The Relationship Between Ethnicity and Opioid Prescription Management Among Cancer Patients using MIMIC IV

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Purpose: To investigate racial disparities in opioid prescription practices among cancer patients, focusing on differences in access and undertreatment across racial groups using the MIMIC-IV database.

Methods: We analyzed data from the MIMIC-IV dataset (2008–2019), focusing on cancer patients prescribed opioids. Demographic, clinical, and contextual variables, including race, gender, age, pain level, and insurance type. Statistical analyses, such as chi-square tests and stratified analyses, were conducted to assess disparities to evaluate disparities across racial and demographic subgroups.

Results: Asian cancer patients were consistently found to have the lowest rates of opioid prescription across multiple stratified analyses, particularly among male patients and those covered by Medicaid ($p < 0.05$). No statistically significant disparities were identified for Black or Hispanic patients in the overall analysis, although subgroup trends warrant further investigation.

Conclusion: Significant racial disparities exist in opioid prescription practices for Asian cancer patients, especially among Asian male groups and Medicaid recipients, highlighting an overlooked inequity. These findings emphasize the need for equitable pain management strategies and further research to address systemic healthcare disparities.

Problem Statement

Pain management is a critical component among cancer patients. However, studies have shown that racial disparities occur in treatment among different ethnic groups of cancer patients. Minorities receive lesser or lower quality pain care than non-Hispanic whites. Such circumstances raise inequality concerns in pain management, which could lead to negative health outcomes, increased suffering.

This study aims to investigate whether racial bias influences opioid prescription practices among cancer patients using the MIMIC-IV database. We will focus on patients diagnosed with cancers who have been prescribed opioids, exploring the relationship between ethnicity and pain management to uncover disparities.

Literature Review

The question of whether racial disparities exist in pain management for cancer patients has long been a focus of research. For instance, Anderson et al. (2002) found that minority cancer patients, specifically African Americans and Hispanics, often reported inadequate pain management compared to non-Hispanic white patients. In interviews, the result has revealed that "25% of African-American patients described physician reluctance to prescribe opioid medications for their pain." (Anderson et al., 2002); in the meantime, physicians may warn them about addition to pain medication (Anderson et al., 2002). Also, since "35% of Hispanic patients were receiving analgesics that were inadequate for the severity of their pain." (Anderson et al., 2002), it further highlights the disparity in care quality.

Further research supports these findings, which indicates that, relative to white patients, black patients are less likely to be given pain medications and, if given pain medications, they receive lower quantities (1–10), despite having similar self-reported pain.(Hoffman et al., 2016) Black cancer patients were 4.3% less likely to receive any opioid prescription, similar differences were observed in Hispanic cancer patients, compared with White patients, and they tend to receive lower doses, indicating issue of undertreatment. This disparity persists across different cancer types and care settings, underscoring the systemic bias in how pain management is approached for non-white patients. Such biases are often linked to misconceptions about racial differences in pain tolerance, which contribute to unequal treatment outcomes.

Such circumstance is not limited among cancer, where "review reveals the persistence of racial and ethnic disparities in acute, chronic, cancer and palliative pain care across the life span and treatment settings with minorities receiving lesser quality pain care than non-Hispanic whites." (Anderson et al., 2009)

Socioeconomic factors also play a critical role in pain management disparities. Rodin and Smith (2023) highlighted that while Medicaid provided some benefits for white patients, these benefits were less evident for Black and Hispanic patients, potentially exacerbating disparities in pain treatment. Moreover, intersectional factors such as sex and insurance type further complicate the picture of pain management inequities. Rodin and Smith (2023) also found that Black males were less likely to receive opioid prescriptions than white males, suggesting that both race and gender contribute to disparities. Exploring this intersectionality is crucial to understanding the full scope of racial disparities in pain management, supporting us to add these variables for our analysis.

This evidence from prior research serves as a foundation for our study, which aims to explore whether racial disparities in opioid prescriptions continue to exist in cancer patients using the MIMIC-IV database. In this case, this study seeks to verify and expand upon previous findings, providing a deeper understanding of pain management inequalities.

Data Preprocessing

Table 1: Baseline Clinical Characteristics of Patients in Our Study Comparing Those Receiving Opioid Analgesics and Non-Opioid Analgesics

Characteristics	**Overall (n=23,057)**	**Opioid drugs usage (n=522)**	**Non-opioid drugs usage (n=22,535)**
Age, median [IQR]	66 [18, 91]	55 [21, 91]	66 [18, 91]
Male gender, n(%)	11,089 (48.09)	296 (56.70)	10,793 (47.89)
Female gender, n(%)	11,968 (51.91)	226 (43.30)	11,742 (52.11)
Ethnicity, n(%)			
White	16,892 (73.26)	372 (71.26)	16,520 (73.31)
Black	2,954 (12.81)	70 (13.41)	2,884 (12.80)
Hispanic	891 (3.86)	25 (4.79)	866 (3.84)
Other	1,404 (6.09)	44 (8.43)	1,360 (6.04)
Asian	916 (3.97)	11 (2.11)	905 (4.02)
Pain Level, n(%)			
Level 1	7,495(32.51)	58(11.11)	7,437(33.0)
Level 2	3,675(15.94)	31(5.94)	3,644(16.17)
Level 3	5,183(22.48)	140(26.82)	5,043(22.38)
Level 4	6,704(29.08)	293(56.13)	6,411(28.45)

We will be using MIMIC-IV, which is a large dataset of patients at the Beth Israel Deaconess Medical Center in Boston between 2008 and 2019. Combining we also used MIMIC-IV-ED which is a subset of MIMIC-IV and mainly zooms in on emergency department visits.

In our analysis of cancer patients prescribed opioids, we addressed cases where the same patient appeared multiple times in the dataset. To avoid overrepresentation of individuals with higher prescription frequencies, we decide to aggregate the data so that it only includes one unique patient entry to avoid bias from repeated prescription.

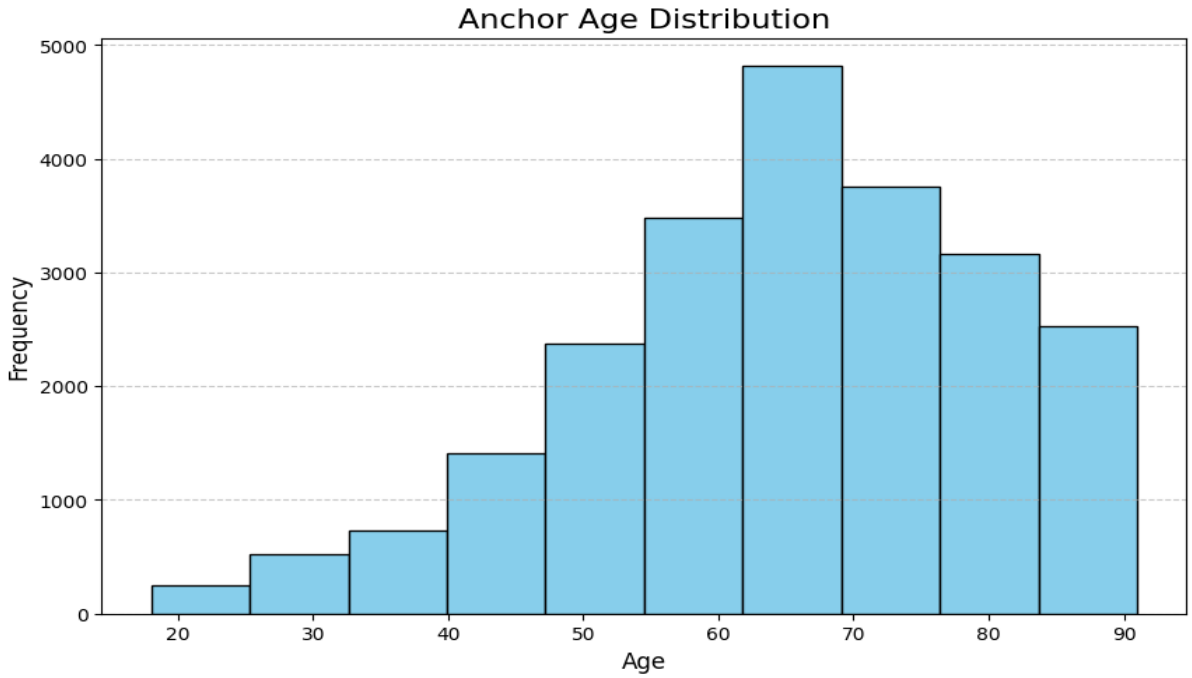
Initially, we only focused on patients diagnosed with one of five specific cancer types: skin cancer, pancreatic cancer, breast cancer, lung cancer, and prostate cancer, providing a representative sample for our study. However, after aggregating the data, we realized it reduces our sample size and could potentially lead to underpower of the analysis. Therefore, we decide to include all cancer types in MIMIC-IV, ensuring a sufficient amount of dataset for meaningful analysis.

To identify all cancer patients, we used ICD code to locate and result in 40552 cancer patients in the entire MIMIC-IV dataset. With subject id of these cancer patients, we merged with admission and patient dataset to include essential demographic and administrative variables, including race, gender, age, pain level, insurance type, primary language, admission type, and etc., which are all

based on our literature review. To ensure the consistency of the race variable, we standardize the category into White, Black, Asian, Hispanic, Native American, creating a uniform framework for further analysis.

Pain level is considered as a critical independent variable for us to examine the relationship. However, the data in this column is very inconsistent, containing a mix of text, dates and numerical values exceeding the regular scale of 0 to 10. In this case, we decide to drop all text value and date value in the pain level column, and we will only include levels that are between 0 to 10. Since some patients had multiple pain level recordings, we retained only the maximum pain level for each subject ID and joined it back with the original dataset.

For the age variable, we categorized patients into three distinct groups to facilitate analysis: Level 1 represents patients under 50-year-old, level 2 is patients from 51-70 years old. Level 3 is over 70-year-old.This categorization was chosen based on the prevalence of cancer, as most cases of cancer in people aged 50 and over. (Cancer Research UK) By stratifying, we are able to capture potential differences in opioid prescription across different age cohorts.



To incorporate medication information, we utilized the prescription file and filtered it to include only certain types of painkillers relevant to the study. These records were merged using subject IDs. Then, we created a binary variable for opioid use, assigning a value of 1 if the patient was prescribed an opioid and 0 otherwise. In this case, we examined there are in total 22535 cancer patients prescribed with non-opioid, and 522 cancer patients prescribed with opioid cancer patients.

To ensure the robustness of our analysis and to confirm that our sample size is sufficient for meaningful statistical testing, we conducted a statistical power analysis. The results indicate that our sample sizes for all racial groups meet the minimum required threshold for sufficient power (minimum sample size needed = 64). Specifically, we observe adequate representation across all racial categories: White (16,892), Black (2,954), Hispanic (891), Asian (916), and Other (1,404). This confirms that our dataset is adequately powered to detect significant differences and interactions among the groups analyzed.

Results

To examine potential racial disparities in pain management, we conducted a series of statistical analyses, including chi-square tests and stratified analysis between race and other key variables, to evaluate their relationship with opioid prescription practices.

- **Race and Opioid Prescription**
  We conducted a chi-square test to identify the relationship between race and whether patients are prescribed with opioid. From the result, we notice that the result is statistically significant (p-value: 0.02543). Specifically, we realize that Asian cancer patients have a chi-square of 4.38, and p-value is 0.036, suggesting that the likelihood of receiving opioid prescriptions differs significantly from expected frequencies in Asian group. Similarly, we observed such likelihood in Other racial group, with chi-square of 4.70 and p-value of 0.030. However, we are not able to identify. However, no significant differences were observed for Black, White, or Hispanic patients.
  Although prior research highlights that Black and Hispanic patients are more likely to be undertreated for pain management, our analysis did not reveal significant disparities for these groups, which may be due to sample size limitation. However, we did identify that Asian cancer patients are likely to be at risk of undertreatment, while didn't receive sufficient attention in current existing literature. Such result emphasized the need for further research into pain management practices for Asian groups to address inequities that may be overlooked in current healthcare disparities. (Appendix 1)
- **Stratified analysis in race and gender**
  As mentioned, to reveal the pattern between opioid prescription among cancer patients considering both race and gender, we conducted a stratified analysis. The result indicates noticeable disparity, especially among Asian patients, which further support our result from first analysis. Among female cancer patients, chi-square statistics is 7.78, with a P-value of 0.0998, indicating that there is no statistically significant differences across racial groups. However, among male cancer patients, we have a chi-square of 11.73, with a P-value of 0.0194, which is less than 0.05. Therefore, it demonstrates a statistically significant relationship between race and opioid prescription. Asian male shows the

lowest prescription rate, with only 1.13% (5 out of 440), significantly lower than Black male patients (2.12%), White male patients (2.67%) and Hispanic male patients (4.21%). Such result suggests a consistent undertreatment in opioid prescription among Asian groups, particularly in male patients. It indicates the potential bias in current healthcare system among Asian male patients, which further emphasized the necessity of improving cultural competence to avoid implicit bias and address inequality. (Appendix 2)

- **Stratified analysis in race and insurance**

  The stratified analysis of race and insurance type also reflected some disparities in opioid prescription practices across different insurance groups. Among Medicaid patients, there was a statistically significant difference in different race groups, with a chi-square statistic of 15.02 (p-value = 0.00465). Asian patients within the Medicaid group had considerably lower rates of opioid prescriptions compared to other racial groups. For patients with Medicare, the chi-square statistic was 8.60 (p-value = 0.07183); similarly, no significant racial differences were identified among patients with private insurance (chi-square = 4.36, p-value = 0.36002) or other insurance types (chi-square = 3.28, p-value = 0.51169). These findings suggest that racial disparities in opioid prescribing are most evident within the Medicaid group, particularly for Asian patients, highlighting the need for targeted strategies to address inequities in pain management within this vulnerable population. (Appendix 3)

- **Stratified analysis in race and admission type**

  In this analysis, most subgroups did not show statistically significant differences in opioid prescription rates among racial groups, since most of the p-value is over our threshold. However, for the admission type categorized as "Observation Admit," the chi-square statistic was 10.13, with a p-value of 0.038, suggesting significant differences in opioid prescription likelihood across racial groups within this admission type. This result indicates further investigation is needed to understand how admission types interact with race to influence prescribing patterns.

- **Stratified analysis in race and pain level**

  The stratified analysis of race by pain levels revealed no statistically significant differences in opioid prescription practices among racial groups within each pain level category. For patients with low pain levels, the chi-square statistic was 3.58 (p-value = 0.46570). Among medium pain level patients, the chi-square statistic was 7.44 (p-value = 0.11427), and for high pain levels, the chi-square statistic was 4.89 (p-value = 0.29922). These results suggest that racial disparities in opioid prescribing may not vary significantly within specific pain levels, although broader patterns could still exist across the full dataset.

Persona

This paper is aimed at addressing social disparities issues, we mainly focus on healthcare provider. The findings indicate significant disparities in opioid prescription practices, with a particular focus on overlooked populations such as Asian cancer patients. These disparities were further proved through stratified analyses involving gender, pain level, insurance type, and admission context, which revealed consistent patterns of undertreatment for Asian patients even when controlling for these factors. Based on the analysis result, the paper highlight the necessarity for clinicians to adopt more equitable pain management strategies that prioritize individualized care and ensure all patients, receive appropriate treatment.

This paper emphasize the exsiting issue of implicit biases in prescribing practices, in this case, healthcare professionals should advocate more training sessions and equitable access to resources to create a healthcare environment promoting fairness in pain management.

Challenge

During our analysis, we have encountered several challenges that need to be addressed in future work. One significant limitation, which is also considered as the confounder in our analysis, is the absence of cancer stage information. Pain severity and opioid prescription need vary a lot by cancer stage. Patients diagnosed with advanced-stage cancer are more likely to require more opioids for pain management than early-stage cancer. In this context, if racial minorities are more likely to be diagnosed with late-stage cancer compared to Caucasian patients, this could lead to an underestimation of racial disparities in pain management since the increased opioid prescriptions for late-stage cancer in racial minority patients may mask underlying disparities in how opioids are prescribed within different cancer stage.

Another limitation we have is that pain may be reported differently among different races. For instance, research has shown that “African–Americans report greater sensitivity and reduced pain tolerance” compared with non-Hispanic white patients. (Campbell & Edwards, 2012) Cultural norms will potentially influence pain reported as well. Such differences introduce potential bias into the analysis, as they affect both independent variables and the dependent variable.

Aside from that, there is potential limitation in generalizability of our analysis result. Since MIMIC-IV is only derived from one single medical center, it is not able to reflect the diversity of all healthcare systems across the country. As a result, future research would benefit from incorporating datasets from a broader range of healthcare institutions to enhance the generalizability and applicability of the results.

Future Work

Based on our analysis, we also conclude some future work that can be done to provide a more comprehensive result. Since MIMIC-IV is a dataset from a single medical center, future research should include datasets from a wider range of healthcare institutions across diverse geographic and socioeconomic contexts, so that it can mitigate the effect from limited sample size. In the meantime, MIMIC-IV contains general information, which is not designed for a specific target. Therefore, future work will be benefit more with a well-designed data collection process tailored to our objectives. Additionally, when collecting specific data, we will need to include columns stating cancer stage to avoid confounder as opioid prescription vary differently in different cancer stage.

Conclusion

This study highlight the racial disparity in opioid prescription among cancer patients. Although due to sample size limitation, we didn't find significant result in Black and Hispanic cancer patients, we realize Asian patients, as a largely overlooked population in existing literature, have been experiencing undertreatment in opioid prescription. Through our statistical analyses, including chi-square tests and stratified analyses, it revealed consistent patterns of lower opioid prescription rates for Asian patients, especially among males and Medicaid recipients. Although our prior literature review put a lot of emphasis on Black and Hispanic patients, this paper helps us to broaden the scope of equity-focused healthcare research to include all racial minority groups.

Reference:

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Appendix

	Race	Chi-squared	P-value	Degrees of Freedom	Expected Frequencies
0	Black	0.120707	0.728269	1	[[2887.1227826690374, 66.8772173309624], [1964...
1	White	0.986098	0.320698	1	[[16509.57279784881, 382.4272021511905], [6025...
2	Other	4.703394	0.030103	1	[[1372.2140781541398, 31.78592184586026], [211...
3	Hispanic	0.988378	0.320139	1	[[870.8281649824348, 20.171835017565165], [216...
4	Asian	4.384570	0.036266	1	[[895.2621763455784, 20.73782365442165], [2163...

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Chi-square Test Results:
Chi2 Statistic: 11.10
P-value: 0.02543
Degrees of Freedom: 4
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Appendix 1. Chi-square test between race and opioid prescription

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Results for F:

Contingency Table:
is_opioid        0    1
general_race
Asian          465    6
Black         1732   45
Hispanic       502    9
Other          681   18
White         8362  148

Chi-square statistic: 7.78
P-value: 0.09980
Degrees of freedom: 4

Opioid Prescription Rates (%):
general_race
Asian       1.27
Black       2.53
Hispanic    1.76
Other       2.58
White       1.74
dtype: float64
```

```
Results for M:

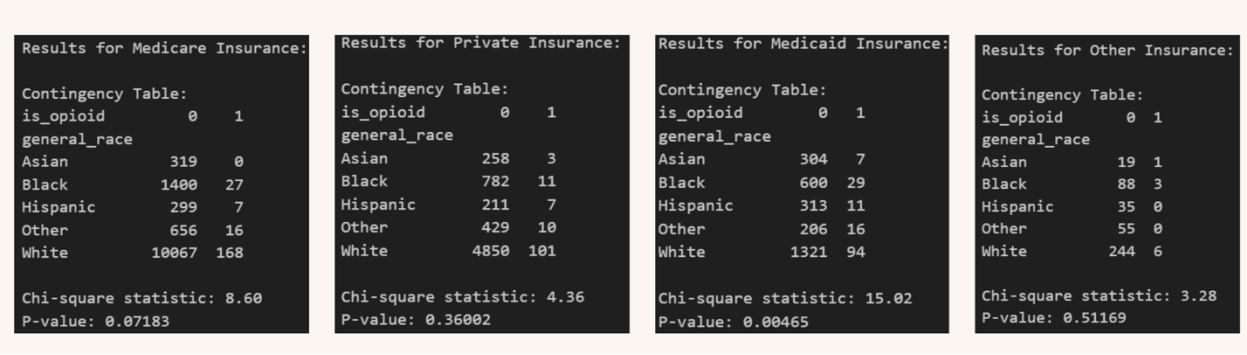
Contingency Table:
is_opioid        0    1
general_race
Asian          440    5
Black         1152   25
Hispanic       364   16
Other          679   26
White         8158  224

Chi-square statistic: 11.73
P-value: 0.01948
Degrees of freedom: 4

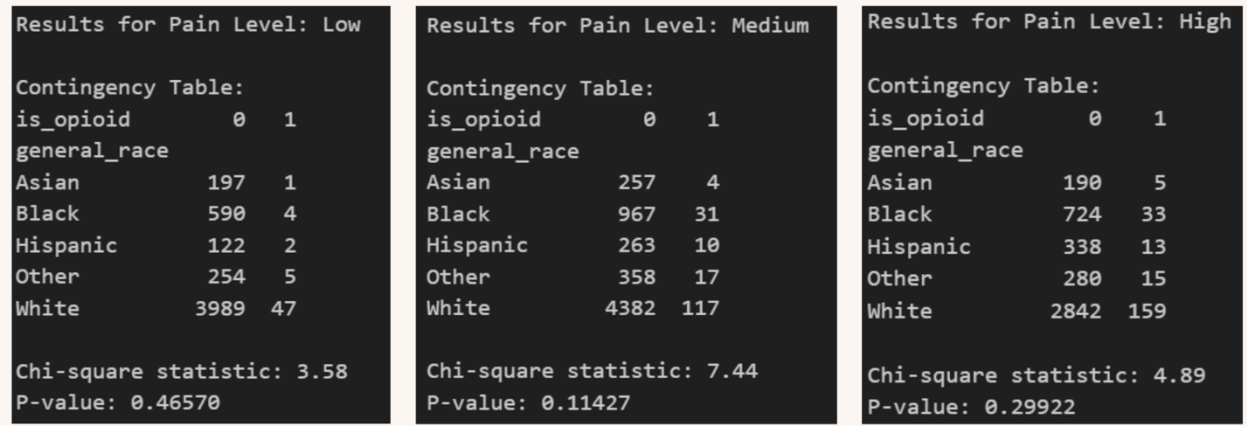
Opioid Prescription Rates (%):
general_race
Asian       1.12
Black       2.12
Hispanic    4.21
Other       3.69
White       2.67
dtype: float64
```

	Gender	Sample Size Needed	Actual Sample Size	Meets Requirement
0	F	64.0	11968	True
1	M	64.0	11089	True

Appendix 2. Stratified Analysis in both race and gender with opioid prescription



Appendix 3. Stratified Analysis in race and insurance with opioid prescription



Appendix 4. Stratified Analysis in race and pain level with opioid prescription