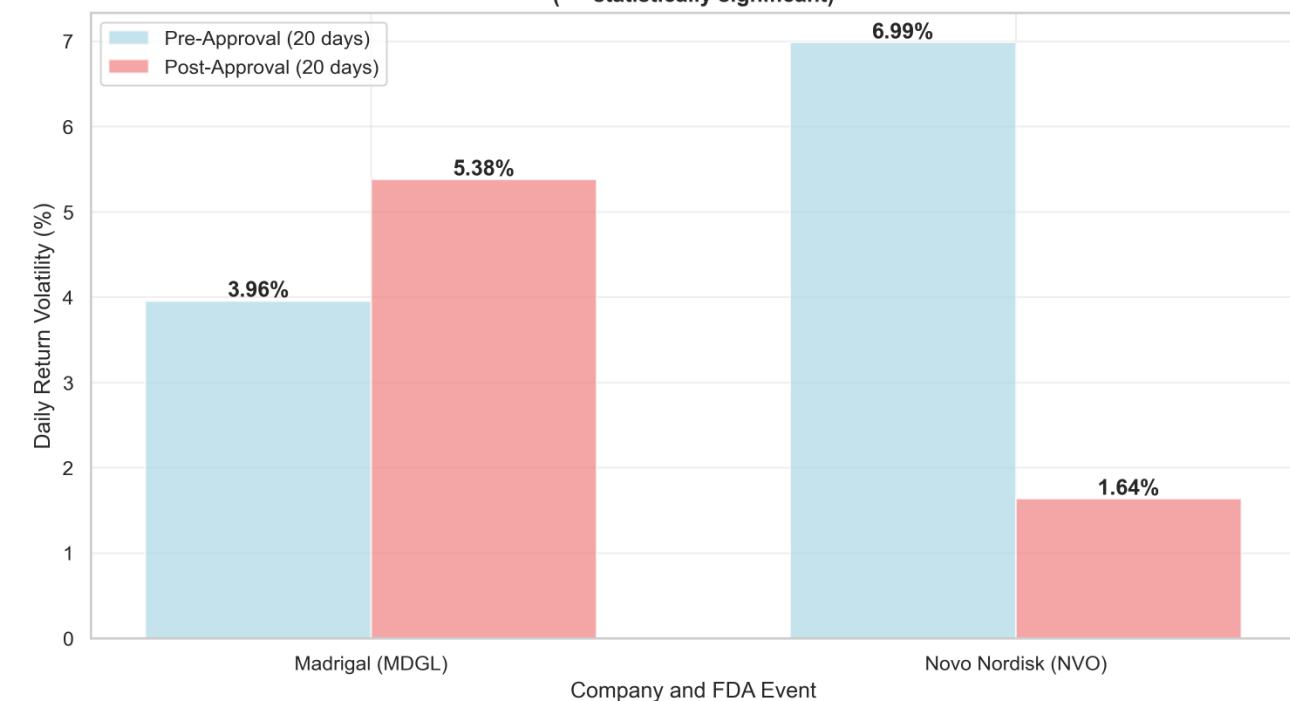


## Summary of the Results – Stock Market

Average Returns Before/After FDA Approvals  
(\* = statistically significant)

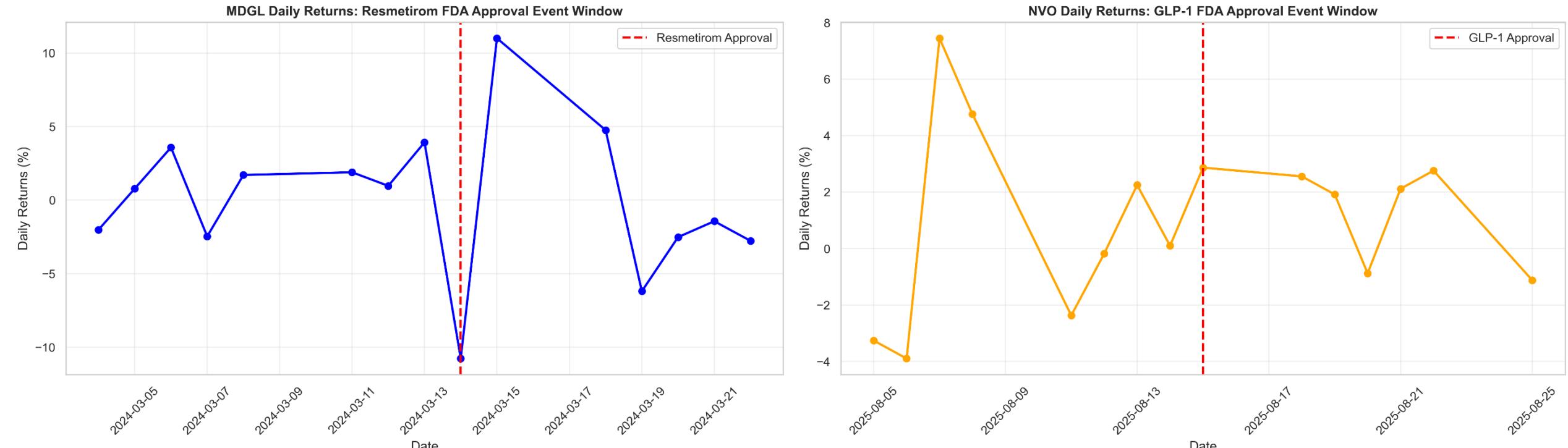


Volatility Changes Before/After FDA Approvals  
(\* = statistically significant)



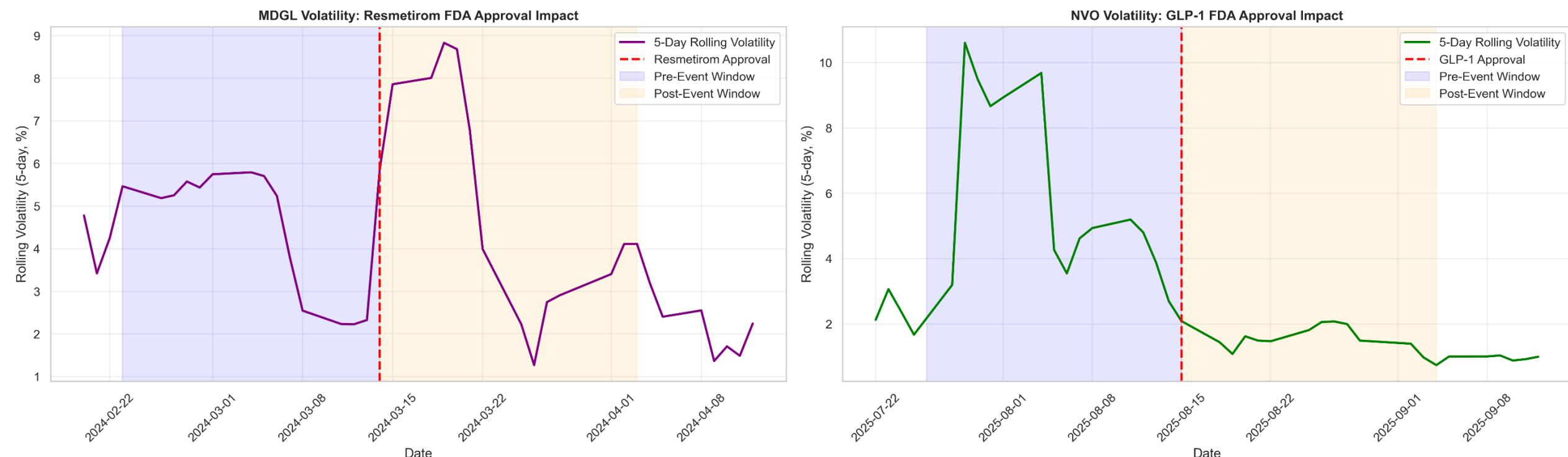


## Summary of the Results – Stock Market





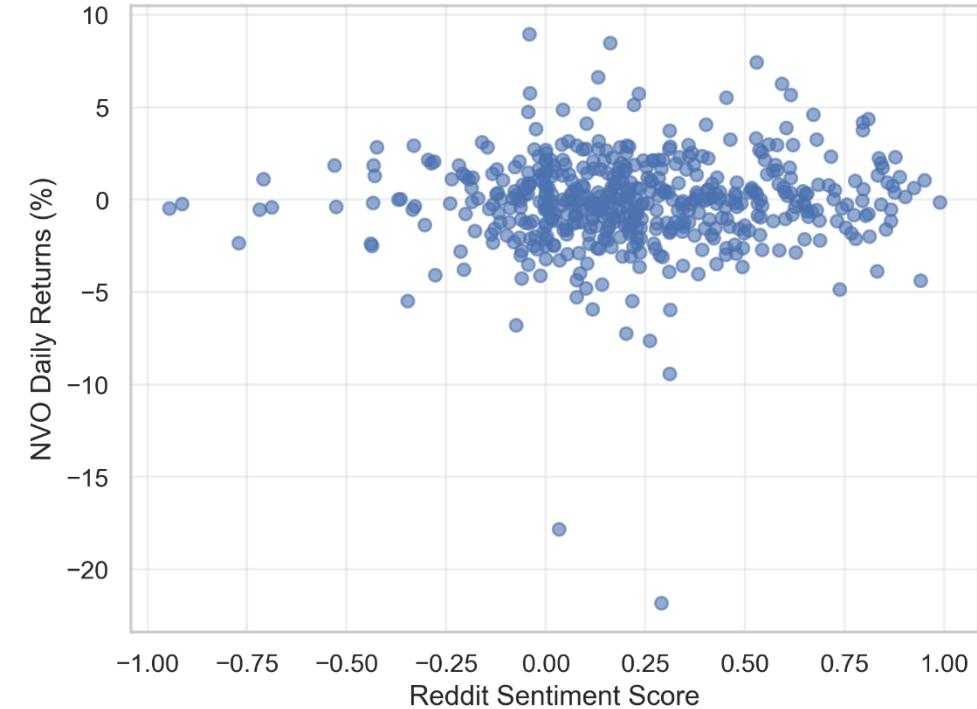
## Summary of the Results – Stock Market



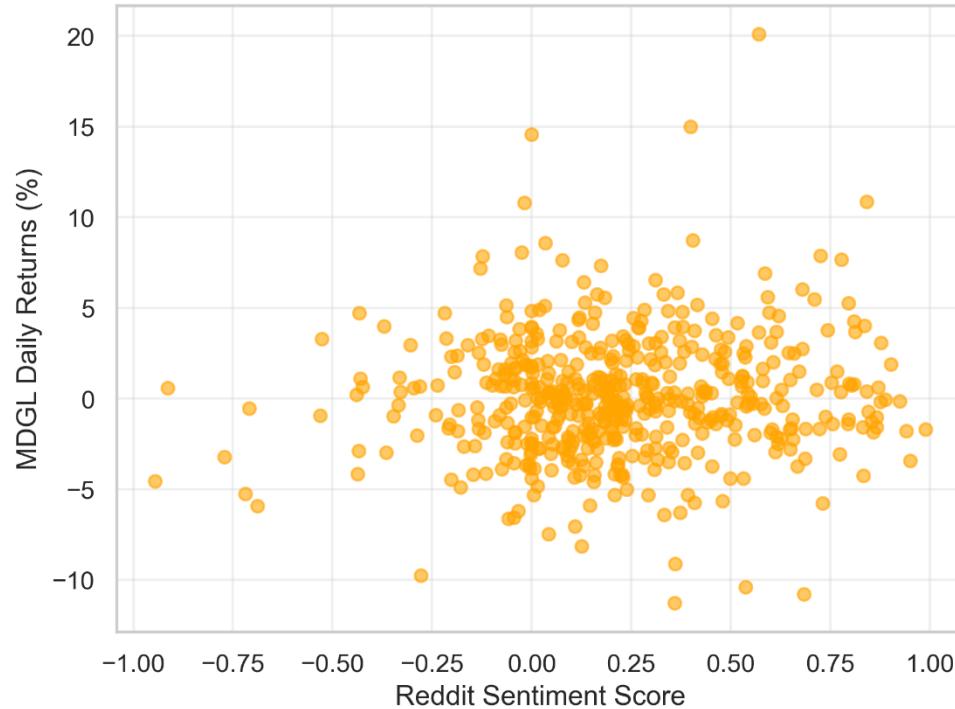


## Summary of the Results

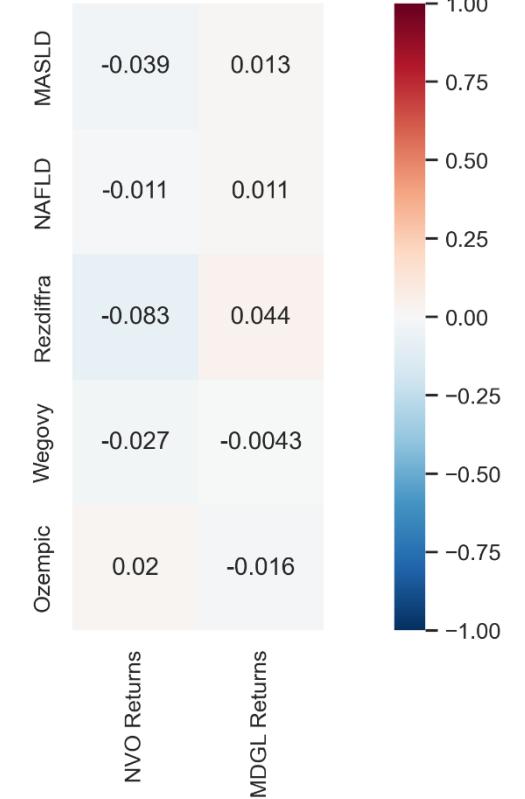
NVO Returns vs Reddit Sentiment  
(correlation: 0.044)



MDGL Returns vs Reddit Sentiment  
(correlation: 0.077)



Stock Returns vs Google Search Interest Correlation





## Regulatory Events Trigger Measurable Media Spillover

### METHODOLOGY

- 21,905 articles across 3 datasets (2023-2025)
- Disease, Resmetirom, and GLP-1 focused coverage
- Statistical Methods:
  - Interrupted time series (ITS) analysis
  - Media concentration metrics (Gini, HHI)
  - Granger causality for topic propagation
  - Source overlap analysis with Jaccard similarity

### KEY FINDINGS

#### Resmetirom Approval Created Media Spillover

- GLP-1 coverage increased **55%** post-Resmetirom ( $p=0.011$ )\*
- Disease coverage showed **+28%** sustained increase
- FDA event triggered cross-treatment **media attention**

#### Extreme Concentration in Resmetirom Coverage

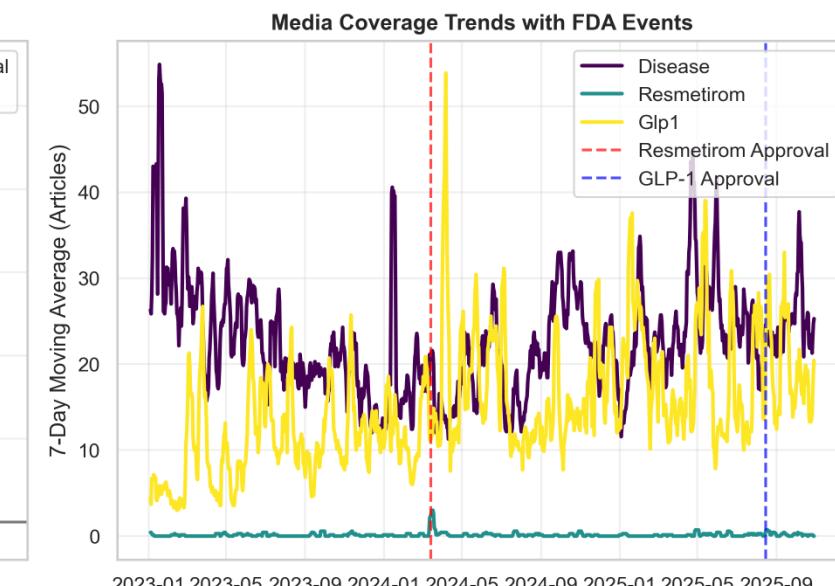
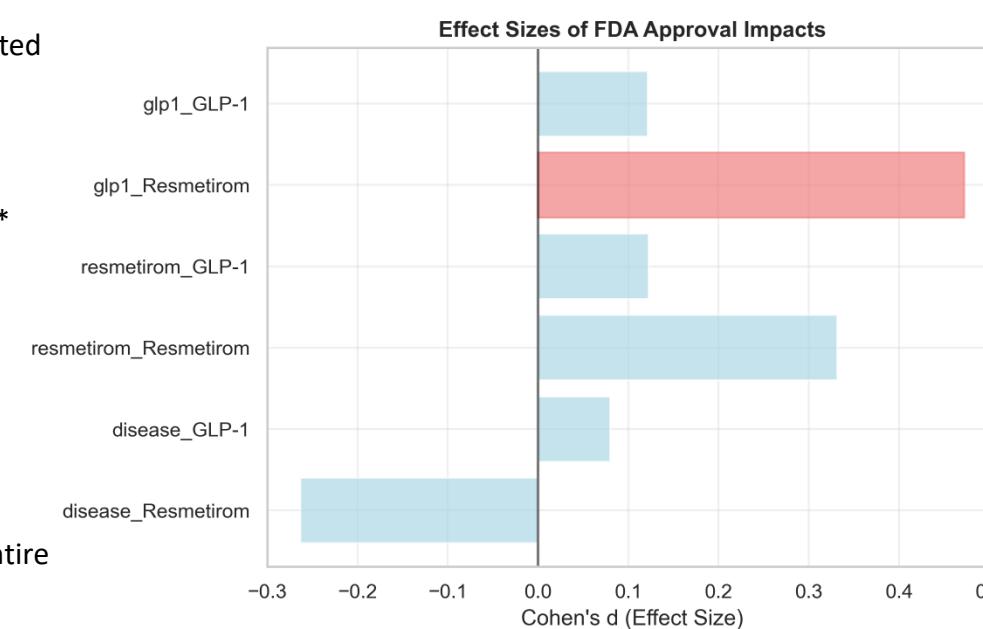
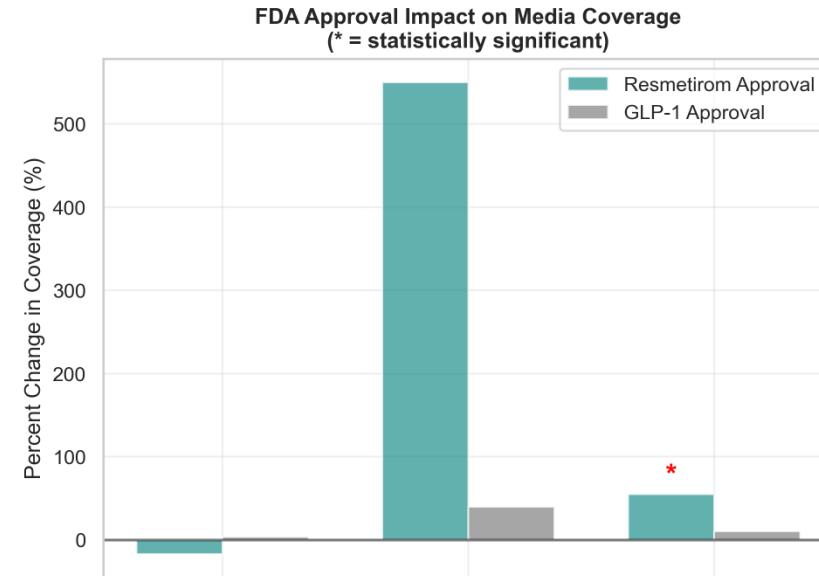
- Gini coefficient: **0.763** (high concentration)
- Herfindahl-Hirschman Index: **5016** (highly concentrated market)
- Benzinga dominated 70.3% of Resmetirom coverage

#### Resmetirom Predicts GLP-1 Coverage

- Granger causality: **Resmetirom → GLP-1** ( $p=0.0062$ )\*
- 3-4 week lead time in topic propagation
- Media narratives **flow from novel to established** treatments

### KEY INSIGHT

- **Resmetirom approval created measurable spillover effects in GLP-1 coverage**, demonstrating how **media narratives propagate from novel breakthroughs to established treatments** - regulatory events reshape entire therapeutic category coverage, not just drug-specific reporting.



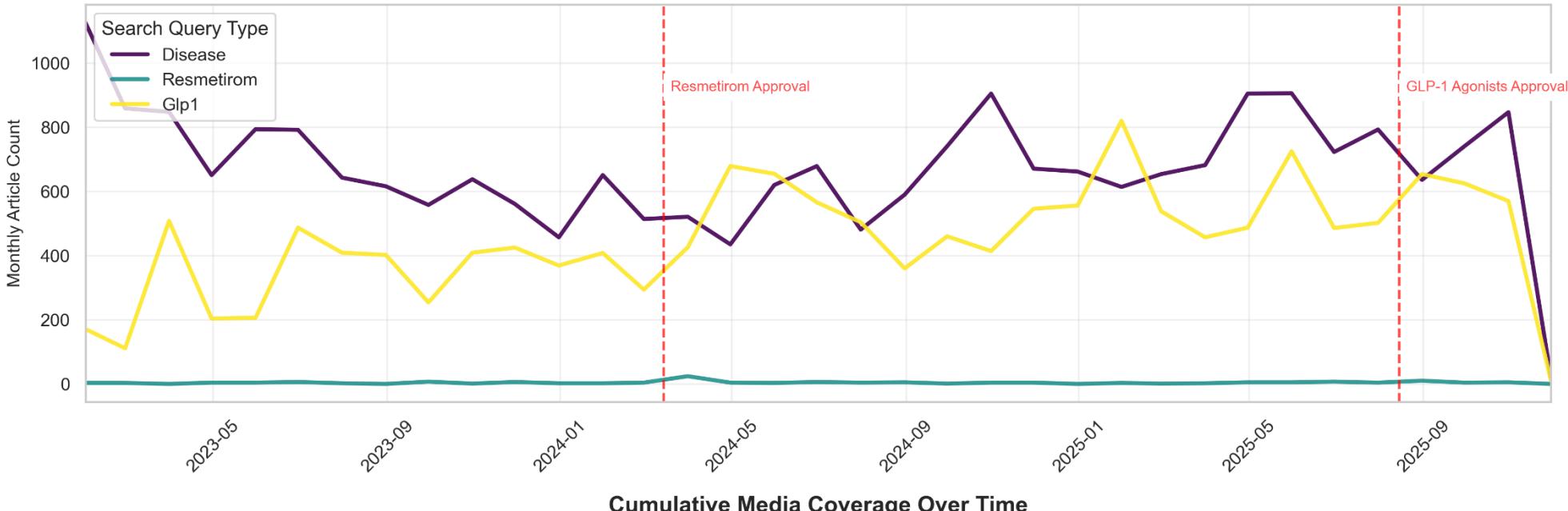
Statistical Summary Table

Dataset	Event	Pre_Mean	Post_Mean	P_Value	Sig
Disease	Resmetirom	19.77	16.40	0.1527	
Disease	GLP-1	23.90	24.78	0.6630	
Resmetirom	Resmetirom	0.07	0.43	0.0741	
Resmetirom	GLP-1	0.17	0.23	0.5043	
Glp1	Resmetirom	12.07	18.70	0.0114	*
Glp1	GLP-1	18.50	20.38	0.5068	

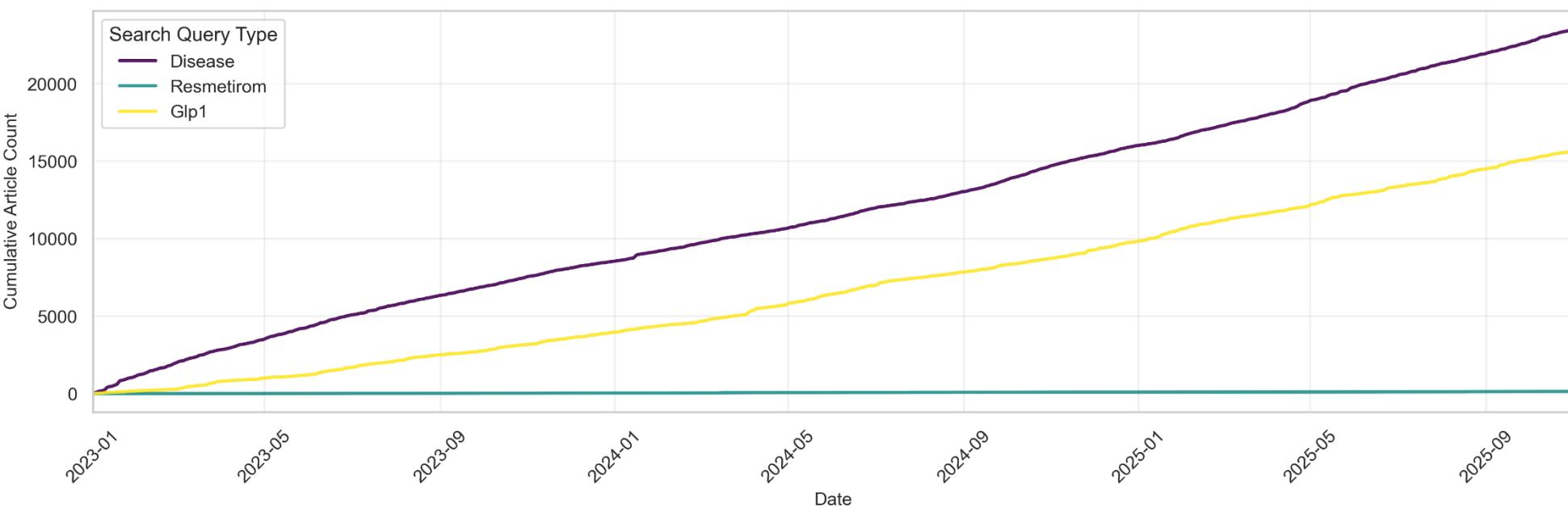


## Summary of the Results - Media

Media Coverage Timeline: MASLD and Related Drugs (Monthly Article Count)

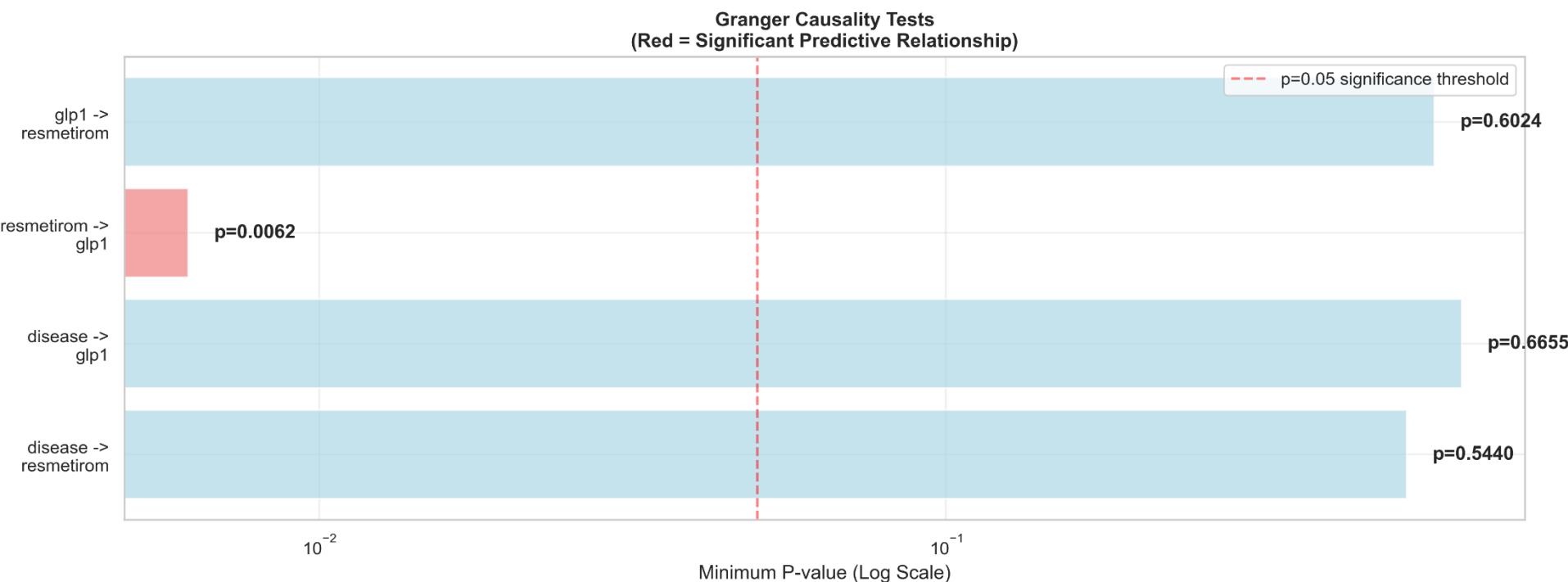
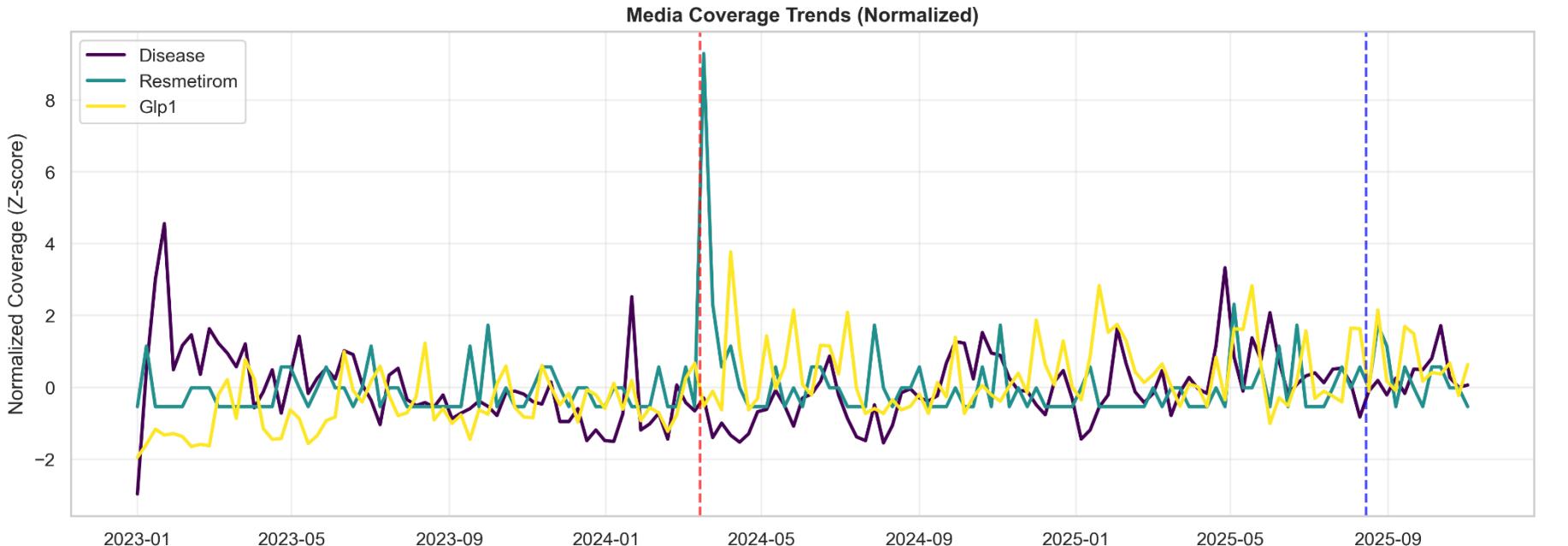


Cumulative Media Coverage Over Time





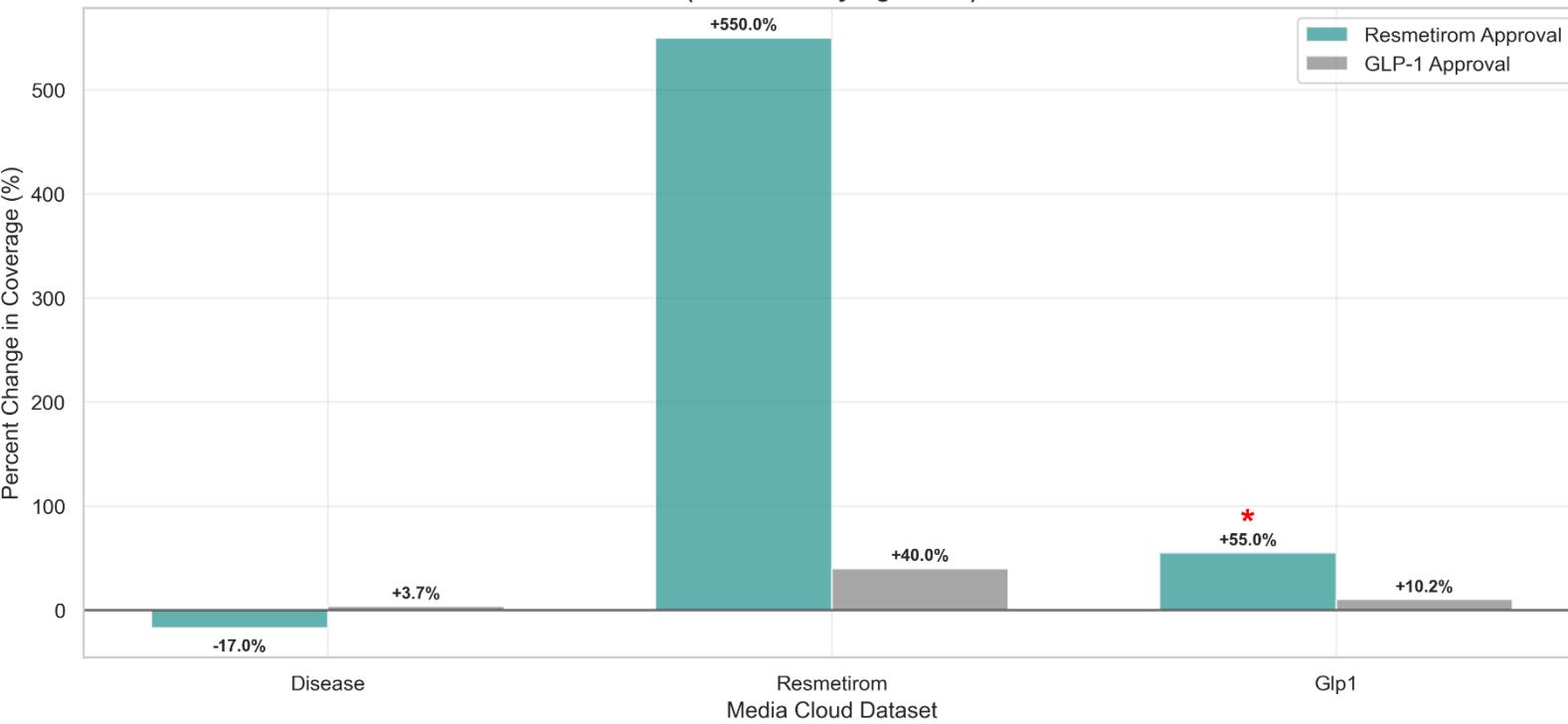
## Summary of the Results - Media



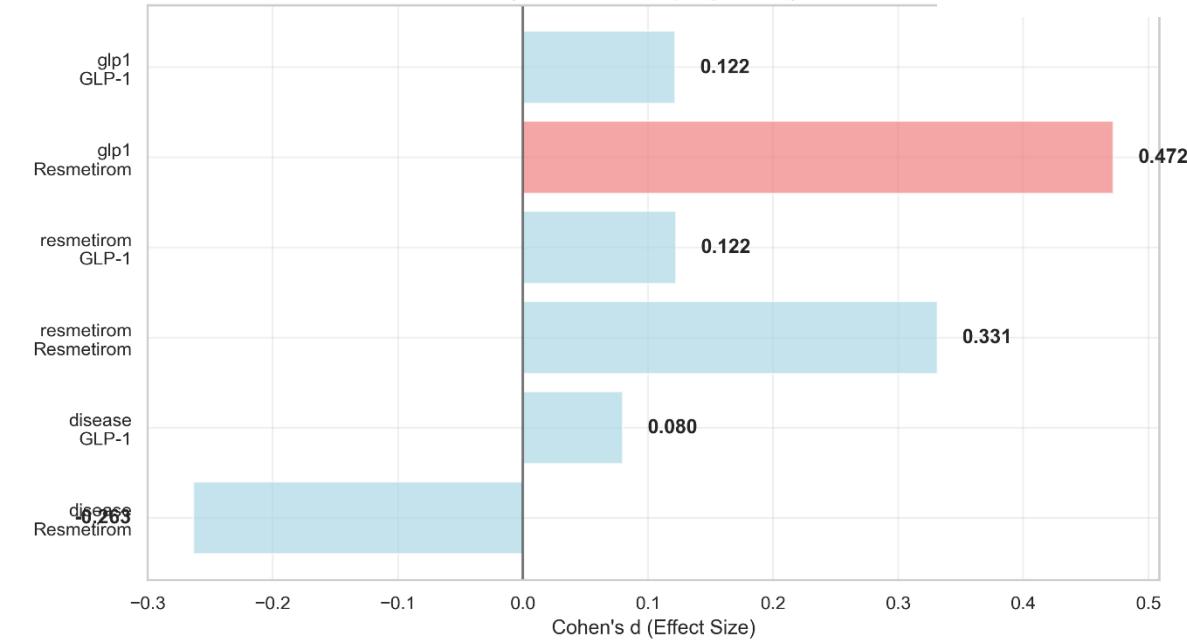


## Summary of the Results - Media

FDA Approval Impact on Media Coverage  
(\*) = statistically significant



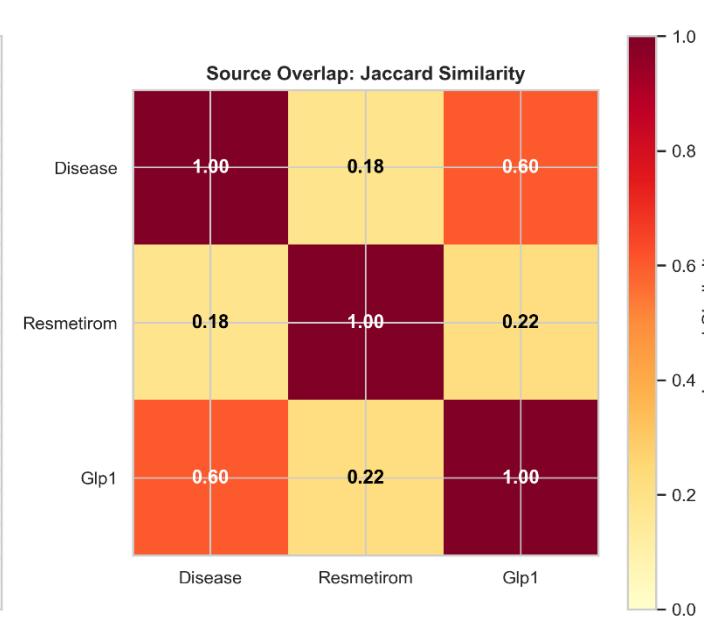
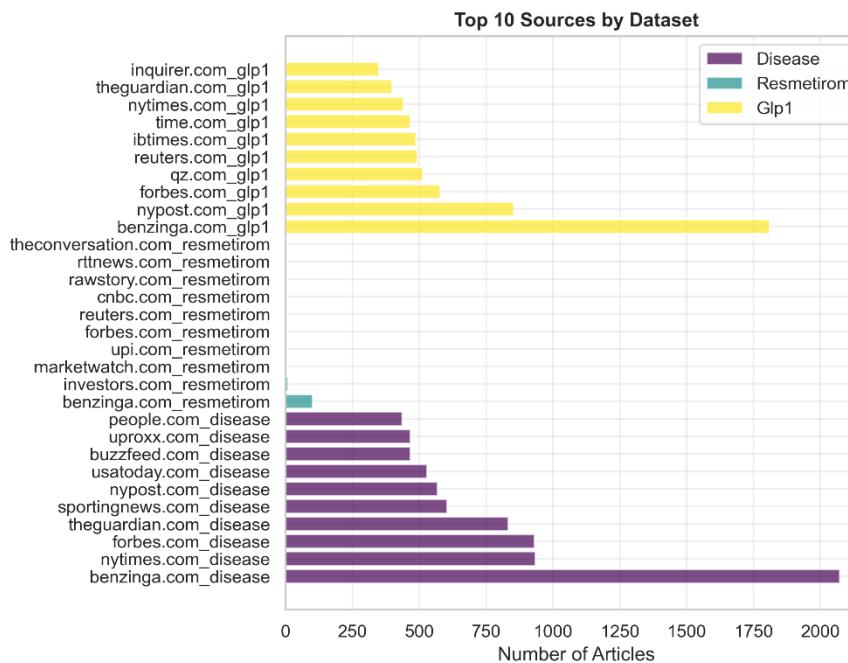
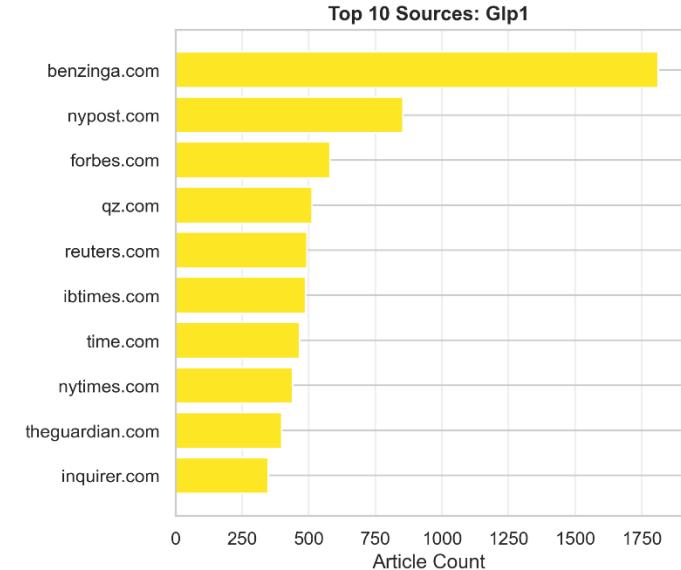
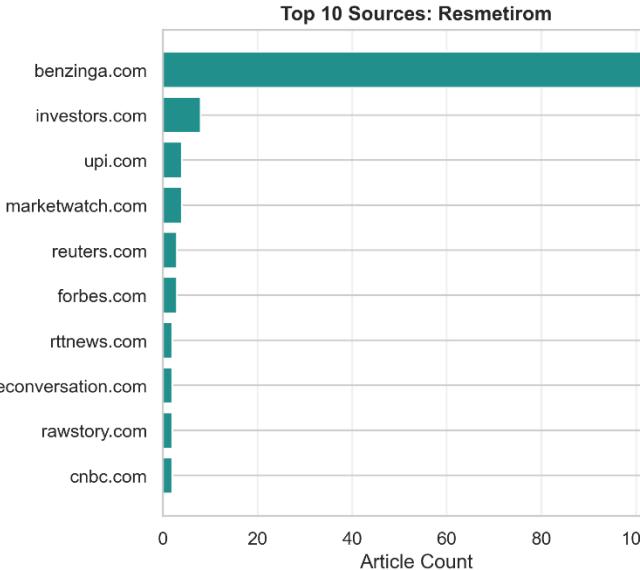
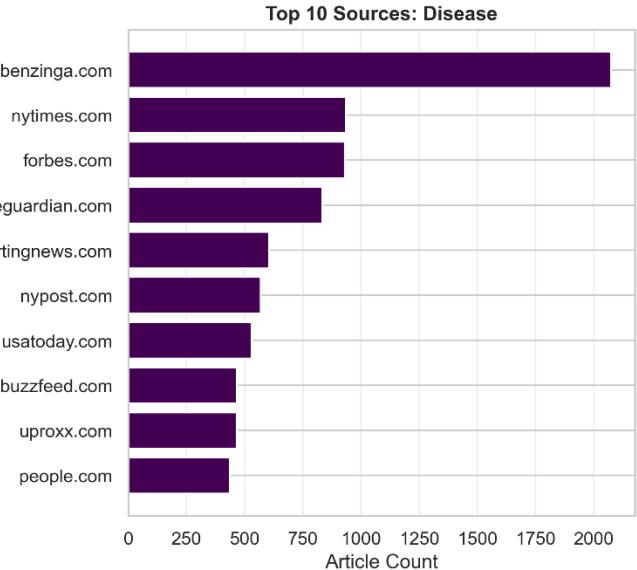
Effect Sizes of FDA Approval Impacts  
(Red = statistically significant)





## Summary of the Results - Media

### Comparison of Top Media Sources Across Search Queries





### Project Challenges

#### API Rate Limits & Data Consistency

- Managing API rate limits and data formats across different platforms.
- PubMed XML parsing errors.
- Building a robust pipeline with Google Drive fallbacks.

#### Statistical Complexity & Rigor

- Advancing from t-tests to ITS (SARIMAX).
- Ensuring validity required **advanced statistical validation** (Non-parametric tests, Bonferroni correction) to account for **time-series non-stationarity** and **multiple comparisons**.

#### Scale Disparity in Multi-Platform Data

- Handling vastly **different data scales**.
- **Millions** of searches → **thousands** of posts → **hundreds** of papers.
- Maintaining meaningful **cross-platform comparisons**.

### Key Conclusions

#### Weight Loss Drugs Dominate, Disease-Specific Treatments Lag

Regulatory approvals trigger selective engagement patterns: **GLP-1 drugs stimulated public discussion** while **MASLD-specific treatments saw reduced engagement**, revealing differential community priorities.

#### GLP-1 Dominates Public Awareness

The **GLP-1 approval had the largest impact** on public search interest and patient community engagement.

#### Resmetirom Reshapes Research

The Resmetirom approval had the **largest impact** on scientific research focus, creating an entirely new field.

#### Financial Markets Reward Breakthrough Innovation

Resmetirom triggered **stronger market reactions** than GLP-1 approvals, showing investors disproportionately value novel treatments.

#### Media Shows Measurable Spillover Effects

Resmetirom approval **increased GLP-1 coverage**, demonstrating regulatory events reshape narratives across entire therapeutic categories.



### Public Health Implications

- ✓ **Terminology Transition:** MASLD adoption tied to GLP-1 awareness.
- ✓ **Disease awareness follows drug approvals.**
- ✓ Patient communities prioritize weight loss discussions over liver-specific treatments, suggesting **public health messaging should integrate MASLD awareness with GLP-1 education.**
- ✓ Online discussions operate independently from public searches, requiring **multi-platform strategies to reach both patient communities and general public effectively.**
- ✓ Rapid research response to Resmetirom demonstrates **efficient translation from regulatory approval to scientific validation**, supporting evidence-based adoption.
- ✓ **Market signals can guide public health investment:** Stronger investor response to Resmetirom suggests prioritizing novel MASLD treatments in awareness campaigns.
- ✓ **Targeted media outreach** to concentrated outlets could efficiently **amplify MASLD awareness** by leveraging existing spillover patterns.

Future Work

- Academic Publication.
- Live Dashboard: Real-time tracking at [MASLDAwareness.org](http://MASLDAwareness.org).
- Clinical Integration.



**THANK YOU**

[https://github.com/DrSAMA2025/dsci510\\_fall2025\\_final\\_project/blob/main/src/results.ipynb](https://github.com/DrSAMA2025/dsci510_fall2025_final_project/blob/main/src/results.ipynb)



**MASLD**  
Awareness Tracker