

Trends of Mental Health Comorbidities among Youth Presenting for a Substance-Related Visit to US Children's Hospitals, 2016-2021



Project Leads

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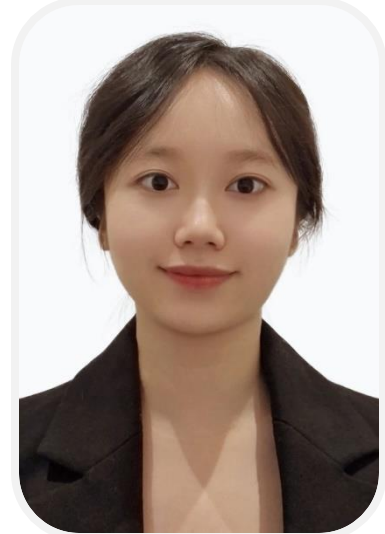
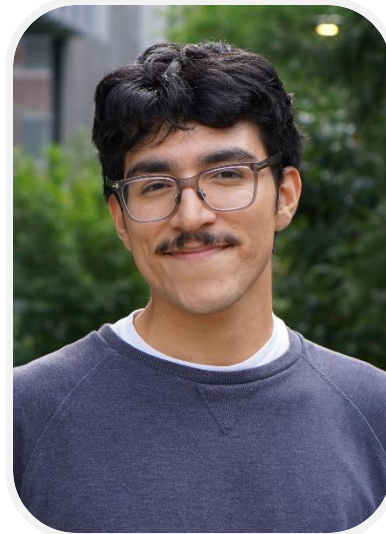
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Youth are facing a health crisis

Over the last decade, youth in the United States have experienced a concurrent **mental health crisis** and **alarming rise in substance use**.

Co-occurrence in youth induces greater risk of severe outcomes

- Academic failure, self-injury, violence

Understanding the burden of co-occurrence on hospital care may inform prevention, intervention, and treatment.

Objectives

Study **comorbid mental health** among youth visiting hospitals for a **substance-related** reason.

- **Trends** for all comorbid visits (any mental health condition)
 - Most common comorbid mental health conditions
- **Hospital utilization** for all comorbid mental health visits
- Impact of the **COVID-19** pandemic

Our target is a “big picture” of national adolescent health, as experienced by pediatric hospitals in recent history.

Data

Patient Population

- Over 100 thousand substance-related visits
- Adolescents aged 12 to 21

Visit Location and Time

- 39 pediatric hospitals within the United States
- Jan 1, 2016 – Dec 31, 2021[†]

Variables of Interest

- **Substance**: Diagnosis related to usage, dependence, or poisoning from alcohol, cannabis, opioids, and more.
- **Mental health**: Diagnosis of disorders related to personality and behavior, stress and trauma, learning and development, food and eating, and more.
- **Patient demographics** and **Hospital information**
- **Details of visit** (time and location, duration, involved departments)

[†]Duration of a diagnostic coding system, ICD-10 (International Classification of Disease, 10th Revision)

Source: Pediatric Health Information System (PHIS), Children's Hospital Association

Trends of comorbid visits

1. Count **number of visits** at monthly and annual intervals.
Calculate annual **percent change** from 2016 (baseline).

2. Estimate **monthly number of visits** for each hospital.

Log linear mixed-effects model

- Modeling discrete counts with the negative binomial distribution
- Accounting for random effects within hospital clusters
- Including time, MH condition and interaction
- Adjusting for demographics

Test for the difference between trends for those **with** and **without** a comorbid mental health condition.

Department utilization of comorbid visits

1. Count **number of visits** of the Emergency Department (**ED**), an intensive care unit (**ICU**), or being formally admitted into the hospital (**inpatient**).
2. Estimate monthly department volume for each hospital.
 - **Log linear mixed-effects** model as described before (modeling counts with the negative binomial distribution), adjusting for demographics.

Test for significant difference between number of visits of ED/ICU/Inpat for those **with** and **without** a comorbid mental health condition.

Length of stay of comorbid visits

1. Measure **length of stay** as the number of days (continuous) spent formally admitted in the hospital.
2. Estimate length of stay among hospitals.
 - GLMM with the gamma distribution, accounting for random effects among hospitals, adjusting for demographics.

Test for significant difference between length of stay for those **with** and **without** a comorbid mental health condition.

Interruption of COVID-19 pandemic

1. Count **number of visits** at monthly intervals.
2. Estimate pre-COVID trend and change in trend post-COVID.

Interrupted Time Series Analysis (ITSA) model

- Considered March, 2020 as the interruption point.

The ITSA model is specified as:

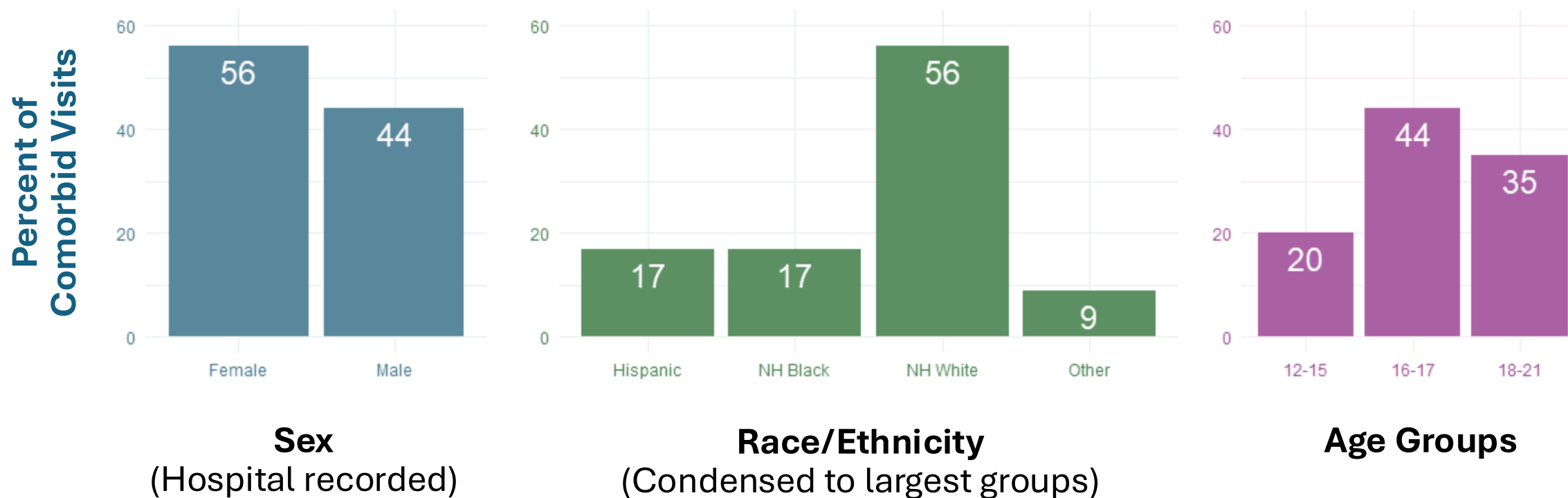
$$Y_t = \beta_0 + \beta_1 \cdot TIME + \beta_2 \cdot POST + \beta_3 \cdot TIME_POST + \epsilon_t$$

- POST: Tests if there was an immediate change after COVID-19.
- TIME:POST : Tests if the trend of visits changed after COVID-19.

Test for a significant change in trend for both those **with** and **without** a comorbid mental health condition.

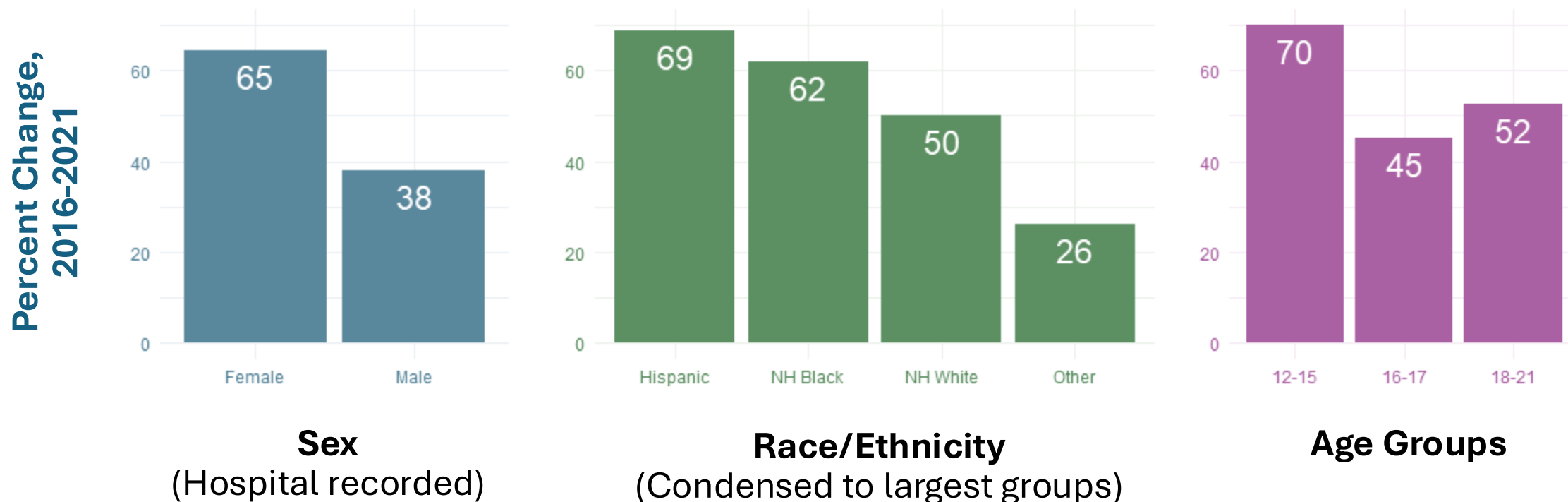
Overview of patient characteristics

Between 2016 and 2021, over **64,600 (61%)** comorbid mental health visits within 106,700 substance-related visits.



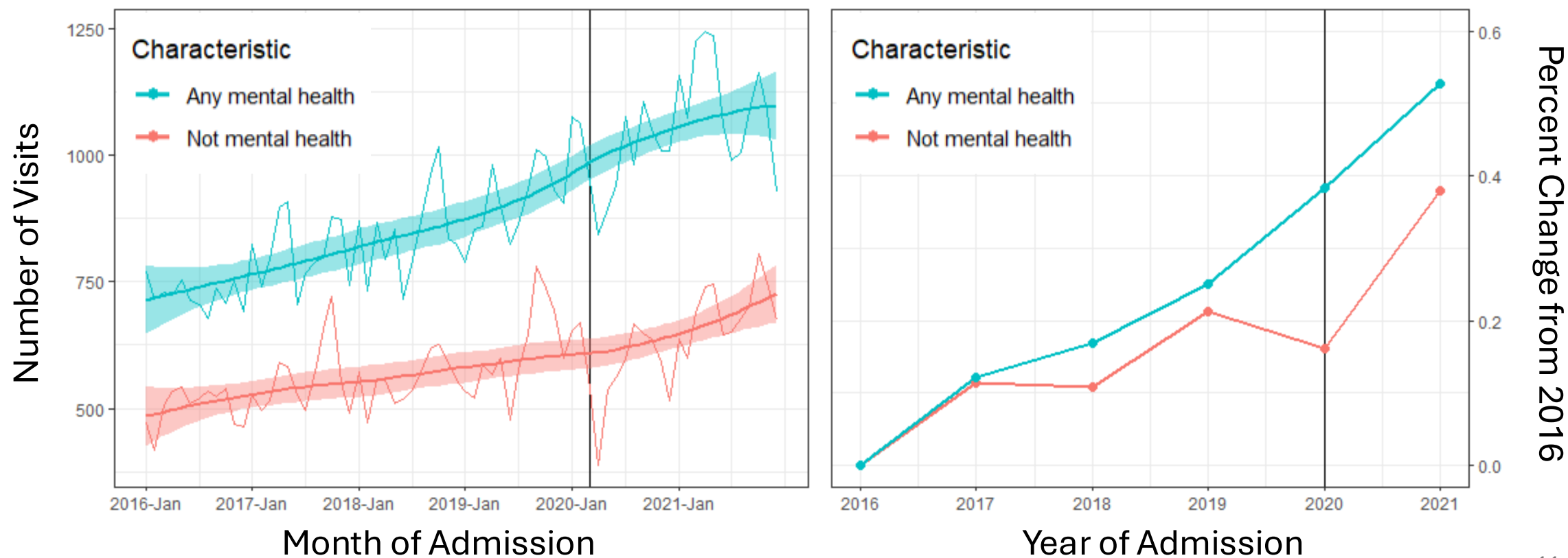
Trends in patient characteristics

Cumulative growth of comorbid visits was positive within **all groups** of sex, race/ethnicity, age, insurance type, and region.

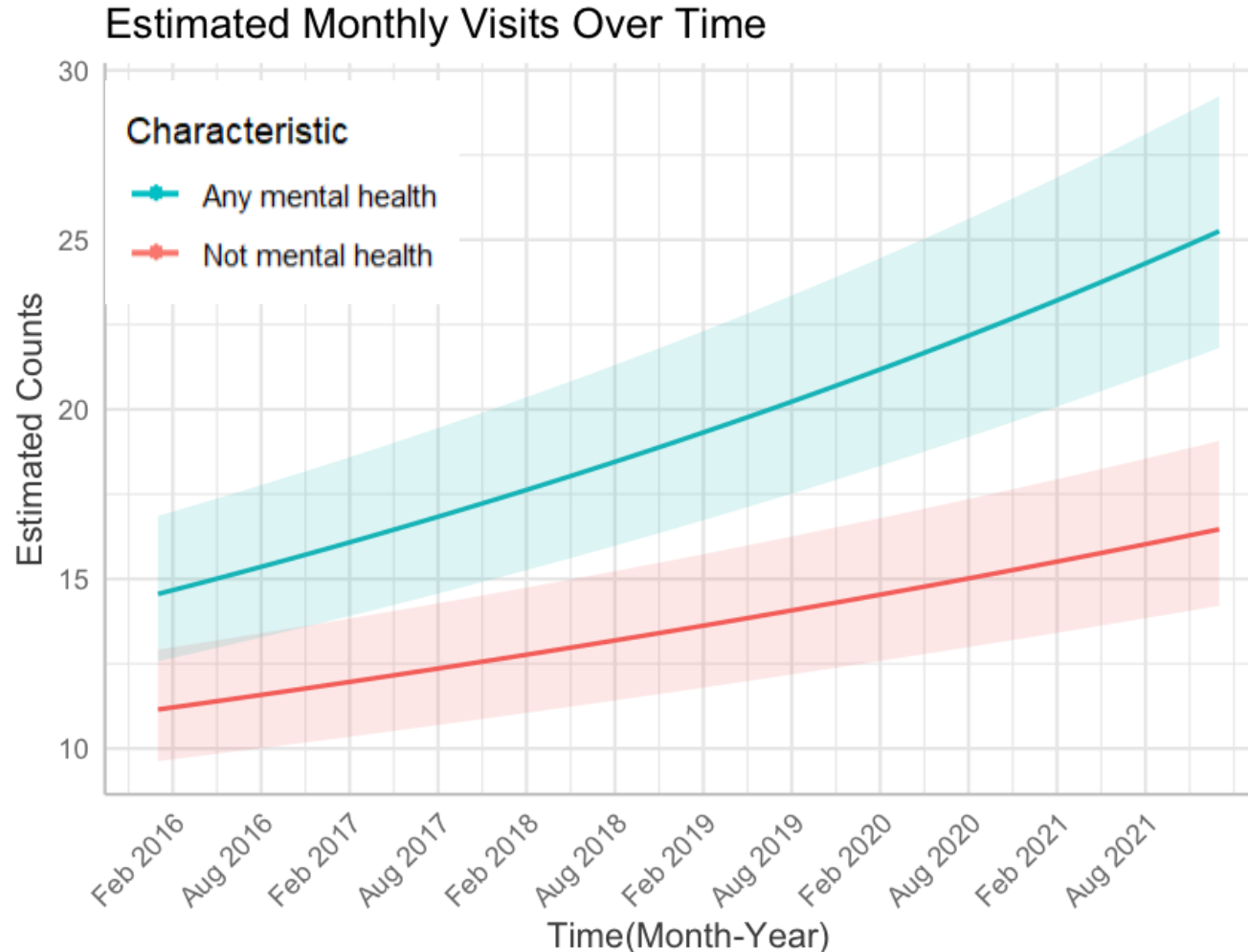


Trends of comorbid visits

Comorbid mental health visits rose **53%** over the study period.



Trends of comorbid visits

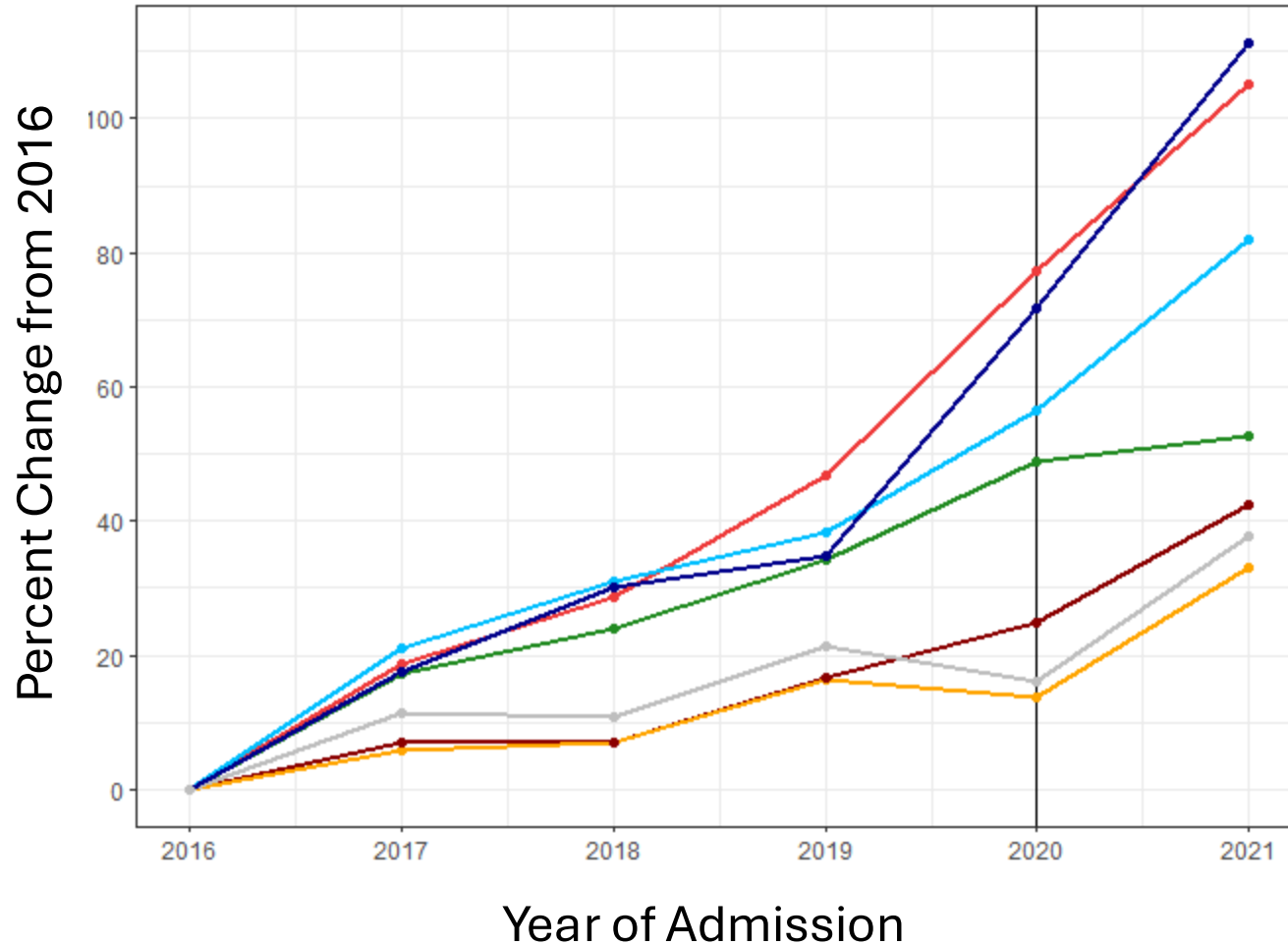


- **Model showed that both groups** are estimated to have a steady **increase** in visits over time.
- **For each hospital, Monthly Visit Counts with mental health comorbidity** is estimated to be **30%** more than the visit counts without ($p < 0.01$).
- Notably, **visit counts with mental health comorbidity** is estimated to increase at a **0.2% faster rate**, implying a cumulative burden in the long term ($p < 0.01$).

Trends of common conditions

Rank	Condition or Disorder	Total number of visits
	Any Mental Health	64,617
1	Depressive Disorders	35,677 (55%)
2	Self-Injury or Suicide	30,041 (46%)
3	Substance Dependence	28,351 (44%)
4	Anxiety Disorders	27,545 (43%)
5	ADHD	16,693 (26%)
6	Trauma and Stressor Related	11,761 (18%)

Trends of common conditions



Condition or Disorder	Percent Change from 2016-2021
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Trauma and Stressor Related	111
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Anxiety Disorders	105
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Self-Injury or Suicide	82
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Depressive Disorders	53
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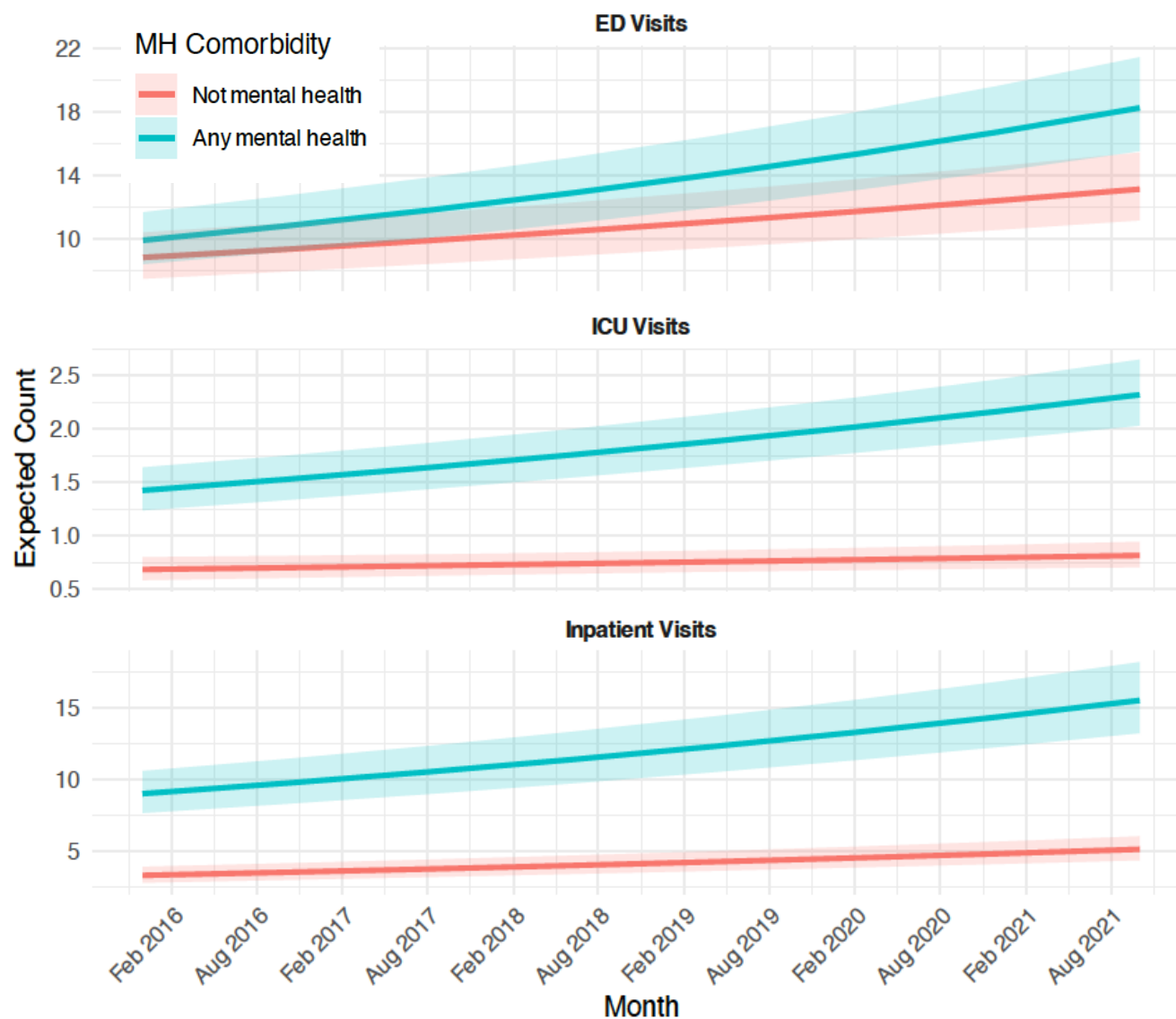
ADHD	43
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Substance Dependence	33
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No Mental Health	38
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Department utilization of comorbid visits

Estimated ED, ICU, and Inpatient Visits Over Time

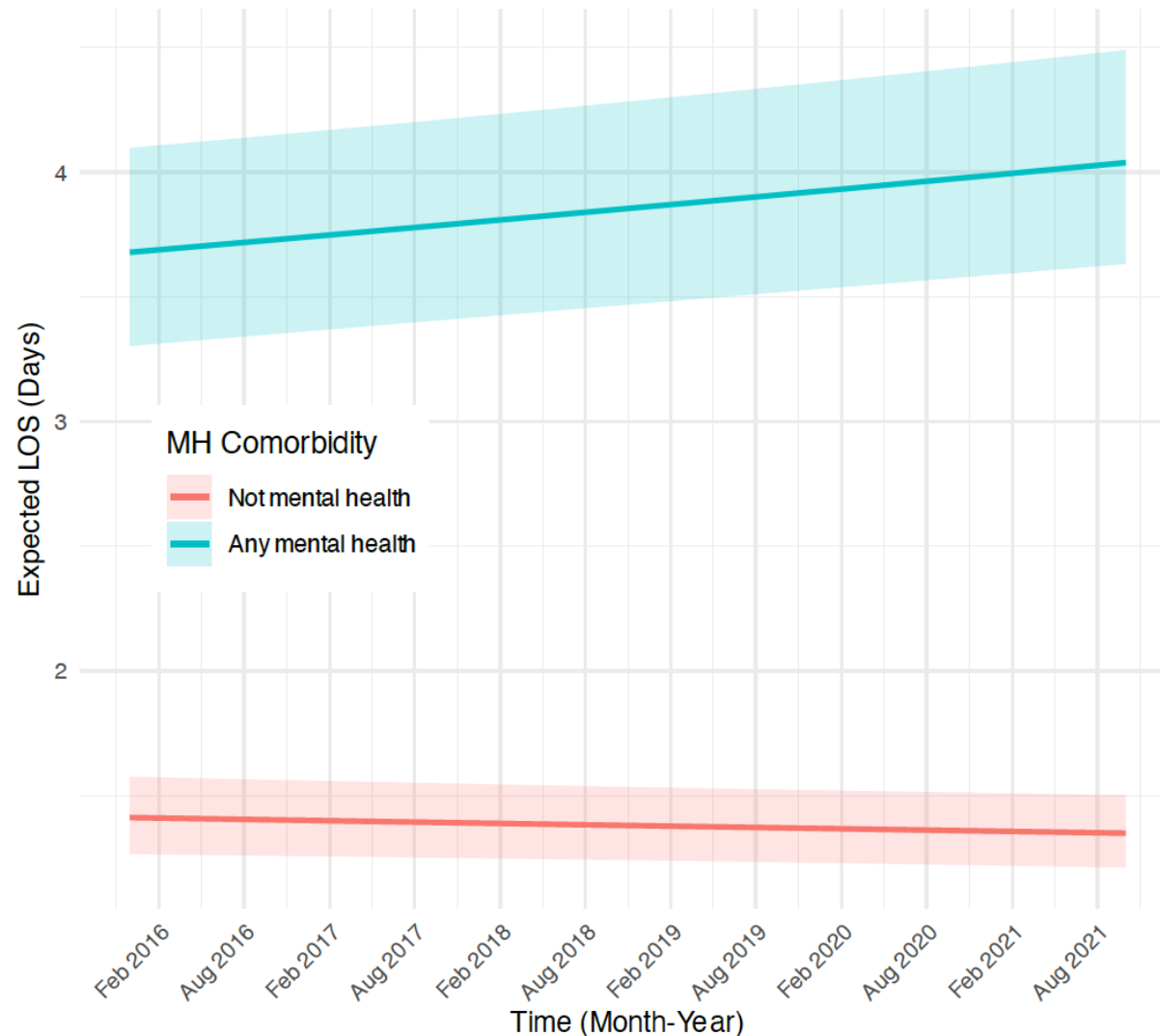


Mental health comorbidities **significantly increase** hospital utilization across all settings (27%, 151%, 188% increase for ED, ICU, and inpatient, respectively).

- All groups exhibit an **increasing trend**, indicating a growing burden over time.
- The **gap is growing** between those with and without mental health conditions, highlighting a persistent challenge.
- **ICU visits remain the lowest** in frequency, but the trend is still increasing.

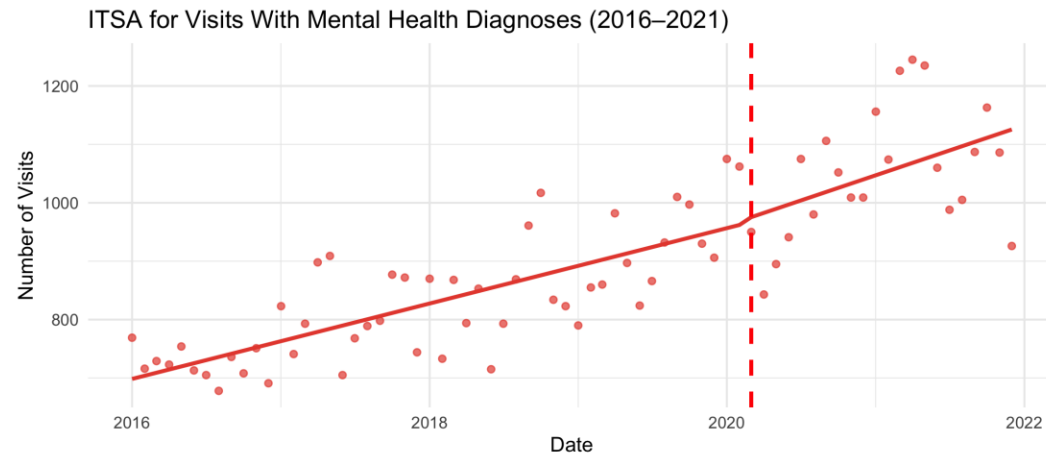
Length of stay for comorbid visits

Estimated LOS by Month and Mental Health Status

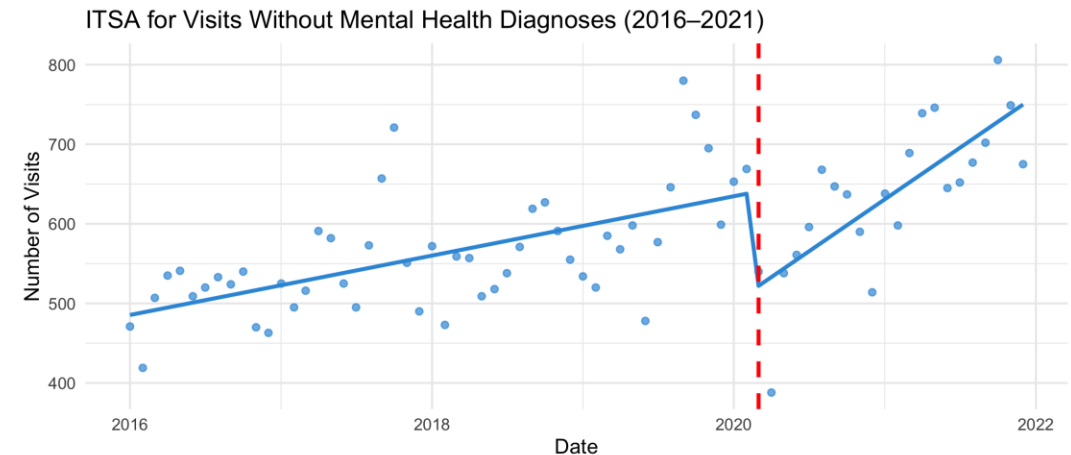


- Patients with a mental health comorbidity stay **significantly longer** in the hospital than those without.
- Overall hospital LOS for patients w/ mental health is **increasing** over time, and the **gap is growing** between mental health and non-mental health patients.
- Visits involving multiple substances, male youth, and older youth were associated with longer LOS. Hispanic youth were associated with a shorter LOS.

Interruption of the COVID-19 pandemic



- **POST:** $p = 0.62$ (not significant) – No immediate change in visits **after COVID-19** (interruption point).
- **TIME:POST :** $p = 0.52$ (not significant) – No change in the **trend of visits** after COVID-19 compared to before.
- **Conclusion:** COVID-19 had **no significant impact** on mental health-related hospital visits.



- **POST:** $p = 0.00013$ (significant) – COVID-19 caused an **immediate decrease** in hospital visits.
- **TIME:POST :** $p = 0.00050$ (significant) – COVID-19 led to a **significant change in the trend** of hospital visits over time.
- **Conclusion:** COVID-19 had a **significant interruption effect** on hospital visits for non-mental health conditions, with both an immediate drop and a long-term trend change.

Principal Findings

Between 2016-2021, across nearly 40 US pediatric hospitals, in over 64,000 substance-related visits with a comorbid mental health condition from adolescents aged 12 to 21:

- **Rising trend** in comorbid mental health visits
 - Prevalent depression, self-injury/suicide, and substance dependence
 - Fastest rise in trauma/stress, anxiety, and self-injury/suicide
- Comorbidity associated with **significant rise** in hospital utilization across multiple departments
- Rise in comorbid mental health visits was **uninterrupted** by the COVID-19 pandemic

Discussion

Limitations of our work

- Known source of selection bias excluding visits toward the end of the study period
- Hospitals represent a particular side of pediatric health, there is much to learn from smaller community clinics

Underlying changes to the social landscape

- Increased supervision of adolescents during the pandemic
- Public discussion and identification of mental health
- Expansion of cannabis and limited public access to test strips

Grander implications of pediatric care

Highlight a critical need in adolescent healthcare

- Integrated care
- Outpatient care and services
- Early intervention within communities
- Proactive public awareness

Seattle Children's Hospital opens first mental health pediatric urgent care clinic in WA

by Molly Shen, KOMO News Anchor | Tue, October 8th 2024 at 1:24 PM

Updated Wed, October 23rd 2024 at 1:15 PM



Seattle Children's Hospital has opened a new mental health urgent care clinic to help provide mental and behavioral services to children and families. This is the first clinic of its kind in the state of Washington. (Photo: Seattle Children's Hospital)

Acknowledgements

We extend our deepest gratitude to **Dr. Dwight Barry, Dr. Alexis Ball, Dr. Katherine Wilson,** and **Dr. Lloyd Mancl** for their mentorship and to academic advisors at the Department of Biostatistics for making this project possible.

We have been provided with invaluable guidance, resources, and support throughout the project's duration.

We hope this work will contribute meaningfully to the ongoing efforts and mission of Seattle Children's Hospital.

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BIostatISTICS
SCHOOL OF PUBLIC HEALTH

Supplementary

Figures

Figure 1. Right truncation in length of stay

Tables

Table 1. Characteristics of substance-related visits and percent change from 2016 to 2021

Table 2. Characteristics of comorbid mental health visits and percent change from 2016 to 2021

Table 3. Sex of comorbid mental health visits and percent change from 2016 to 2021

Table 4. Age of comorbid mental health visits and percent change from 2016 to 2021

Table 5. Region of comorbid mental health visits and percent change from 2016 to 2021

Right truncation in length of stay

Visits in our sample must have ended before December 31st, 2021.
Selection bias toward the end of the study period: shorter visits are included but longer visits are not.

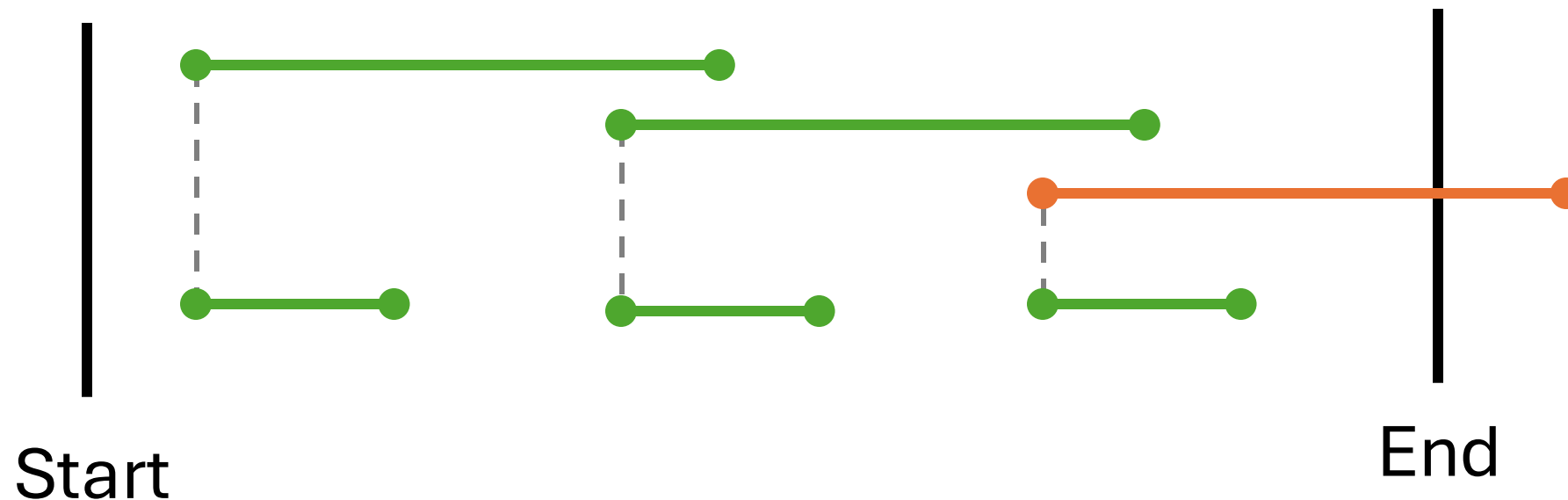


Table 1. Characteristics of substance-related visits and percent change from 2016 to 2021.

Characteristic	Total number of visits (%)	Number of visits (%) in 2016	Number of visits (%) in 2021	Percent change from 2016-2021
Overall	106,693	14,705	21,567	46.7
Any Mental Health Condition	64,617 (60.6)	8,673 (59.0)	13,251 (61.4)	52.8
Depressive Disorders	35,677 (33.4)	4,591 (31.2)	7,014 (32.5)	52.8
Self-Injury or Suicide	30,041 (28.2)	3,623 (24.6)	6,595 (30.6)	82
Substance Use Disorder	28,351 (26.6)	4,194 (28.5)	5,585 (25.9)	33.2
Anxiety Disorders	27,545 (25.8)	3,142 (21.4)	6,448 (29.9)	105
ADHD	16,693 (15.7)	2,393 (16.3)	3,411 (15.8)	42.5
Trauma and Stress Related	11,761 (11.0)	1,367 (9.3)	2,872 (13.3)	111

Table 2. Characteristics of comorbid mental health visits and percent change from 2016 to 2021.

Race/Ethnicity	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
Non-Hispanic White	36,389 (56.3)	4,903	7,368	50.3
Black or African American	11,208 (17.4)	1,485	2,403	61.8
Hispanic	10,973 (17.0)	1,398	2,361	68.9
Asian	635 (1.0)	59	123	108.5
American Indian/Alaska Native	246 (0.4)	35	57	62.9
Native Hawaiian/Pacific Islander	151 (0.2)	24	34	41.7
Multiracial	847 (1.3)	110	210	90.9
Another Race/Ethnicity	2,381 (3.7)	353	447	26.6
Missing	1,787 (2.8)	306	248	-19.0

Table 3. Sex of comorbid mental health visits and percent change from 2016 to 2021.

Sex	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
Female	36,152 (56.0)	4,849	7,978	64.5
Male	28,447 (44.0)	3,820	5,270	38.0
Missing	18 (<0.5)	4	3	-25.0

Table 4. Age of comorbid mental health visits and percent change from 2016 to 2021.

Age Group	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
12-15	13,082 (20.3)	1,695	2,880	69.9
16-17	28,199 (43.6)	3,930	5,701	45.1
18-21	22,762 (35.2)	2,984	4,550	52.5

Table 5. Region of comorbid mental health visits and percent change from 2016 to 2021.

Region	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
Midwest	23,603 (36.5)	3,216	4,888	52.0
Northwest	6,420 (9.94)	866	1,225	41.5
South	21,702 (33.6)	2,840	4,542	59.9
West	12,892 (20.0)	1,751	2,596	48.3

Table 6. Insurance of comorbid mental health visits and percent change from 2016 to 2021.

Type of Insurance	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
Government	34,379 (53.2)	4,781	6,902	44.4
Commercial	26,495 (41.0)	3,495	5,395	54.4
Other or Missing	3,743 (5.8)	397	954	140.3

Table 7. Encountered departments of comorbid mental health visits and percent change from 2016 to 2021.

Department	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
ED	48,157 (74.5)	6,136	10,285	67.6
Hospitalization	45,279 (70.1)	6,313	9,352	48.1
Intensive-care-unit	6,328 (9.8)	856	1,245	45.4

Table 8. Hospitalization of comorbid mental health visits and percent change from 2016 to 2021.

Type of Hospitalization	Total number of visits (%)	Number of visits in 2016	Number of visits in 2021	Percent change from 2016-2021
Overall	64,617	8,673	13,251	52.8
ED Discharge	18,921 (29.3)	2,348	3,742	59.4
Hospitalization	45,279 (70.1)	6,313	9,352	48.1

Supplementary

Figures

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