



Finding Causal Impacts of Social Determinants of Mental Health on Opioid Use Disorder from Clinical Notes

Madhavi Pagare, Inyene Essien Aleksi, Atqiya Munawara Mahi, Mohammad Arif Ul Alam





Poster No.

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Introduction

Opioid Epidemic:

•Over 645,000 deaths since the 1990s •75% of 107,000 overdose deaths in 2022 involved

Objective: Investigating the role of Sociocultural Factors of Mental Health (SFOMHs) in OUD from clinical notes.

Challenges

opioids

Complex Interconnections:

 Linked to social inequalities and generational health issues.

Complex Interactions:

unemployment, housing instability

Data Limitations:

 Challenges in extracting SFOMHs from Electronic Health Records (EHR) and the limitations of LLMs (large language models) in medical applications.

Proposed Framework

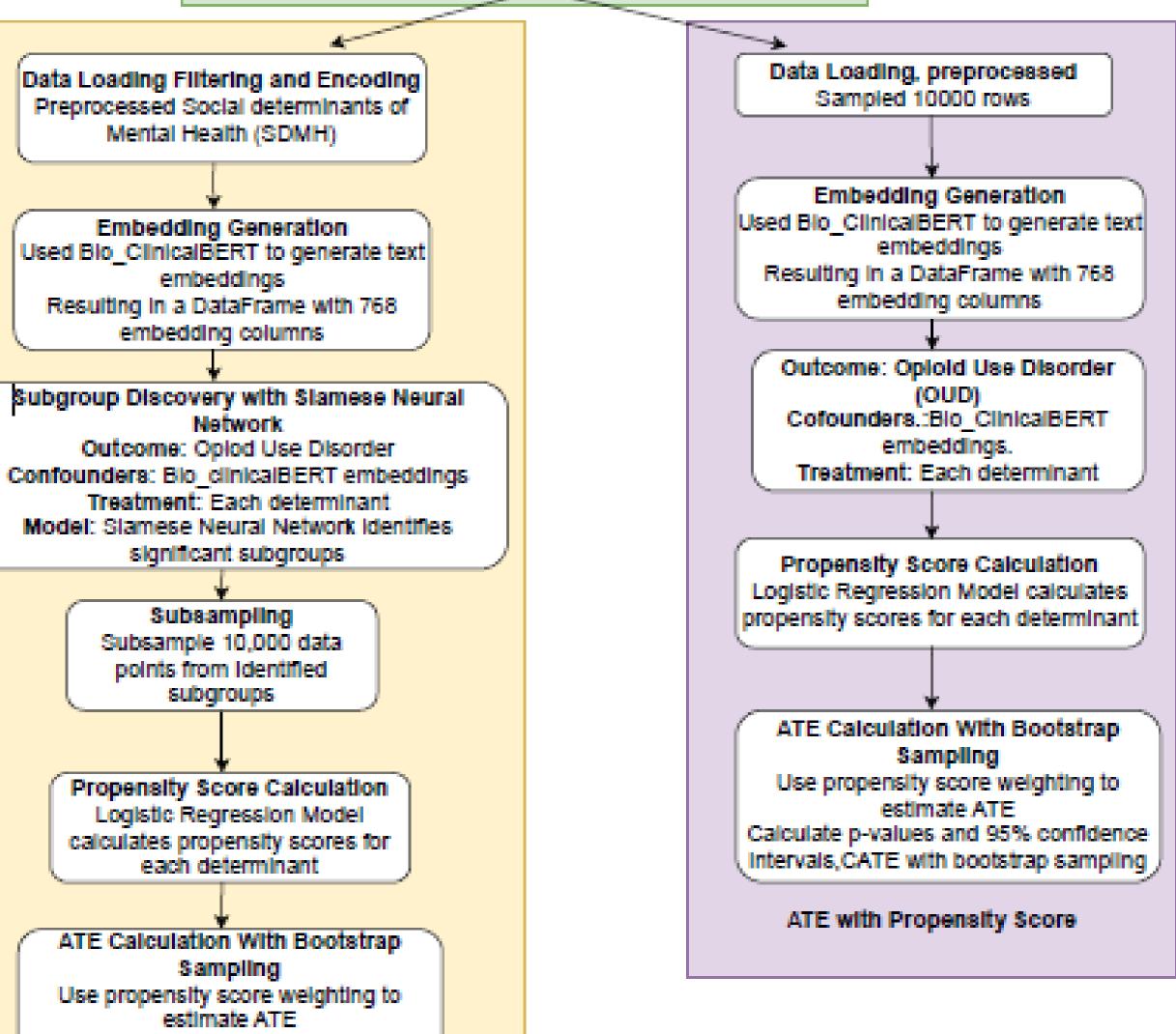
Model Approach:

- MMCL Model: Detects and classifies SFOMHs.
- SNN Model: Identifies causal effects of SFOMHs on OUD.
- New Dataset: SFOMH-OUD-Clinic dataset created for evaluation.

Methodology:

Subgroup discovery and causal inference using Clinical-Longformer embeddings.

SDMH Label Prediction for OUD MIMIC IV Datasets Patients: 145,914, Clinical Notes (texts): 331,793 Data Loading and Preprocessing Targetted 2636 Clinical Notes (Discharge.csv) Implemented Clinical-Longformer Tokenizer and model: Train Validation Test Predicted SDMH labels for OUD (331,793 Clinical Notes)



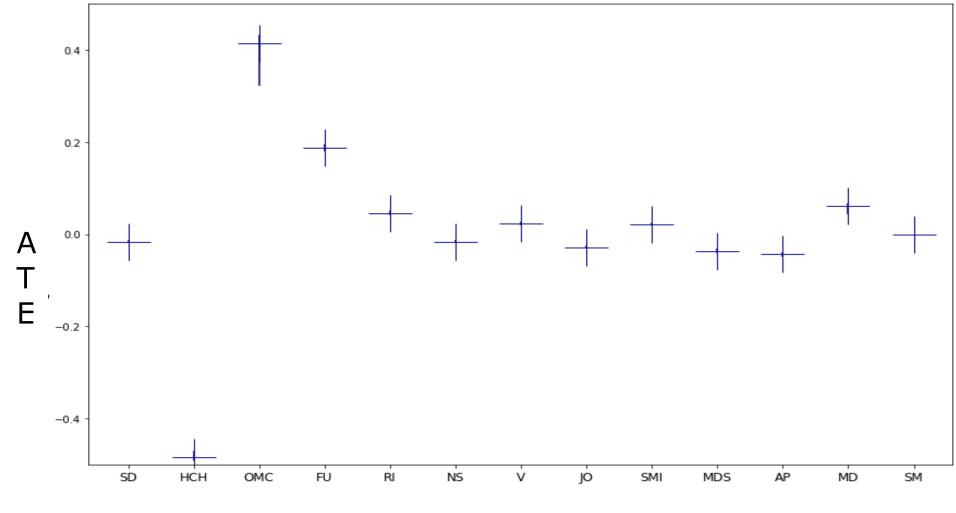
Causal Inference Methodology

- Dataset Segmentation: Separation of treatment/control groups.
- •SNN Architecture: Uses a dual-network structure and dropout layers to prevent overfitting.
- •Outcome Estimation: Identifies Average Treatment Effect (ATE) for subgroup analysis.

Model Performance Metrics

Model	Metric	T1	T2	Т3	
	Acc	99.00	95.82	96.29	
	F1	98.99	95.68	95.41	
	Prec	99.02	95.85	96.03	
Clinical- Longformer	Recall	98.97	95.80	94.81	

Average Treatment Effect on Social Determinants of Mental Health (SDMHs) with 95% Confidence Intervals with Siamese Neural Network(SNN)-based Subgroup Discovery



Social Determinants

With SNN

Overview of Social determinant of Mental Health(SDMHs) prediction for OUD and Causal inference estimates and methods for obtaining them.

Calculate p-values and 95% confidence

Jntervals,CATE with bootstrap sampling

ATE with Subgroup Discovery Using Slamese NN

Causal Inference Results for Social Determinants of Mental Health for Opioid Use Disorder without and with using Siamese Neural Network(SNN)-based Subgroup Discovery (p<0.05=*)

Without SNN

	WICHOUC SININ					WICH SININ				
	Sample		ATE	95% CI Lower	95% CI Upper	Treated Sample Size	_		95% CI Lower	95% CI Upper
-0.02	3	9997	0.007094	0.007094	0.007094	4985	5015	-0.01587*	-0.01885	-0.01312
-0.47*	9905	95	0.032744*	0.032744	0.032744	4980	5020	-0.48389*	-0.4931	-0.4702
0.29*	27	9973	0.007259*	0.007259	0.007259	5100	4900	0.413967*	0.322766	0.4333
-0.01	83	9917	0.00601*	0.00601	0.00601	5034	4966	0.187476*	0.179297	0.196402
0.01	4966	5034	-0.001046	-0.05715	0.0562548	4984	5016	0.045997*	0.040655	0.051002
-0.02	1	9999	0.008548	0.008548	0.008548	5015	4985	-0.015945*	-0.0184	-0.0134
-0.02	48	9952	0.008842*	0.008842	0.008842	4966	5034	0.023299*	-0.0186	0.027902
0.05	4503	5497	0.016091*	0.016091	0.016091	4967	5033	-0.027919*	-0.0314	-0.024297
-0.10*	7735	2265	-0.01734*	-0.01734	-0.01734	4964	5036	0.021832*	0.019097	0.024802
0.03	9910	90	0.008605*	0.008605	0.008605	5045	4955	-0.03695*	-0.0419	-0.0319
0.18*	8569	1431	0.071611*	0.071611	0.071611	5017	4983	-0.043365*	-0.0485	-0.0384
0.34*	2372	7628	-0.01734*	-0.01734	-0.01734	5095	4905	0.060525*	0.044121	0.0665
-0.45*	9375	625	-0.01598*	-0.01598	-0.01598	4984	5016	-0.16492*	-0.1725	-0.157
	-0.02 -0.47* 0.29* -0.01 -0.02 -0.02 -0.05 -0.10* 0.03	Correlation Sample Size -0.02	Correlation Coefficient Treated Sample Size ed Sample Size -0.02 3 9997 -0.47* 9905 95 0.29* 27 9973 -0.01 83 9917 0.01 4966 5034 -0.02 1 9999 -0.02 48 9952 0.05 4503 5497 -0.10* 7735 2265 0.03 9910 90 0.18* 8569 1431 0.34* 2372 7628	Correlation Coefficient Treated Sample Size Untreat ed Sample Size ATE -0.02 3 9997 0.007094 -0.47* 9905 95 0.032744* 0.29* 27 9973 0.007259* -0.01 83 9917 0.00601* 0.01 4966 5034 -0.001046 -0.02 1 9999 0.008548 -0.02 48 9952 0.008842* 0.05 4503 5497 0.016091* -0.10* 7735 2265 -0.01734* 0.03 9910 90 0.008605* 0.18* 8569 1431 0.071611* 0.34* 2372 7628 -0.01734*	Correlation Coefficient Treated Sample Size Sample Size ATE 95% CI Lower -0.02 3 9997 0.007094 0.007094 -0.47* 9905 95 0.032744* 0.032744 0.29* 27 9973 0.007259* 0.007259 -0.01 83 9917 0.00601* 0.00601 0.01 4966 5034 -0.001046 -0.05715 -0.02 1 9999 0.008548 0.008548 -0.02 48 9952 0.008842* 0.008842 0.05 4503 5497 0.016091* 0.016091 -0.10* 7735 2265 -0.01734* -0.01734 0.03 9910 90 0.008605* 0.008605 0.18* 8569 1431 0.071611* 0.071611 0.34* 2372 7628 -0.01734* -0.01734	Treated Coefficient Size Sample Sample Size ATE Lower Upper -0.02 3 9997 0.007094 0.007094 0.007094 -0.47* 9905 95 0.032744* 0.032744 0.032744 -0.29* 27 9973 0.007259* 0.007259 0.007259 -0.01 83 9917 0.00601* 0.00601 0.00601 -0.01 4966 5034 -0.001046 -0.05715 0.0562548 -0.02 1 9999 0.008548 0.008548 0.008548 -0.02 48 9952 0.008842* 0.008842 0.008842 -0.05 4503 5497 0.016091* 0.016091 0.016091 -0.10* 7735 2265 -0.01734* -0.01734 -0.01734 -0.03 9910 90 0.008605* 0.008605 0.008605 -0.18* 8569 1431 0.071611* 0.071611 0.071611 -0.34* 2372 7628 -0.01734* -0.01734 -0.01734	Correlation Sample Coefficient Untreat Sample Size ATE 95% CI Lower 95% CI Sample Size Treated Sample Size -0.02 3 9997 0.007094 0.007094 0.007094 4985 -0.47* 9905 95 0.032744* 0.032744 0.032744 4980 0.29* 27 9973 0.007259* 0.007259 0.007259 5100 -0.01 83 9917 0.00601* 0.00601 0.00601 5034 -0.02 1 9999 0.008548 0.008548 0.008548 5015 -0.02 48 9952 0.008842* 0.008842 0.008842 4966 0.05 4503 5497 0.016091* 0.016091 0.016091 4967 -0.10* 7735 2265 -0.01734* -0.01734 -0.01734 4964 0.03 9910 90 0.008605* 0.008605 0.008605 5045 0.18* 8569 1431 0.071611* 0.071611 0.01734	Correlation Coefficient Treated Sample Size ATE 95% CI Lower 95% CI Upper Treated Sample Size Sample Sample Size Sale Sale Sale Sale Sale Sale Sale Sale Sale <t< td=""><td>Correlation Coefficient Treated Sample Size ATE 95% CI Lower 95% CI Upper Treated Sample Size Lower ATE -0.02 3 9997 0.007094 0.007094 0.007094 4985 5015 -0.01587* -0.47* 9905 95 0.032744* 0.032744 4980 5020 -0.48389* 0.29* 27 9973 0.007259* 0.007259 0.007259 5100 4900 0.413967* -0.01 83 9917 0.00601* 0.00601 5034 4966 0.187476* 0.01 4966 5034 -0.001046 -0.05715 0.0562548 4984 5016 0.045997* -0.02 1 9999 0.008548 0.008548 5015 4985 -0.015945* -0.02 48 9952 0.008842* 0.008842 0.008842 4966 5034 0.023299* 0.05 4503 5497 0.016091* 0.016091 0.016091 4967 5033 -0.027919*</td><td>Correlation Sample Coefficient Untreat ed Sample Size ATE 95% CI Lower 95% CI Upper Treated Sample Size MATE 95% CI Lower Treated Sample Size MATE 95% CI Lower Untreated Sample Size MATE 95% CI Lower 95% CI Lower MATE 95% CI Lower 95% CI Lower MATE 95% CI Lower MATE 95% CI Lower P0.0184 P0.0184</td></t<>	Correlation Coefficient Treated Sample Size ATE 95% CI Lower 95% CI Upper Treated Sample Size Lower ATE -0.02 3 9997 0.007094 0.007094 0.007094 4985 5015 -0.01587* -0.47* 9905 95 0.032744* 0.032744 4980 5020 -0.48389* 0.29* 27 9973 0.007259* 0.007259 0.007259 5100 4900 0.413967* -0.01 83 9917 0.00601* 0.00601 5034 4966 0.187476* 0.01 4966 5034 -0.001046 -0.05715 0.0562548 4984 5016 0.045997* -0.02 1 9999 0.008548 0.008548 5015 4985 -0.015945* -0.02 48 9952 0.008842* 0.008842 0.008842 4966 5034 0.023299* 0.05 4503 5497 0.016091* 0.016091 0.016091 4967 5033 -0.027919*	Correlation Sample Coefficient Untreat ed Sample Size ATE 95% CI Lower 95% CI Upper Treated Sample Size MATE 95% CI Lower Treated Sample Size MATE 95% CI Lower Untreated Sample Size MATE 95% CI Lower 95% CI Lower MATE 95% CI Lower 95% CI Lower MATE 95% CI Lower MATE 95% CI Lower P0.0184 P0.0184

Algorithm 1 Siamese Neural Network(SNN) based Subgroup Discovery

- 1: Input: Data $\mathcal{D} = \{(X_i, T_i, Y_i)\}_{i=1}^n$, hidden dimension h, dropout probability p, epochs e, threshold k
- 2: Output: Identified subgroup S
- 3: Split \mathcal{D} into treatment group \mathcal{D}_1 and control group \mathcal{D}_0
- 4: Create Siamese Neural Network(SNN) model
- 5: Train SNN with \mathcal{D}_0 and \mathcal{D}_1 for e epochs
- 6: Predict outcomes \hat{Y}_0 and \hat{Y}_1 for control and treatment groups, respectively
- 7: Calculate conditional average treatment effects $CATE_i =$ $\hat{Y}_1 - \hat{Y}_0$
- 8: Identify subgroup $S = \{(X_i, T_i, Y_i) \mid CATE_i > k\}$
- 9: return S

Results

- SNN Discovery: Significant causal effects on healthcare handover, obstacles to medical care, and financial uncertainty.
- Validation with Negative Controls: Ensures the model's robustness and consistency.
- Model Performance: SNN-based discovery results in better precision and identification of significant causal effects.

Negative Control Analysis

NCD	Treated Sample Size	Untreated Sample Size	ATE	95% CI Lower	95% CI Upper
ЕНА	4985	5015	-2.98E-05	-0.00277	0.00268
NSTOP	5000	5000	0.0354945	0.020837	0.048788

Conclusion & Implications

- **Key Findings:** SFOMHs significantly influence OUD outcomes.
- Public Health Impact: Insights guide preventive interventions and tailored treatments for OUD patients.