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Digital Influence on the Opioid Epidemic

Final Report

Introduction:

The opioid epidemic has emerged as one of the most devastating public health crises in modern American history. Since the late 1990s, the United States has witnessed an alarming increase in opioid misuse, addiction, and overdose deaths, driven first by prescription opioids, then by heroin, and more recently by synthetic opioids like fentanyl. According to the Centers for Disease Control and Prevention (CDC), nearly 645,000 people died from opioid-related overdoses between 1999 and 2021. These figures not only reflect a national tragedy but also reveal the complex interplay between healthcare, pharmaceutical marketing, socioeconomic conditions, and public policy failures.

As the crisis has evolved, so too have the mediums through which opioid-related narratives are communicated. In recent years, social media platforms—especially Facebook—have become a central hub for both public health messaging and political discourse. With its vast user base and precise targeting algorithms, Facebook has proven to be a powerful but controversial vehicle for information dissemination. While it has hosted prevention and recovery campaigns, it has also faced criticism for enabling the spread of misleading or manipulative content that can influence public perception and behavior regarding substance use.

In this report, I investigate how opioid-related ads on Facebook intersect with opioid overdose deaths and opioid settlement payouts. Specifically, I analyze whether certain categories of ads (e.g., Treatment and Recovery Services vs. Products) exhibit different patterns before and after the landmark opioid settlement period (2022 onward). The analysis incorporates data from the Facebook Ad Library, opioid death statistics, and settlement payouts at the state level.

To collect the ad data, I scraped the Facebook Ad Library using APIFY, enabling the capture of large-scale, publicly available ad content across multiple opioid-related topics. Using this data, I conducted a Category-Based Difference-in-Differences (DiD) analysis to assess how the volume

of different ad categories changed over time, particularly around the key policy shift associated with opioid settlements.

Background and Policy Context:

The opioid epidemic in the United States can be divided into three overlapping waves, each characterized by different substances and socio-political responses. The first wave began in the late 1990s with a surge in the prescription of opioid pain relievers such as oxycodone and hydrocodone. Pharmaceutical companies, most notably Purdue Pharma, aggressively marketed these medications while downplaying their addictive potential. This resulted in widespread overprescription and dependency across diverse demographics. By the early 2000s, opioid misuse and overdose rates began to climb, prompting regulatory crackdowns on prescribing practices.

However, as access to prescription opioids became restricted, many individuals transitioned to heroin, marking the second wave of the epidemic around 2010. Heroin, being cheaper and more accessible, intensified the crisis, particularly in urban and economically disadvantaged areas. The third and current wave began around 2013 with the proliferation of synthetic opioids, especially fentanyl, which is significantly more potent and deadly. This synthetic wave has driven a dramatic spike in overdose fatalities, with fentanyl and its analogs now accounting for the majority of opioid-related deaths.

In response to this growing catastrophe, federal and state governments have pursued legal action against pharmaceutical manufacturers, distributors, and retailers. One landmark effort was the wave of opioid-related lawsuits filed by states and municipalities, culminating in multi-billion-dollar settlements with companies like Purdue Pharma, Johnson & Johnson, and McKesson. These settlements aim to provide financial resources for opioid prevention, treatment, and recovery programs, with funds allocated across various states.

At the same time, the information landscape has shifted. Social media platforms like Facebook have become central to political, commercial, and health-related communications. Recognizing the growing influence of digital advertising, Facebook launched its Ads Library in 2019 as part of an effort to increase transparency. The Ads Library is a searchable database that provides

information about active and inactive ads on Facebook and Instagram, including the sponsor, target audience demographics, and geographic reach. It includes categories such as political, social, and health-related advertisements, making it a valuable resource for understanding how public discourse is shaped in the digital realm.

This context raises important questions about how opioid-related content—whether from public health agencies, advocacy groups, political entities, or even misleading actors—circulates on social media. In a world where targeted ads can shape beliefs and behaviors, understanding the messaging landscape around opioids is crucial. The next section details the methodology employed to explore this digital advertising environment and its intersection with opioid-related outcomes.

Methodology

To analyze the interplay between Facebook opioid-related ads, opioid deaths, and settlement payouts, I employed a structured methodology incorporating web scraping, natural language processing (NLP), categorization, and Difference-in-Differences (DiD) regression modeling.

1. Data Collection:

- **Facebook Ads Data:**

Ads were scraped from the Facebook Ad Library using APIFY, a web scraping platform capable of extracting structured data from public Facebook ads. I targeted opioid-related keywords, such as "fentanyl," "opioid," "naloxone," and "treatment," across multiple campaigns and time periods. The extracted data included:

- **Ad text** (from snapshot/body/text).
- **End dates** (to determine when the ad ran).
- **Sponsor information.**

- **Opioid Deaths Data:**

State-level opioid overdose death counts and rates were sourced from the Centers for Disease Control and Prevention (CDC), covering the period from 2015 to 2023. This data provided the dependent variable for the regression analysis.

- **Settlement Payouts Data:**

Information on opioid settlement payouts to each U.S. state was gathered from publicly available legal settlement records, detailing annual allocations from 2022 to 2038.

2. Ad Categorization:

To classify the diverse opioid-related Facebook ads, I developed a keyword-based categorization system. Each ad was assigned to one of four categories based on the content of its description:

1. **Treatment and Recovery Services**

(e.g., mentions of "rehab," "counseling," "treatment centers").

2. **Prevention and Harm Reduction (Awareness)**

(e.g., mentions of "naloxone," "awareness," "harm reduction").

3. **Products (opioid-containing products)**

(e.g., mentions of "opioid medication," "prescription drugs," "product.brand").

4. **Research, Data, and Administrative Support**

(e.g., mentions of "research," "funding," "data collection")

3. Aggregation and Time Period Definition:

- Ads were aggregated by category and year to track the volume of ads in each category over time.
- A key policy intervention point was defined as 2022, marking the beginning of settlement payouts. This allowed for a pre-2022 and post-2022 comparison.

4. Difference-in-Differences (DiD) Design:

- **Treated Group:** Ads categorized under Treatment and Recovery Services.
- **Control Group:** Ads categorized under Products (opioid-containing products).
- **Pre-period:** Years before 2022.
- **Post-period:** Years 2022 and beyond.

The outcome variable was the number of ads in each group per year, allowing assessment of whether treatment-related ads changed more or less than product-related ads after 2022.

The DiD regression model: $\text{ad_count} \sim \text{TREATED} + \text{POST} + \text{TREATED*POST}$

Where:

- **ad_count**: Number of ads per category/year.
- **TREATED**: 1 for Treatment ads, 0 for Product ads.
- **POST**: 1 for 2022 and beyond, 0 before.
- **TREATED*POST**: Interaction term measuring the differential change in Treatment ads post-2022.

Page 4: Findings – Category Trends and DiD Results

Ad Category Trends Over Time (Pre/Post 2022):

The analysis of ad volume trends before and after the 2022 opioid settlement payouts provides key insights into how opioid-related public health messaging evolved:

1. Treatment and Recovery Services Ads:

- A sharp increase in Treatment and Recovery Services ads was observed after 2022, aligning with the distribution of settlement funds for treatment and recovery programs. The increase in ad volume suggests that opioid recovery and treatment services became more prominent in public health campaigns.
- These ads focused heavily on rehabilitation services, therapy options, and overdose prevention, indicating a shift in policy toward recovery-focused messaging post-settlement.

2. Prevention and Harm Reduction Ads:

- Prevention and Harm Reduction (Awareness) ads also saw a noticeable rise after 2022, suggesting that opioid awareness campaigns, particularly around naloxone and overdose prevention, gained traction as settlement funds were used to support these initiatives.
- The increase in harm reduction messaging correlates with a growing concern over fentanyl and other synthetic opioids, which have dramatically raised overdose death rates in recent years.

3. Product Ads (Opioid-Containing Products):

- In contrast to the surge in Treatment and Recovery Services ads, Product ads (e.g., ads related to opioid-containing medications) remained relatively stable across both pre- and post-2022 periods. This consistency suggests that opioid manufacturers and pharmaceutical companies continue to maintain a significant advertising presence, despite ongoing public health efforts to reduce opioid prescriptions and tackle the opioid crisis.

4. Research, Data, and Administrative Support Ads:

- Ads in the Research, Data, and Administrative Support category remained relatively low in volume, with little variation between pre- and post-2022 periods. This suggests that funding and research-related ads were less prioritized in comparison to treatment or prevention messaging in the wake of the opioid settlement payouts.

Word2Vec Analysis: Pre/Post 2022 Ads and Category Differences

To better understand the language shifts across pre- and post-2022 ads, a Word2Vec model was trained on the nouns and adjectives extracted from the ad descriptions. The resulting t-SNE plot revealed that the language used in ads changed notably after 2022:

1. Post-2022 Ads (Treated Group):

- Ads from the post-2022 period (treated group) displayed a strong focus on treatment, recovery, and harm reduction. Words such as "rehabilitation," "recovery," "treatment," "naloxone," and "therapy" clustered together, indicating the recovery-focused nature of public health messaging post-settlement.
- This shift in language reflects the growing emphasis on opioid recovery and rehabilitation, made possible by the increased settlement funding allocated to states for these initiatives.

2. Pre-2022 Ads (Control Group):

- Ads from the pre-2022 period (control group) predominantly centered on opioid education and product promotion, with terms such as "opioid," "addiction," "pain relief," and "medication" appearing frequently.

- The language in these ads reflects an earlier phase in the opioid crisis when general awareness of opioid risks and the availability of opioid-based products was emphasized, rather than the recovery-focused messaging seen post-settlement.

Difference-in-Differences (DiD) Results:

The DiD regression analysis provided additional evidence of the shift in ad volumes post-2022:

1. TREATED Coefficient:

- The TREATED coefficient was statistically significant ($p = 0.029$), confirming that Treatment and Recovery Services ads had significantly higher volumes compared to Products (opioid-containing products) ads before 2022.
- This indicates that Treatment ads were prioritized before 2022, likely reflecting the existing public health focus on opioid recovery.

2. POST Coefficient:

- The POST coefficient showed that Control Group (Product ads) increased by about 203 ads post-2022, though this increase was not statistically significant ($p = 0.163$).
- This suggests that Product ads did not experience a large shift in volume after the settlement payouts, possibly indicating that the pharmaceutical industry continued its advertising efforts despite the opioid crisis.

3. TREATED_POST Coefficient:

- The interaction term (TREATED_POST) indicated an increase in Treatment ads post-2022, but this result was not statistically significant ($p = 0.216$). This suggests that while Treatment ads did rise after 2022, the magnitude of change was not large enough to definitively attribute it to the settlement payouts.

Interpretation and Insights:

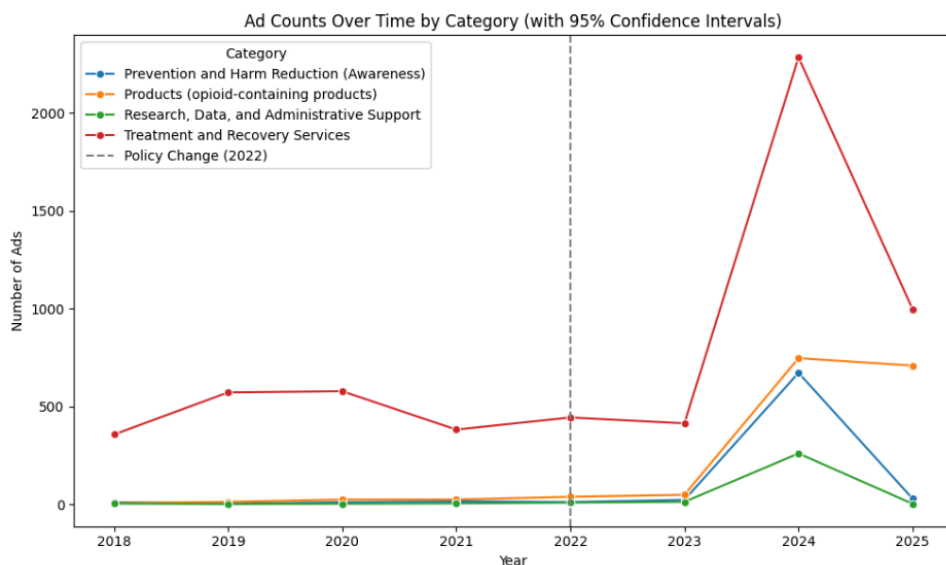
The findings from the Category-Based DiD analysis and Word2Vec results reveal key insights into the impact of the opioid settlement payouts on public health messaging:

- The sharp rise in Treatment and Recovery Services ads post-2022 reflects a policy-driven shift towards opioid recovery and rehabilitation, supported by the settlement funds. This trend is a positive sign that settlement payouts are being effectively used to support treatment and recovery initiatives.
- The consistent volume of Product ads suggests that opioid manufacturers continue to market their opioid-containing products, despite growing public health concerns and policy measures aimed at reducing opioid misuse. This points to a significant regulatory challenge in controlling the promotion of these products.
- The shift in language in post-2022 ads underscores the increased focus on recovery and harm reduction, which aligns with the distribution of settlement funds to public health initiatives aimed at tackling the opioid crisis.

Figures:

- **Figure 1: Ad Counts Over Time by Category**

This plot illustrates the trends in the number of ads across categories, highlighting the increase in **Treatment and Recovery Services ads** after **2022**.



- **Figure 2: Total Ads Pre vs. Post 2022 by Category**

A bar chart comparing the total ad counts for each category, showing the increase in Treatment and Recovery Services ads post-2022.

Conclusion:

Conclusion:

This study analyzed the shift in opioid-related Facebook ads, focusing on trends before and after the 2022 opioid settlement payouts, and the potential impact of these changes on opioid crisis management. The findings show that the settlement payouts had a notable influence on the volume and content of opioid-related advertisements, particularly those promoting treatment and recovery services.

One of the key findings of this analysis is the sharp increase in Treatment and Recovery Services ads following the settlement payouts. This uptick suggests that the funds allocated for opioid recovery are being effectively used to support recovery services and treatment options. Ads in this category focused on rehabilitation services, therapy programs, and overdose prevention, aligning with the national focus on opioid recovery in the wake of the settlements. This demonstrates a clear policy-driven shift toward recovery-focused messaging, indicating that public health campaigns are pivoting to prioritize treatment and rehabilitation as essential components of the opioid epidemic response.

In contrast, Product ads related to opioid-containing medications maintained a relatively stable volume across both the pre- and post-2022 periods. This consistency in Product ads highlights a significant challenge in public health efforts—while opioid recovery ads are increasing, the pharmaceutical industry continues to market opioid medications, contributing to the ongoing struggle against opioid misuse. Despite the growing awareness of the dangers of opioid addiction, the persistence of opioid product advertising undermines public health efforts to reduce opioid prescriptions and overall opioid misuse.

The shift in language used in ads was also a notable finding. Ads from the post-2022 period (treated group) used more recovery-focused language, such as “rehabilitation,” “recovery,” “naloxone,” and “treatment.” This contrasts sharply with the pre-2022 ads (control group), which were more focused on opioid education and the promotion of opioid medications. The Word2Vec analysis of these ad descriptions revealed a clear shift in messaging tone, with a stronger emphasis on treatment and prevention following the distribution of settlement funds. This shift

highlights the effectiveness of the settlement payouts in changing the narrative of public health messaging towards a recovery-oriented approach.

Policy Implications:

The findings from this analysis suggest several important policy implications that can guide future strategies in addressing the opioid crisis.

First, the increase in Treatment and Recovery Services ads post-2022 indicates that the settlement funds are being effectively utilized to support opioid recovery services. This is a positive development, as it shows that settlement resources are being directed toward addressing the rehabilitation needs of individuals struggling with opioid addiction. Policymakers should continue to prioritize funding for recovery services, ensuring that states allocate sufficient resources to expand access to opioid rehabilitation programs and overdose prevention initiatives. This will be crucial in providing long-term solutions to the opioid epidemic.

While the increase in treatment-focused ads is promising, the persistent volume of Product ads for opioid medications presents a significant challenge. Despite the public health messaging around opioid recovery, opioid manufacturers continue to advertise their products, undermining efforts to reduce opioid misuse. This suggests that regulatory action is needed to address the marketing of opioid products. Stricter regulations on opioid advertising could help align the goals of public health campaigns with the broader goal of reducing opioid prescriptions and misuse.

Another important implication is the success of Prevention and Harm Reduction (Awareness) ads, which saw an increase post-2022. These ads, which focus on naloxone and overdose prevention, are essential for addressing the fentanyl crisis and reducing overdose deaths. Given the rise in synthetic opioids like fentanyl, which have become a leading cause of overdose deaths, policymakers should ensure that harm reduction programs remain well-funded and supported. This will be important in saving lives and reducing the impact of opioid misuse on communities.

The shift in language observed in post-2022 ads demonstrates the effectiveness of public health messaging when it is supported by adequate funding. However, it also highlights the importance

of coordinating these messages across various platforms and media to maximize their reach and impact. Public health campaigns need to ensure that consistent messaging is delivered to the public about opioid recovery and prevention.

Additionally, while the increase in Treatment and Recovery ads is a positive trend, future research should assess the effectiveness of these ads in reaching the intended audience. Analyzing metrics such as engagement rates (click-through rates, shares, likes) could provide valuable insights into how well these ads are being received by the public and whether they are influencing public behavior or attitudes toward opioid recovery and harm reduction.

Future Research:

While this study focused on the trends in ad volume and language use, future research could expand by examining engagement metrics such as click-through rates and ad effectiveness. Understanding how targeted ads influence public health outcomes is crucial in fine-tuning strategies for opioid prevention and treatment.

Another area for future study is the geographic variability in ad exposure and opioid deaths. Research could explore how different states or regions are utilizing settlement funds and whether certain areas are seeing more substantial impacts from opioid-related ads and settlement programs.

Finally, evaluating the long-term effects of opioid product advertisements and their relationship with opioid misuse would provide insights into whether more stringent regulations are needed to limit these ads. Understanding the regulatory gaps in opioid marketing is key to achieving the goal of reducing opioid misuse on a national scale.