Psychiatry Research 342 (2024) 116270

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Comparisons of mental health treatment frequency and risk of suicidal thoughts and behaviors among youth

Gareth J. Parry [a,b,*], Lindsay Overhage [a,b], Peyton Williams [a], Katie Holmes [a], Akhil Reddy [a], Gabriel E. Rios Perez [a], Albert Y.H. Lo [a,b], Abigail Thomas [a,g], Brian Mullin [a], Sanam Bhakta [a], Sharon-Lise Normand [b,f], Marcela Horvitz-Lennon [a,b,d], Phil Wang [b,c], Matthew K. Nock [e], Benjamin Lê Cook [a,b], Nicholas J. Carson [a,b]

[a] Health Equity Research Lab, Cambridge Health Alliance, Cambridge, MA, USA
[b] Harvard Medical School, Boston, MA, USA
[c] Center for Learning Health Systems, Brigham and Women's Hospital, Boston, MA, USA
[d] RAND Corporation (Health), Boston, MA, USA
[e] Department of Psychology, Harvard University, Cambridge, MA, USA
[f] Harvard School of Public Health, Boston, MA, USA
[g] Massachusetts Institute of Technology, Cambridge, MA, USA

ARTICLE INFO

Keywords:
Child and adolescent health
Youth
Young adult
Community health system
Mental health
Psychotherapy
Suicide
Electronic health records

ABSTRACT

Suicide is a leading cause of death for adolescents and young adults, or transitional age youth, and suicidal thoughts and behaviors (STBs) are among the top predictors of suicide. This study aimed to compare the effectiveness of low versus high frequency mental health (MH) specialist visits at preventing suicidal thoughts and behaviors (STBs) among adolescents and transitional age youth receiving combined psychotherapy and psychotropic medication treatment in a culturally-diverse community health system in the United States. Between 2010–2020, we identified 4,888 individuals (12–25 years) with MH disorders who received at least one outpatient psychotherapy visit and one psychotropic medication order during their index treatment month. In the 10–12 months following the index month, unadjusted STBs were higher (3.20 %; 95 % CI 0.49 %, 5.89 %; $p < 0.001$) in youth with consistently high frequency MH specialist visits (4.40 %) relative to low (1.20 %). After balancing time-varying covariates, STBs were lower, but not statistically different in the consistently high relative to low group (Diff=-1.93 %; 95 % CI -4.56 %, 0.70 %; $p = 0.150$). Such adjustment for confounding by mental health severity indicators may strengthen evaluations of community-based treatment in diverse populations, where conventional randomization is impossible.

1. Introduction

Suicide is a leading cause of death for adolescents and young adults, or transitional age youth. Suicidal thoughts and behaviors (STBs), which are among the top predictors of suicide death (Franklin et al., 2017), have further increased since the COVID-19 pandemic (Bridge et al., 2023; National Institute of Mental Health, 2023). Twenty percent of high school students reported considering suicide in 2021, and 9 % reported having attempted suicide in the prior year (Jones et al., 2022). Since the onset of the COVID-19 pandemic, adolescents and transitional age youth, in particular females, experienced increases in suicidal ideation, suicide attempt, or intentional self-harm compared to pre-COVID years (Czeisler et al., 2020; Overhage et al., 2023; Xiao et al., 2023).

Rates of suicidal thoughts and behaviors vary by race and ethnicity, and community health systems must consider such rates to provide equitable services. Data from the Centers for Disease Control (CDC) show that American Indian/Alaska Native adolescents have the highest rates of suicide attempt, followed by Black, multiple race, and Latinx youth (Arisoyin et al., n.d.). Among Black youth, suicide attempts have significantly increased over the past ten years (Joe et al., 2018; Riley et al., 2021; Congressional Black Caucus, 2020). Recent increases have also been observed in CDC data measuring suicidal thoughts among Black, Hispanic, and White female students (Gaylor, 2023).

* Corresponding author.
E-mail address: gparry@challiance.org (G.J. Parry).

https://doi.org/10.1016/j.psychres.2024.116270
Received 6 May 2024; Received in revised form 7 November 2024; Accepted 16 November 2024
Available online 20 November 2024

The evidence base for conditions that confer a risk for STBs, such as depressive, bipolar, psychotic, substance use, post-traumatic stress, conduct, borderline personality, or antisocial personality disorders, often involves a combination of psychotropic medication and specialized psychotherapies (Bakker et al., 2017; Brent et al., 2009; Cristea et al., 2017; Fadus et al., 2019; Geller et al., 2012; Institute of Medicine (US) Committee on Pathophysiology and Prevention of Adolescent and Adult Suicide et al., 2002; March et al., 2004; Masi et al., 2023; Mojtabai and Olfson, 2020). As demand for youth mental health care increased throughout the COVID-19 pandemic, the gap between supply of providers and demand widened ((Hoffmann and Duffy, 2021). This gap has persisted during the post-COVID era and has led health care systems to contend with treating fewer individuals more frequently or more individuals less frequently. There is some evidence that clinical recovery may correlate negatively with caseload size (Bailey et al., 2021). In contrast, higher frequency of treatment is associated with more positive outcomes in real-world, mental health settings (Erekson et al., 2015; Tiemens et al., 2019). To extend upon these findings, there is a need for research on what frequency of mental health care should be consistently provided and its effectiveness in preventing STBs, especially for diverse youth served in community health settings (Fedewa et al., 2016). Within community health settings, services are often tasked with treating youth who differ widely in their diagnostic presentation. Such services may lack the resources to offer sub-specialty treatment tailored to each of the different diagnostic presentations that confer risk for STBs. Thus, to optimally direct scarce resources, it is important to determine the relative and overall effectiveness of consistently higher versus lower frequency outpatient mental health treatment in preventing STBs among youth.

In this study, we contribute to efforts to identify effective strategies to prevent STBs among adolescents and transitional age youth. We assess the association between consistently high versus consistently low frequency outpatient specialist mental health visits and STBs (ideation or attempt) in a racially, ethnically, and linguistically diverse sample of youth receiving psychotherapy and psychopharmacology in a community healthcare system. We used longitudinal targeted maximum likelihood estimation (LTMLE), a doubly robust statistical method not yet commonly used in psychiatry research, to better address variation in mental health severity and treatment received over time, which typically limit the impact of observational studies (Smith et al., 2023). Our study also assesses whether treatment received varies by race and ethnicity.

2. Methods

2.1. Patient sample

We used a retrospective cohort of 4888 adolescents and transitional age youth (12–25 years old) treated for a qualifying mental health condition between January 2010 and December 2020 at a public safety-net health system in eastern Massachusetts. Youth were eligible if any of several psychiatric International Classification of Disease 10 (ICD-10) diagnoses conferring increased suicide risk were identified in the electronic health record (EHR): depressive, bipolar, psychotic, substance use, post-traumatic stress, conduct, borderline personality, or antisocial personality disorders. Additionally, youth were required to have an initial mental health visit with at least one psychotropic medication prescribed during the same month, hereafter called the index month. We selected a relatively broad age range for several reasons: 1) to capture early onset occurrences of those disorders; 2) because suicidal behavior is a pressing public health concern for both groups, especially among minoritized racial and ethnic groups; 3) to capture a vulnerable developmental stage of transitioning through later school years to early independence; and 4) to obtain a sufficiently large sample to allow for analyses by race/ethnicity. We required youth to have at least one psychotropic prescription at the index month in order to reduce the impact of psychotropic medication as a confounding factor. Psychotropic medications included EHR orders from the following broad medication classes: antidepressants, anti-anxiety drugs, mood stabilizers including lithium and selected anticonvulsant drugs, antipsychotic drugs, stimulants, anticholinergics, hypnotics, and medications used for alcohol and opioid use disorders. To limit confounding by prior treatment, the final sample included youth with six months of no specialist mental health treatment or psychotropic medication in the EHR prior to the index month (washout).

The study period was a 13-month period consisting of the index month followed by a 12-month period for treatment frequency and outcome assessment. Treatment group, covariates, and outcome variables were summarized quarterly.

2.2. Data and variables

We analyzed EHR data that included demographics, clinical information, and healthcare utilization merged with publicly available area-level social risk data .

2.2.1. Clinical data

These data included medical and psychiatric diagnoses and, where recorded, scores from the Patient Health Questionnaire-9 (Richardson et al., 2010) and urine drug screen results. Healthcare utilization data included counts of primary care visits and emergency department visits (psychiatric and non-psychiatric), in addition to counts and classes of psychotropic medications prescribed. Mental health specialist visits were defined using CPT codes for outpatient visits with a prescribing clinician (psychiatrist or advanced practice registered nurse); or therapist (psychologist, clinical social worker, psychiatrist, or advanced practice registered nurse). Throughout, indicator variables were used to represent missing values.

2.2.2. Social risk variables

Variables were constructed with EHR data capturing health-related social needs and area-level data capturing social determinants of health, specifically:

2.2.2.1. Person-level variables. Sociodemographic variables included individual-level primary language, caregiver unemployment, violence victimization, substance use, foster care, housing insecurity, and history of physical or psychological abuse. These variables were self-reported by the patient or their family and assigned annually in the dataset.

2.2.2.2. Area-level variables. We merged youths' primary addresses with publicly available area-level information from the United States Census and PolicyMap, an aggregator of area-level datasets (PolicyMap, 2020; *Social Determinants of Health Database (Beta Version)*, n.d.). At the zip code level, we included the percentage of the population receiving food stamps, the percentage of owner-occupied housing, and the percentage of single-parent households. At the city level, we included the percentage of adults who reported binge or excessive drinking, robberies per 100k population, and rates of food insecurity. At the census block group level, we merged information on the percentage of non-Hispanic White residents; the percentage who utilize public transit for work; the percentage unemployed; crime rates; and the percentage experiencing poverty, racial segregation, housing instability, and food insecurity.

2.2.3. Race and ethnicity

Self-reported race and ethnicity was extracted annually from the EHR. Individuals could be in more than one race or ethnicity group. We included Portuguese speaking communities as an ethnicity because it represents a sizable portion of individuals seeking care at the hospital system studied.

2.2.4. Definition of dynamic treatment regimens

Our analysis compared the impact of high versus low frequency outpatient specialty mental health care from the index month to the ninth study month (baseline and quarters 1, 2, and 3) on outcomes in months 10–12 (fourth quarter). For the index month (month 0), high frequency was defined as 1 or more visits after the index visit. For each quarter (months 1–3, 4–6, and 7–9), youth with 4 or more visits were considered to have high frequency treatment, and youth with 3 or fewer were considered to have low frequency treatment. Overall, dynamic treatment regimens were defined as all the combinations of high and low frequency periods observed during the 10-month period encompassing the index month and the first 3 quarters of the study period, for a total of 16 possible dynamic treatment regimens. We defined the reference regimen as consistently low frequency visits (all four time periods with low frequency of mental health specialist visits). Our primary focus was a comparison between the consistently high frequency visit regimen (all four periods with high frequency) with the consistently low frequency visit regimen.

2.2.5. Outcome

The primary outcome is an indicator of suicidal thoughts and behaviors (STBs), defined as suicidal ideation or attempt in the fourth quarter (months 10–12) of the study period. STBs were identified using ICD-9/10 codes. We used codes that have been validated in prior research (Barak-Corren et al., 2017) and include injuries of self-intent (E95*), questionable intent (E98*), and without information on intent but reflecting injuries common in suicidal behavior: E850–8, 868.*, 874.*, 881.*, 903.2–4, 968, 970.*, 986.*, 95*, 965.*, 966.*, 967.*, 969.*, 994.7.20, U03, X60–84, Y87.50. ICD10 codes include X60–84; and codes within T360 × 2-T72323.

2.3. Statistical analysis

We summarized sample characteristics overall, among youth with STBs, among youth with an STB in the index month, and among youth with an STB in quarter 4. Among youth with any STB, we summarized the number of study periods with STB to understand the frequency of repeat STB events. We compared unadjusted rates of STBs in the fourth quarter between youth with consistently low frequency and consistently high frequency mental health specialist visits and reported the other 14 combinations of treatment frequency treatment over time.

2.3.1. Longitudinal targeted maximum likelihood estimation (LTMLE)

We compared all possible combinations of high and low frequency treatment for their impact on STB using LTMLE, a causal inference method that balances treatment groups at each time period (Lendle et al., 2017; Schomaker et al., 2019). Typically, in longitudinal healthcare studies, youth with greater severity of mental health difficulties, including suicidal behavior, might be expected to receive more treatment, a common threat to validity called confounding by indication (Brookhart et al., 2010). In this setting, strategies that address both fixed and time-varying confounding are required. Such methods, including LTMLE, that capitalize on machine learning can provide robust estimators. Machine learning is particularly attractive in large healthcare datasets with many fixed and time-varying confounders (Schomaker et al., 2019; Snowden et al., 2011). To date, these new, robust approaches have generally been confined to statistical and public health literature and a small number of clinical studies (Kreif et al., 2017; Levin-Rector et al., 2023; Moreno-Betancur et al., 2023; Poulos et al., 2022; Schomaker et al., 2019; Smith et al., 2023; Van Der Laan and Rose, 2018). The technical details, including censoring and handling of missing values of the LTMLE approach are detailed in Appendix 3; of note, *SuperLearner* was used to optimally combine balancing weights across an ensemble of machine learning methods, including *Random Forest, glm,* and *glmnet* (Lendle et al., 2017).

2.3.2. Variable selection

In the current study, we operationalized mental health severity through proxy variables that would be typically associated with greater levels of mental health difficulties, in addition to indicators of actual levels of mental health symptoms (e.g., PHQ-9 scores). Our initial dataset had 2290 variables to be considered for inclusion as mental health severity covariates. A psychiatrist (author A) and health services researcher (author B) reduced the list to 283 covariates indicating or acting as proxies for psychiatric severity, medical severity, and social determinants of health (Appendix 1). The selection criteria also removed those variables with low frequency and limited inclusion of highly correlated variables.

2.3.3. Model adequacy

After applying the LTMLE method, we assessed undue influence of outlier variables on the LTMLE model by examining the mean weights of each covariate within each of the 16 treatment group combinations. To assess the adequacy of the LTMLE balancing, for each baseline covariate, we calculated the standardized mean difference between the unbalanced consistently high and low frequency groups, repeating this for the differences between the balanced groups. This allowed us to create and compare standardized percent bias for each covariate between the unbalanced and balanced groups. We reported the median percent bias across all covariates for the unbalanced and balanced groups, setting an adequate balancing criteria as a median of the absolute values of less than 5 % (Tepper et al., 2017).

2.3.4. Influential covariates

The most influential balancing covariates at baseline were identified as those with the largest absolute difference in percent standardized bias between the unbalanced and LTMLE balanced groups.

2.3.5. STB estimates

For STB in the fourth quarter, we reported the resulting average treatment effect estimates for each regimen compared to the consistently low frequency treatment regimen, with standard errors estimated using the estimated influence curve (Lendle et al., 2017).

In secondary analysis, we compared treatment frequencies by race and ethnicity. We tested for statistically significant differences by race and ethnicity among youth with at least one high frequency treatment period using *t*-tests that compared members of a group to the rest of the study population (for example, Black vs. non-Black and White vs. non-White). We did not adjust for multiplicity of comparisons.

2.3.6. Statistical power

Our study was originally powered to anticipate a sample size of approximately 5590, which would provide 90 % power to detect a difference between two groups of at least 1.5 % on univariate analysis.

Dataset collation was undertaken in SAS (version 9.4, SAS Institute) and analyses completed in R Statistical Software (version 4.3.1; R Core Team 2023). For LTMLE, we used the 'ltmle' package in R (Lendle et al., 2017). We followed STROBE reporting guidelines (von Elm et al., 2007). This study was approved by the Institutional Review Board at the host institution.

3. Results

Our sample included 4888 youth who had a psychotropic medication fill and an initial mental health specialist outpatient visit following a 6-month washout of no mental health treatment or psychotropic medication fills. Sixty percent were female and 71 % ages 18–25 years at their initial mental health visit. Two thirds of youth were White, 11 % were Black, 4 % were Asian, 1.4 % were of "Other" race, 1.9 % were of unknown race, 12 % were from Portuguese-speaking communities, 9 % were Latinx. For close to 1/3 (29 %), English was not their primary language. Most were publicly insured (49 % had Medicaid and 4.3 % had

Medicare coverage), and 2.9 % were uninsured (Table 1).

There were 9.3 % of youth with STBs during the study period (n = 455, Table 1). The percentage of STBs was highest in the index month (5.1 %, N = 247) and decreased in each subsequent time period, with 1.1 % of youth having STB in the last time period of the study (quarter 4). Rates of STBs were no different overall for females and males (9.4 % and 9.2 % respectively). Thirteen percent of Latinx youth reported STBs during the study period, the highest of any racial and ethnic group, followed by Asian youth (11.8 %), with Black youth having the lowest (8.4 %). Youth whose primary language was not English were more likely to report STBs during the study period compared with English-speaking youth (11.3 % versus 8.5 %, p = 0.002, respectively, Table 1). Among youth with any STBs, 19 % had STBs in two or more periods (15 % in one period).

For the full treatment period, 43 % of youth (n = 1663) received consistently low frequency mental health visit regimen, and 7 % (n = 273) consistently high frequency. Over the same periods, 29 % (n = 1121) had high frequency for only 1 period, while 14 % (n = 538) and 8 % (n = 303) had high frequency treatment for 2 and 3 periods (Fig. 1).

After applying the LTMLE method, examination of the balancing properties (Appendix 2) suggested no truncated weights, which would be indicative of extreme and overly influential values. Moreover, concerns with balancing were not flagged by examining the mean weights within each treatment group and over time, with all values near to 1. Assessing the adequacy of the LTMLE balancing in more detail, we found the median (5th, 95th percentile) standardized percent bias for the baseline covariates was 8.8 % (2 %, 30 %) for the unbalanced groups and 4.2 % (0 %, 16 %) for the balanced groups, a median reduction in bias of 4.8 % (0.3 %, 15 %; $p < 0.001$), indicating adequate balancing. Fig. 2 illustrates these percent biases for the 22 covariates with the largest absolute difference between the standardized percent bias between the unbalanced and balanced groups. Fig. 3 shows how these covariates vary over time, illustrating the need for the LTMLE approach. These 22 covariates represent the most influential balancing variables from the index month in the comparison of the consistently high and consistently low frequency treatment groups. They include index-month service utilization, including attendance at a teen mental health clinic, inpatient stays, and not attending scheduled visits; specific diagnoses, including anxiety, schizophrenia, and PTSD; and receipt of medications, including anticonvulsants and antipsychotics (Fig. 2).

In unadjusted analyses, 4.4 % of youth who had received the consistently high frequency regimen during the prior 10-month period had STBs in the 4th quarter, compared with 1.2 % of youth in the consistently low frequency regimen, representing a 3.2 percentage point (95 % CI 0.5, 5.9; $p < 0.001$) *higher* risk of STB. After adjusting for time-dependent confounding, while STBs were 1.93 percentage points lower

Table 1
Demographic description of individuals with suicidality across study period by group.

	Youth in Study		Any STB		STB in Index Month		STB in Q4	
	N	(%)	N	(%)	N	(%)	N	(%)
Full Sample	4888	100.0 %	455	9.3 %	247	5.1 %	54	1.1 %
Age group								
12 to 17 years	1409	28.8 %	159	11.3 %	75	5.3 %	27	1.9 %
18 to 25 years	3479	71.2 %	296	8.5 %	172	4.9 %	27	0.8 %
Sex assigned at birth								
Female	2947	60.3 %	276	9.4 %	151	5.1 %	32	1.1 %
Male	1941	39.7 %	179	9.2 %	96	4.9 %	22	1.1 %
Race								
White	3299	67.5 %	310	9.4 %	160	4.8 %	38	1.2 %
Black	522	10.7 %	44	8.4 %	27	5.2 %	<11	<2.1 %
Asian	253	5.2 %	29	11.5 %	12	4.7 %	<11	<4.3 %
Other (Including AI/AN)	67	1.4 %	<11	<16.4 %	0	0.0 %	<11	<16.4 %
Unknown	94	1.9 %	<11	<11.7 %	<11	<11.7 %	<11	<11.7 %
Ethnicity								
Portuguese speaking communities	581	11.9 %	61	10.5 %	31	5.3 %	<11	<1.9 %
Latinx	456	9.3 %	58	12.7 %	37	8.1 %	<11	<2.4 %
Primary Language								
English	3484	71.3 %	296	8.5 %	165	4.7 %	41	1.2 %
Not English	1404	28.7 %	159	11.3 %	82	5.8 %	13	0.9 %
Primary Insurance								
Medicare	211	4.3 %	18	8.5 %	<11	<5.2 %	<11	<5.2 %
Medicaid	2389	48.9 %	226	9.5 %	117	4.9 %	25	1.0 %
Private	2147	43.9 %	191	8.9 %	107	5.0 %	24	1.1 %
None	141	2.9 %	20	14.2 %	13	9.2 %	<11	7.8 %
Index Month Service Utilization								
Any ED Visit	704	14.4 %	141	20.0 %	105	14.9 %	<11	<1.6 %j
Diagnoses								
Anxiety/Trauma[a]	2251	46.1 %	239	10.6 %	123	5.5 %	24	1.1 %
Disruptive Behavior[b]	807	16.5 %	50	6.2 %	25	3.1 %	<11	<1.4 %
Eating Disorders	93	1.9 %	18	19.4 %	<11	11.8 %	<11	<11.8 %
Mood Disorders[c]	4146	84.8 %	411	9.9 %	226	5.5 %	48	1.2 %
Personality Disorders[d]	266	5.4 %	23	8.6 %	13	4.9 %	<11	<4.1 %
Psychotic Disorders[e]	439	9.0 %	46	10.5 %	28	6.4 %	<11	<2.5 %
Substance Use[f]	743	15.2 %	104	14.0 %	59	7.9 %	<11	<1.5 %

Legend: AI/AN,American Indian/Alaska Native; ED, emergency department; STB, suicidal thoughts and behavior.
Note: Race and ethnicity groups are not mutually exclusive; one individual may be included in multiple groups.
Diagnoses categories.
[a] Includes anxiety and PTSD.
[b] Includes ADHD and conduct.
[c] Includes bipolar and depression.
[d] Includes antisocial and borderline personality.
[e] Includes schizophrenia and psychosis.
[f] Includes alcohol, drugs, and tobacco.

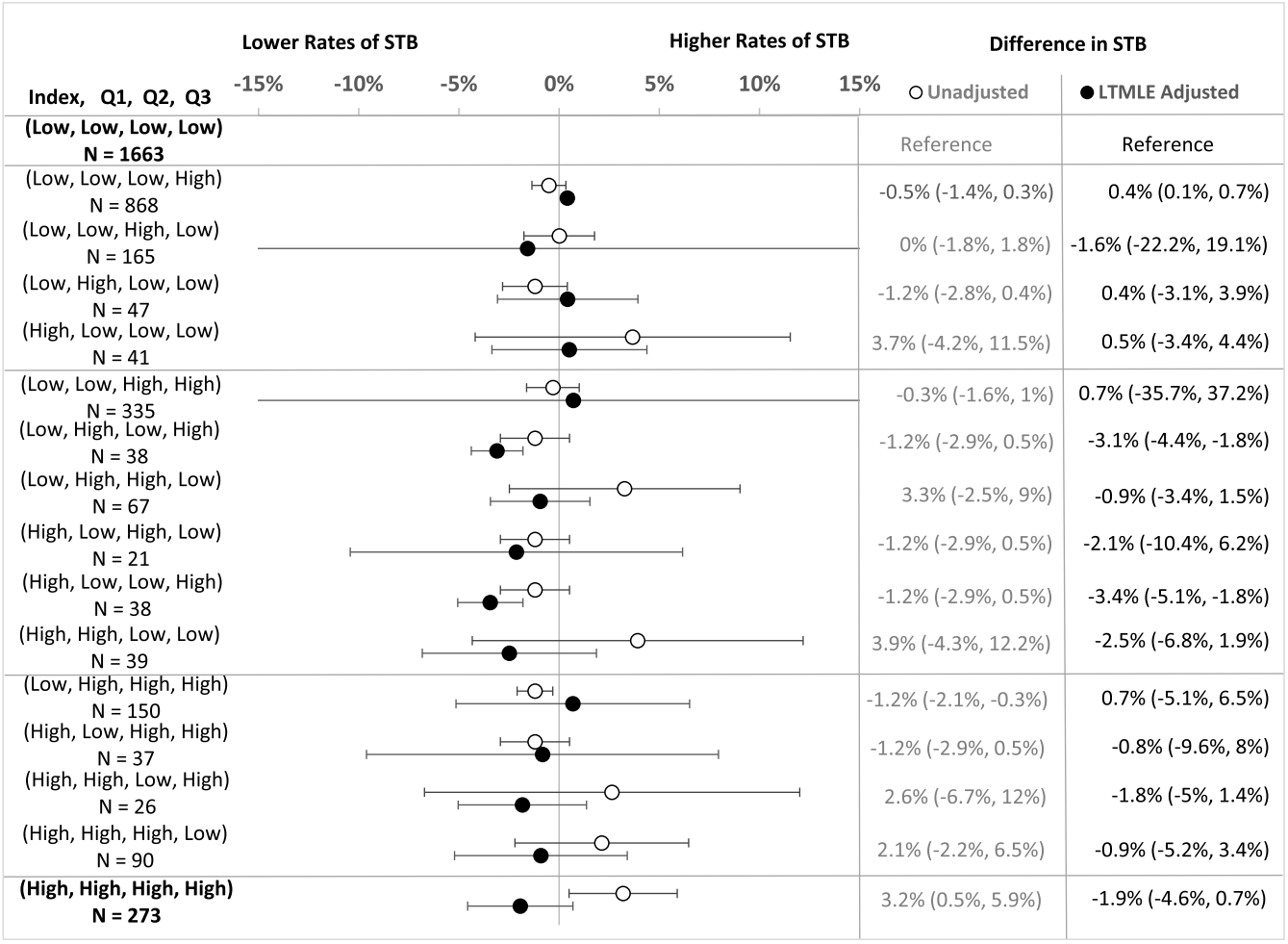

Fig. 1. Unadjusted and LTMLE balanced impact of regimen on suicidal thoughts and behaviors in quarter four.
Legend: The figure shows the unadjusted and LTMLE balanced impact of all 16 combinations of treatment frequency. Treatment frequency over the index month and quarters 1, 2 and 3 are labeled as "Low" L (low treatment frequency) or "High" (high treatment frequency). Thus, consistently low treatment frequency is labeled (Low, Low, Low, Low) and consistently high as (High, High, High, High). For the consistently low MH specialist visits frequency group, 20/1663 (1.20 %) of youth had STBs in the fourth quarter.

in the high frequency treatment group relative to the low frequency group (Fig. 1), the difference was not significant (95 % CI −4.56, 0.7; $p = 0.150$).

Some variation in treatment regimen by race and ethnicity was observed (Fig. 4), namely, Asian youth (63.6 %) were more likely than non-Asian youth (55.2 %) to have any high frequency treatment periods (Diff=8.4 %; p5 % CI 1.4 %, 8.4 %; $p = 0.028$). No other differences were observed among youth with any high frequency treatment periods.

4. Discussion

In this retrospective analysis of electronic health record data merged with area-level social risk data, we assessed the association between consistently high versus consistently low frequency outpatient visits with a mental health specialist and suicidal thoughts and behaviors (STBs) among adolescents and transitional age youth in a community health setting. We found that consistently high frequency visits over 10 months was associated with a 1.93 percentage point reduction in STBs in the last 3 months of the study, but this difference did not reach statistical significance (95 % CI −4.56, 0.7). Findings suggest that historically marginalized racial and ethnic groups were as likely as White patients to receive consistently high frequency treatment.

To identify the most effective treatments for suicide prevention retrospectively requires following individuals longitudinally. Datasets should contain sufficient information about illness, treatment, and the social context over time to adequately estimate mental health severity (Fig. 3). This study demonstrates how such factors vary over time, while providing an example of how LTMLE can be used to meaningfully study dynamic treatment regimens in retrospective observational data. Confounding by indication and mental health severity (i.e., higher risk patients receive more treatment) will obscure the true impact of higher frequency treatment on outcomes. In this study, the most influential covariates were indicators of psychiatric severity, such as inpatient care, diagnosis of schizophrenia or PTSD, use of antipsychotics or anticonvulsants, and missed visits. Observational data from community health systems are arguably more representative of all youth than many clinical trials and reflect the intricacies and limitations of real-world treatment.

While our study did not find statistically significant evidence to suggest that youth at risk for STBs with consistently high mental health treatment visits (i.e. >3 visits per quarter) will have fewer suicide-related events than youth with consistently low frequency, the point estimate of a 1.93 % reduction in the consistently higher group is clinically significant. This suggests research with larger samples might provide a firmer answer. Although higher frequency treatment may offer the reassurance of continued protective supportive monitoring, public mental health settings continue to struggle to meet a large need for mental healthcare. With limited resources, they can benefit from research such as this that measures the impact of reducing treatment

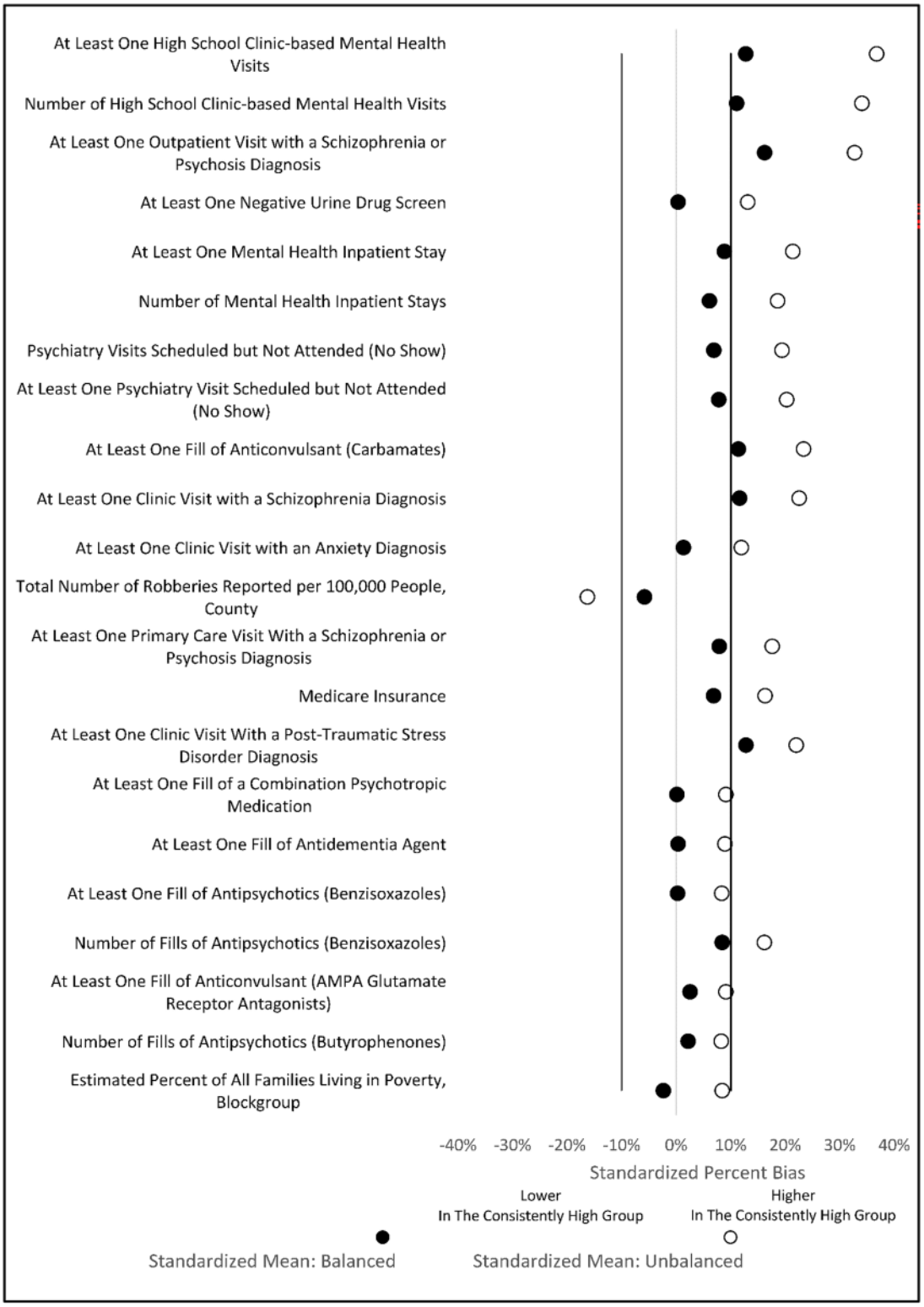

Fig. 2. Summary of the most influential balancing variables at baseline.
Legend: The figure shows the standardized percent bias for the most influential 20 covariates. The influence of each variable is visualized as the difference between the balanced and unbalanced standardized mean in the consistently high and consistently low MH specialist visits frequency groups.

frequency as a means to increase access. If a causal association between higher frequency of visits and STBs were established, as is suggested by prior literature, the field would build on an effective strategy to bend the current rising curve of STBs in youth (Erekson et al., 2015; Tiemens et al., 2019). Such a finding could provide valuable evidence for safety net systems providing mental healthcare to target higher frequency treatment more efficiently, while providing lower frequency treatment safely to lower risk patients. Further research could identify what aspects of higher frequency visits are most beneficial for suicide prevention (e.g., psychotherapy versus medication visits versus non-specific

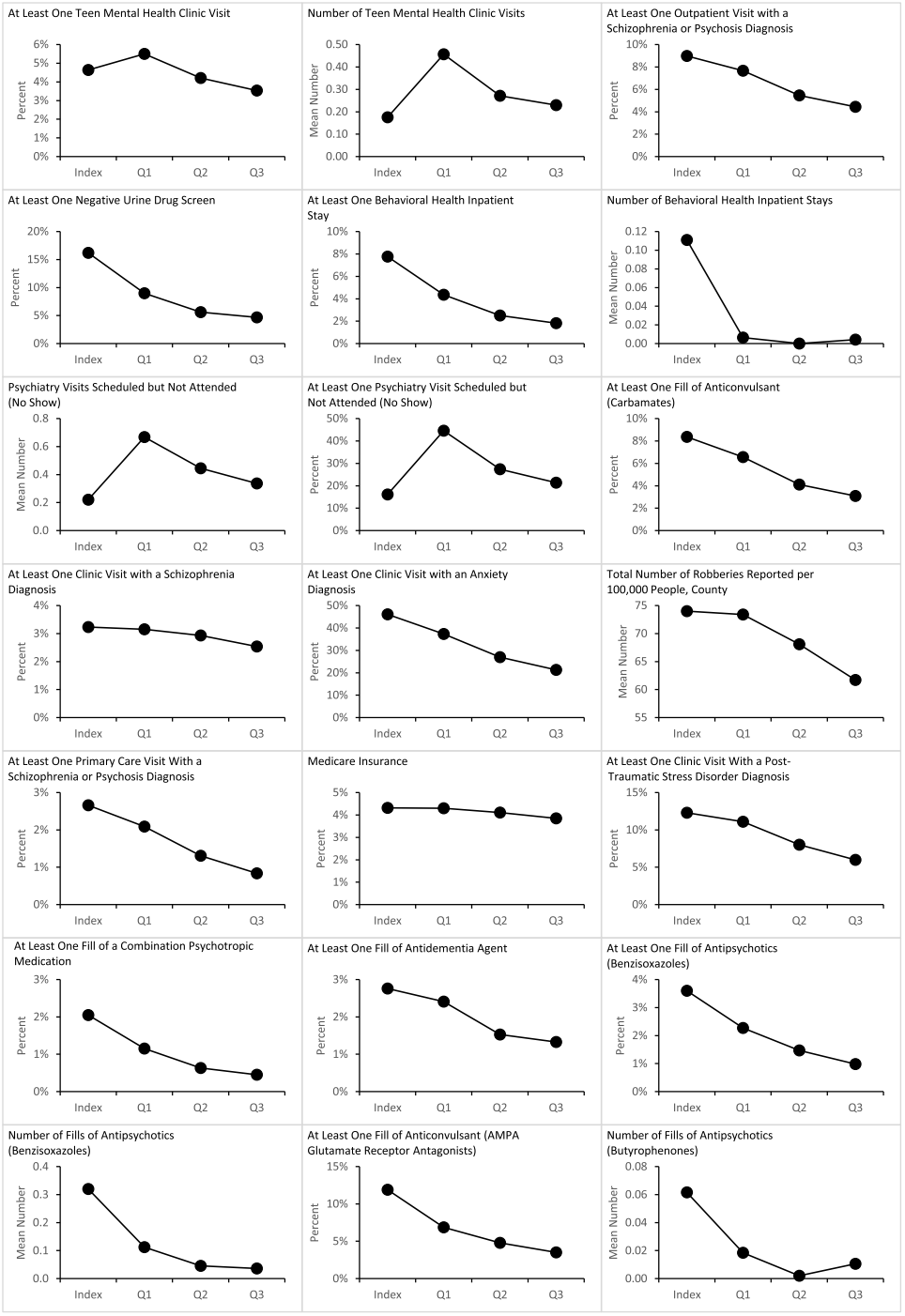

Fig. 3. Summary of the most influential covariates over time.

inter-visit contact by specialists or non-clinical healthcare staff providing outreach). One example is the period immediately following psychiatric discharge, which is characterized by a very high rate of suicide death relative to non-hospitalized individuals. Although hospital systems are expected to provide mental health follow-up within seven calendar days of discharge, recent research has hypothesized that outpatient follow-up within 48 to 72 h could further reduce suicide deaths among certain groups (e.g. individuals with personality disorders or premature discharge) (Bojanić et al., 2020; Chung et al., 2019).

Our study has several limitations. To begin, the sample design may have limited our ability to identify the expected positive effect of higher frequency treatment that has been established in prior studies using other outcomes (Erekson et al., 2015; Tiemens et al., 2019). The sample size (4888) was lower than anticipated by our a priori power calculation (5590); therefore, the study may have been insufficiently powered to identify a difference between the consistently high and low treatment regimens. Patients in the sample could have received treatment outside of the study health system, including during the washout period, and this treatment would not be reflected in the study dataset. In addition, the sample was heterogeneous in mental health diagnoses, medication use, and other clinical factors that may influence response to treatment, which may have further decreased statistical power (Jiang et al., 2010). Since many communities mental health programs do not have sub-specialty clinics for specific disorders, grouping higher risk

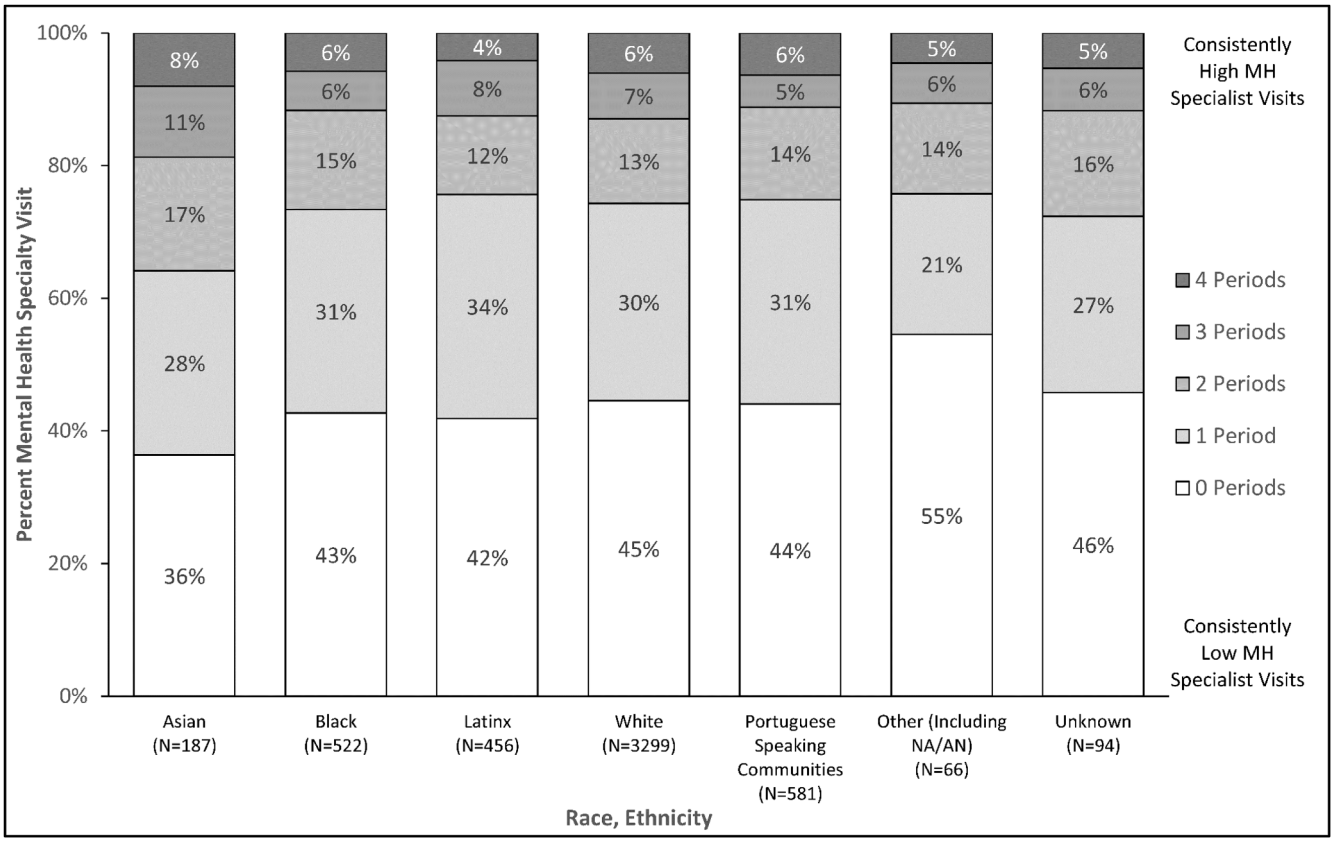

Fig. 4. Distribution of mental health specialty visit frequency over the study period by race and ethnicity.
Legend: The figure shows the percentage of youth for each race or ethnicity group by the number of study periods with low or high treatment frequency. Consistently low MH specialist visits frequency group is labeled "0 Periods" and consistently high "4 Periods".

disorders into one risk category may be justified because the therapy and providers may be similar across disorders. Future research with larger samples could stratify treatment groups by diagnosis or exposure to inpatient treatment.

Our sample includes data from 2020, which introduced extraordinary health challenges for vulnerable populations who were hardest hit by the early COVID pandemic. The downstream impact on health service use could manifest in several ways. The forced transition to virtual care in March 2020 likely resulted in a decrease in referrals to mental health care (due to a decrease in primary care treatment), a change in mental health treatment (virtual care may have facilitated access once technological barriers were addressed), and a decrease in emergency department visits, which likely resulted in an undercount of suicide outcomes (Velázquez et al., 2020). However, the social determinants related to health inequities are arguably captured well in the study dataset, which linked electronic health records to a variety of geocoded social determinants datasets that described the social context of patients in the study.

With respect to the statistical analysis, despite the large number of covariates we included, there may still be unmeasured confounders, including other measures of symptom severity, treatment quality, and family ability to support treatment. This is common with most models based on observational data. Additionally, experiences of discrimination or mental health stigma could be confounding. It is possible that youth who were asked about STB more frequently were also more likely to report them, even with similar STB frequency. This may lead us to underestimate the benefit of more frequent treatment. Furthermore, the rate of STBs may have been underestimated by using ICD-9/10 codes as proxies. The limitations of this practice have been identified in prior studies of both ICD9 and 10, which further suggest that patients with more severe so-called Axis 1 and 2 diagnoses may have lower rates of ICD codes for STBs (Simon et al., 2022; Stanley et al., 2018). For example, suicidal ideation and self-injurious behaviors are part of the diagnostic criteria for major depressive disorder and borderline personality disorder respectively, suggesting that STBs in patients with more severe mental health difficulties could have been missed using the current strategy. Finally, we are not able to observe suicide deaths reliably in the study data, although death by suicide remains a relatively rare event (an estimated 100 youth ages 12–24 across the state of Massachusetts died by suicide from 2018 to 2020; Centers for Disease Control and Prevention, 2020). In terms of external validity, restricting to youth with a medication in the index month of treatment may limit generalizability, and whether or not someone is prescribed medication in an index month may vary by demographics, insurance, and clinical characteristics.

Community-based safety net health systems play a key role in enabling access to mental health care for vulnerable adolescents and young adults, particularly those at high risk for STBs. Given resource constraints, it is critical to understand which dynamic treatment regimens are most effective for preventing STBs in these settings. Balancing on confounders at multiple time periods, we were unable to determine a significant difference between higher frequency mental health specialist visits and lower frequency treatment in rates of STBs following ten months of care. Future research with larger samples, including prospective studies such as adaptive clinical trials, may implement the approach in this study to establish the effectiveness of other treatments in preventing STBs and how treatments can be implemented. Future research could also compare the effectiveness of different treatment sequences, such as starting with psychotherapy and adding medication or introducing a different modality of psychotherapy.

CRediT authorship contribution statement

Gareth J. Parry: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Lindsay Overhage:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Peyton Williams:** Writing – review & editing, Project administration. **Katie Holmes:** Writing – review & editing, Project administration. **Akhil Reddy:** Writing – review & editing, Project administration. **Gabriel E. Rios Perez:** Writing – review & editing, Formal analysis. **Albert Y.H. Lo:** Writing – review & editing, Investigation. **Abigail Thomas:** Writing – review & editing, Formal analysis. **Brian Mullin:** Writing – review & editing, Methodology, Investigation, Data curation. **Sanam Bhakta:** Writing – review & editing. **Sharon-Lise Normand:** Writing – review & editing, Methodology, Conceptualization. **Marcela Horvitz-Lennon:** Writing – review & editing, Investigation, Conceptualization. **Phil Wang:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization. **Matthew K. Nock:** Writing – review & editing, Investigation. **Benjamin Lê Cook:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Nicholas J. Carson:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

<one anonymized author> has provided paid statistical consultancy for the University of California, Los Angeles. ⟨one anonymized author⟩ has received funding from NIA T32AG51108 and the National Institute of Mental Health (Grant No. P50 MH126283, T32 MH019733) since the beginning of this work. In the past 36 months, ⟨one anonymized author⟩ has received funding from the Manton foundation.

Acknowledgments

Supported by NIMH P50MH126283 (all authors), T32 MH019733 (LO), and NIA T32AG51108 (LO). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Mental Health (NIMH), National Institute of Aging (NIA), or the National Institutes of Health (NIH).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2024.116270.

References

Arisoyin, A.E., Adeyemi, A.H., Okobi, O.E., Alaga, A.H., Adekunle, O.J., Ajayi, O.O., Aladeniyi, F., Oni, E.O., Okobi, E., Okeaya-Inneh, M., Young, C.-L., 2023. Analyzing trends in suicide attempts among the pediatric population in the united states: a study using CDC's youth risk behavior surveillance system (YRBSS) database. Cureus 15 (8), e44099. https://doi.org/10.7759/cureus.44099.

Bailey, R.J., Erekson, D.M., Goates-Jones, M., Andes, R.M., Snell, A.N., 2021. Busy therapists: examining caseload as a potential factor in outcome. Psychol Serv 18 (4), 574–583. https://doi.org/10.1037/ser0000462.

Bakker, M.j., Greven, C.u., Buitelaar, J.k., Glennon, J.c., 2017. Practitioner Review: psychological treatments for children and adolescents with conduct disorder problems – a systematic review and meta-analysis. Journal of Child Psychology and Psychiatry 58 (1), 4–18. https://doi.org/10.1111/jcpp.12590.

Barak-Corren, Y., Castro, V.M., Javitt, S., Hoffnagle, A.G., Dai, Y., Perlis, R.H., Nock, M. K., Smoller, J.W., Reis, B.Y., 2017. Predicting Suicidal Behavior From Longitudinal Electronic Health Records. American Journal of Psychiatry 174 (2), 154–162. https://doi.org/10.1176/appi.ajp.2016.16010077.

Bojanić, L., Hunt, I.M., Baird, A., Kapur, N., Appleby, L., Turnbull, P., 2020. Early post-discharge suicide in mental health patients: findings From a National Clinical Survey. Front Psychiatry 11, 502. https://doi.org/10.3389/fpsyt.2020.00502.

Brent, D., Greenhill, L., Compton, S., Emslie, G., Wells, K., Walkup, J., Vitiello, B., Bukstein, O., Stanley, B., Posner, K., Kennard, B., Cwik, M., Wagner, A., Coffey, B., March, J., Riddle, M., Goldstein, T., Curry, J., Barnett, S., Turner, J.B., 2009. The Treatment of Adolescent Suicide Attempters (TASA) Study: predictors of Suicidal Events in an Open Treatment Trial. J Am Acad Child Adolesc Psychiatry 48 (10), 987–996. https://doi.org/10.1097/CHI.0b013e3181b5dbe4.

Bridge, J.A., Ruch, D.A., Sheftall, A.H., Hahm, H.C., O'Keefe, V.M., Fontanella, C.A., Brock, G., Campo, J.V., Horowitz, L.M., 2023. Youth Suicide During the First Year of the COVID-19 Pandemic. Pediatrics 151 (3), e2022058375. https://doi.org/10.1542/peds.2022-058375.

Brookhart, M.A., Stürmer, T., Glynn, R.J., Rassen, J., Schneeweiss, S., 2010. Confounding control in healthcare database research: challenges and potential approaches. Med Care 48 (6 Suppl), S114–S120. https://doi.org/10.1097/MLR.0b013e3181dbebe3.

Centers for Disease Control and Prevention. (2020, July 1). *National Center for Injury Prevention and Control*. https://www.cdc.gov/injury/wisqars/index.html.

Chung, D., Hadzi-Pavlovic, D., Wang, M., Swaraj, S., Olfson, M., Large, M., 2019. Meta-analysis of suicide rates in the first week and the first month after psychiatric hospitalisation. BMJ Open 9 (3), e023883. https://doi.org/10.1136/bmjopen-2018-023883.

Congressional Black Caucus. (2020). *Ring the Alarm: the Crisis of Black Youth Suicide in America*. https://watsoncoleman.house.gov/uploadedfiles/full_taskforce_report.pdf.

Cristea, I.A., Gentili, C., Cotet, C.D., Palomba, D., Barbui, C., Cuijpers, P., 2017. Efficacy of Psychotherapies for Borderline Personality Disorder: a Systematic Review and Meta-analysis. JAMA Psychiatry 74 (4), 319–328. https://doi.org/10.1001/jamapsychiatry.2016.4287.

Czeisler, M.É., Lane, R.I., Petrosky, E., Wiley, J.F., Christensen, A., Njai, R., Weaver, M. D., Robbins, R., Facer-Childs, E.R., Barger, L.K., Czeisler, C.A., Howard, M.E., Rajaratnam, S.M.W., 2020. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic—United States, June 24–30, 2020. MMWR Morb. Mortal. Wkly. Rep. 69 (32), 1049–1057. https://doi.org/10.15585/mmwr.mm6932a1.

Erekson, D.M., Lambert, M.J., Eggett, D.L., 2015. The relationship between session frequency and psychotherapy outcome in a naturalistic setting. J Consult Clin Psychol 83 (6), 1097–1107. https://doi.org/10.1037/a0039774.

Fadus, M.C., Squeglia, L.M., Valadez, E.A., Tomko, R.L., Bryant, B.E., Gray, K.M., 2019. Adolescent substance use disorder treatment: an update on evidence-based strategies. Curr Psychiatry Rep 21 (10), 96. https://doi.org/10.1007/s11920-019-1086-0.

Fedewa, A.L., Ahn, S., Reese, R.J., Suarez, M.M., Macquoid, A., Davis, M.C., Prout, H.T., 2016. Does psychotherapy work with school-aged youth? A meta-analytic examination of moderator variables that influence therapeutic outcomes. J Sch Psychol 56, 59–87. https://doi.org/10.1016/j.jsp.2016.03.001.

Franklin, J.C., Ribeiro, J.D., Fox, K.R., Bentley, K.H., Kleiman, E.M., Huang, X., Musacchio, K.M., Jaroszewski, A.C., Chang, B.P., Nock, M.K., 2017. Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. Psychol Bull 143 (2), 187–232. https://doi.org/10.1037/bul0000084.

Gaylor, E.M., 2023. Suicidal thoughts and behaviors among high school students—youth risk behavior survey, United States, 2021. MMWR Supplements 72, 45–54. https://doi.org/10.15585/mmwr.su7201a6.

Geller, B., Luby, J.L., Joshi, P., Wagner, K.D., Emslie, G., Walkup, J.T., Axelson, D.A., Bolhofner, K., Robb, A., Wolf, D.V., Riddle, M.A., Birmaher, B., Nusrat, N., Ryan, N. D., Vitiello, B., Tillman, R., Lavori, P., 2012. A randomized controlled trial of risperidone, lithium, or divalproex sodium for initial treatment of bipolar I disorder, manic or mixed phase, in children and adolescents. Arch. Gen. Psychiatry 69 (5), 515–528. https://doi.org/10.1001/archgenpsychiatry.2011.1508.

Institute of Medicine (US) Committee on Pathophysiology and Prevention of Adolescent and Adult Suicide, Goldsmith, S.K., Pellmar, T.C., Kleinman, A.M., Bunney, W.E., 2002. Psychiatric and Psychological Factors. Reducing Suicide: A National Imperative. National Academies Press, US. https://www.ncbi.nlm.nih.gov/books/NBK220933/.

Hoffmann, J.A., Duffy, S.J., 2021. Supporting youth mental health during the COVID-19 pandemic. Academic Emergency Medicine 28 (12), 1485–1487. https://doi.org/10.1111/acem.14398.

Jiang, D., Pepler, D., Yao, H., 2010. The effect of population heterogeneity on statistical power in the design and evaluation of interventions. Int J Behav Dev 34 (5), 473–480. https://doi.org/10.1177/0165025410375912.

Joe, S., Scott, M.L., Banks, A., 2018. What Works for Adolescent Black Males at Risk of Suicide: a Review. Res Soc Work Pract 28 (3), 3. https://doi.org/10.1177/1049731517702745. Article.

Jones, S.E., Ethier, K.A., Hertz, M., DeGue, S., Le, V.D., Thornton, J., Lim, C., Dittus, P.J., Geda, S., 2022. Mental Health, Suicidality, and Connectedness Among High School Students During the COVID-19 Pandemic—Adolescent Behaviors and Experiences Survey, United States, January–June 2021. MMWR Supplements 71 (3), 16–21. https://doi.org/10.15585/mmwr.su7103a3.

Kreif, N., Tran, L., Grieve, R., De Stavola, B., Tasker, R.C., Petersen, M., 2017. Estimating the Comparative Effectiveness of Feeding Interventions in the Pediatric Intensive Care Unit: a Demonstration of Longitudinal Targeted Maximum Likelihood Estimation. Am. J. Epidemiol. 186 (12), 1370–1379. https://doi.org/10.1093/aje/kwx213.

Lendle, S.D., Schwab, J., Petersen, M.L., Van Der Laan, M.J., 2017. **ltmle**: an *R* Package Implementing Targeted Minimum Loss-Based Estimation for Longitudinal Data. J Stat Softw 81 (1). https://doi.org/10.18637/jss.v081.i01.

Levin-Rector, A., Firestein, L., McGibbon, E., Sell, J., Lim, S., Lee, E.H., Weiss, D., Geevarughese, A., Zucker, J.R., Greene, S.K., 2023. Reduced Odds of Severe Acute Respiratory Syndrome Coronavirus 2 Reinfection After Vaccination Among New York City Adults, July 2021–November 2021. Clinical Infectious Diseases 76 (3), e469–e476. https://doi.org/10.1093/cid/ciac380.

March, J., Silva, S., Petrycki, S., Curry, J., Wells, K., Fairbank, J., Burns, B., Domino, M., McNulty, S., Vitiello, B., Severe, J., Treatment for Adolescents With Depression Study (TADS) Team, 2004. Fluoxetine, cognitive-behavioral therapy, and their combination for adolescents with depression: treatment for Adolescents With

Depression Study (TADS) randomized controlled trial. JAMA 292 (7), 807–820. https://doi.org/10.1001/jama.292.7.807.
Masi, G., Carucci, S., Muratori, P., Balia, C., Sesso, G., Milone, A., 2023. Contemporary diagnosis and treatment of conduct disorder in youth. Expert Rev Neurother 23 (12), 1277–1296. https://doi.org/10.1080/14737175.2023.2271169.
Mojtabai, R., Olfson, M., 2020. National Trends in Mental Health Care for US Adolescents. JAMA Psychiatry 77 (7), 703–714. https://doi.org/10.1001/jamapsychiatry.2020.0279.
Moreno-Betancur, M., Lynch, J.W., Pilkington, R.M., Schuch, H.S., Gialamas, A., Sawyer, M.G., Chittleborough, C.R., Schurer, S., Gurrin, L.C., 2023. Emulating a target trial of intensive nurse home visiting in the policy-relevant population using linked administrative data. Int J Epidemiol 52 (1), 119–131. https://doi.org/10.1093/ije/dyac092.
National Institute of Mental Health. (2023). Strategic Framework for Addressing Youth Mental HealthDisparities. U.S. Department of Health and Human Services, National Institutes of Health. Retrieved November 19, 2024, from https://www.nimh.nih.gov/sites/default/files/documents/health/publications/nimh-strategic-framework-for-addressing-youth-mental-health/Youth-MH-Disparities-Framework_0.pdf.
Overhage, L., Hailu, R., Busch, A.B., Mehrotra, A., Michelson, K.A., Huskamp, H.A., 2023. Trends in Acute Care Use for Mental Health Conditions Among Youth During the COVID-19 Pandemic. JAMA Psychiatry. https://doi.org/10.1001/jamapsychiatry.2023.2195.
PolicyMap. (2020). *PolicyMap*. https://www.google.com/url?q=https://www.policymap.com/&sa=D&source=docs&ust=1692811698507302&usg=AOvVaw2ZpY5IKE4sbdztFrVa7DcR.
Poulos, J., Horvitz-Lennon, M., Zelevinsky, K., Cristea-Platon, T., Huijskens, T., Tyagi, P., Yan, J., Diaz, J., & Normand, S.-L. (2022). *Targeted learning in observational studies with multi-valued treatments: an evaluation of antipsychotic drug treatment safety*. doi:10.48550/ARXIV.2206.15367.
Richardson, L.P., McCauley, E., Grossman, D.C., McCarty, C.A., Richards, J., Russo, J.E., Rockhill, C., Katon, W., 2010. Evaluation of the patient health questionnaire-9 item for detecting major depression among adolescents. Pediatrics 126 (6), 1117–1123. https://doi.org/10.1542/peds.2010-0852.
Riley, T., O'Reilly, L., Adams, S., 2021. Addressing suicide among black youths: a call to action within and outside clinical practice. JAMA Pediatr. https://doi.org/10.1001/jamapediatrics.2021.1693.
Schomaker, M., Luque-Fernandez, M.A., Leroy, V., Davies, M.-A., 2019. Using Longitudinal Targeted Maximum Likelihood Estimation in Complex Settings with Dynamic Interventions. Stat Med 38 (24), 4888–4911. https://doi.org/10.1002/sim.8340.
Simon, G.E., Shortreed, S.M., Boggs, J.M., Clarke, G.N., Rossom, R.C., Richards, J.E., Beck, A., Ahmedani, B.K., Coleman, K.J., Bhakta, B., Stewart, C.C., Sterling, S., Schoenbaum, M., Coley, R.Y., Stone, M., Mosholder, A.D., Yaseen, Z.S., 2022. Accuracy of ICD-10-CM encounter diagnoses from health records for identifying self-harm events. Journal of the American Medical Informatics Association 29 (12), 2023–2031. https://doi.org/10.1093/jamia/ocac144.
Smith, M.J., Phillips, R.V., Luque-Fernandez, M.A., Maringe, C., 2023. Application of targeted maximum likelihood estimation in public health and epidemiological studies: a systematic review. Ann Epidemiol 86, 34–48. https://doi.org/10.1016/j.annepidem.2023.06.004 e28.
Snowden, J.M., Rose, S., Mortimer, K.M., 2011. Implementation of G-Computation on a Simulated Data Set: demonstration of a Causal Inference Technique. Am. J. Epidemiol. 173 (7), 731–738. https://doi.org/10.1093/aje/kwq472.
Social Determinants of Health Database (Beta Version). Retrieved November 2, 2023, from https://www.ahrq.gov/sdoh/data-analytics/sdoh-data.html.
Stanley, B., Currier, G.W., Chesin, M., Chaudhury, S., Jager-Hyman, S., Gafalvy, H., Brown, G.K., 2018. Suicidal Behavior and Non-Suicidal Self-Injury in Emergency Departments Underestimated by Administrative Claims Data. Crisis 39 (5), 318–325. https://doi.org/10.1027/0227-5910/a000499.
Tepper, M.C., Cohen, A.M., Progovac, A.M., Ault-Brutus, A., Leff, H.S., Mullin, B., Cunningham, C.M., Cook, B.L., 2017. Mind the Gap: developing an Integrated Behavioral Health Home to Address Health Disparities in Serious Mental Illness. Psychiatr Serv 68 (12), 1217–1224. https://doi.org/10.1176/appi.ps.201700063.
Tiemens, B., Kloos, M., Spijker, J., Ingenhoven, T., Kampman, M., Hendriks, G.-J., 2019. Lower versus higher frequency of sessions in starting outpatient mental health care and the risk of a chronic course; a naturalistic cohort study. BMC Psychiatry 19 (1), 228. https://doi.org/10.1186/s12888-019-2214-4.
Van Der Laan, M.J., Rose, S., 2018. Targeted Learning in Data Science: Causal Inference For Complex Longitudinal Studies. Springer International Publishing. https://doi.org/10.1007/978-3-319-65304-4.
Velázquez, P.P., Gupta, G., Gupte, G., Carson, N.J., Venter, J., 2020. Rapid Implementation of Telepsychiatry in a Safety-Net Health System During Covid-19 Using Lean. NEJM Catalyst.
von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C., Vandenbroucke, J.P., 2007. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ : British Medical Journal 335 (7624), 806–808. https://doi.org/10.1136/bmj.39335.541782.AD.
Xiao, Y., Junus, A., Li, T., Yip, P., 2023. Temporal and spatial trends in suicide-related visits before and during the COVID-19 pandemic in the US, 2018–2021. J Affect Disord 324, 24–35. https://doi.org/10.1016/j.jad.2022.12.062.