Factors Supporting Substance Use Improvement for Black Americans: A Population Health Observational Study

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Abstract

Background: Black clients in substance use disorder (SUD) treatment are associated with the lowest successful completion and substance use reductions. More work is needed to identify specific factors that support successful recovery of Black clients.

Methods: Data from U.S. outpatient SUD treatment facilities receiving public funding from 2015-2019 were analyzed (N = 2,239,197). Primary analyses consisted of Black clients (n = 277,726) reporting admission and discharge substance use frequency. Multiple logistic regression was used to predict substance use frequency improvement from Black client demographic, recovery capital, treatment characteristics, and state. Disparities were compared between Black and non-Black clients.

Results: The overall Black client improvement percentage was 46.95%. Mutual-help group attendance and Length of Stay demonstrated clinically meaningful effect sizes controlling for all other variables and state. Attending mutual-help groups 8-30 times per month (State aOR = 2.54, 95% CI = 2.43, 2.64) and outpatient treatment stays of 4 months or more (State aOR = 2.50, 95% CI = 2.44, 2.56) were factors supporting Black client improvement. Importantly, states are associated with disparate Black client risk differences and only South Dakota had greater Black improvement (RD = 6.35, 95% CI = 1.00, 11.71).

Conclusions: Black client factors supporting substance use improvement include ancillary mutual-help group attendance and increased treatment retention. These factors may be more critical in states with larger Black improvement disparities. In general, treatment providers increasing access to mutual-help groups, and adjusting program inclusiveness and motivational factors for retention, would make strides in increasing improvement outcomes for Black clients.

Keywords: treatment outcomes; racial disparity; mutual-help; 12-step; treatment retention

1. Introduction

Multiple and overlapping racial disparities in substance use disorder (SUD) treatment outcomes have been identified across the U.S. national treatment system (Sahker et al., 2020). Acknowledging and addressing such disparities is needed to promote equitable treatment for all. The Institute of Medicine (IOM) defines racial/ethnic disparities as variations in care quality due to attributes other than individual preference, clinical need, or intervention appropriateness (Nelson, 2002). Racial health disparities are driven by structural racism, and are attributable to racialized healthcare systems, discriminatory legal and regulatory actions, interpersonal discrimination, and socioeconomic status (SES) (Lê Cook et al., 2009). Disparities in SUD treatment outcomes are largest among Black clients in the U.S. (Substance Abuse and Mental Health Services Administration, 2021). Compared to other groups, Black clients are less likely seek treatment, more likely to experience barriers to treatment, less likely to successfully complete treatment, and less likely to report reduced substance use at discharge (Cummings et al., 2014; Grant et al., 2015; Sahker et al., 2020; Stahler et al., 2016). Despite this, Black clients tend to stay in treatment longer (Mennis et al., 2019). Treatment characteristics associated with poorer outcomes for Black clients have been specifically identified in treatment length, setting, referral source, and primary problem substance (Mennis et al., 2019; Sahker et al., 2015; Stahler et al., 2016). These treatment characteristics are also complicated by U.S. state administrative differences, with some states performing better than others among Black client completion (Arndt et al., 2013).

For Black Americans, structural racism associated with health disparities is explained by legal structures (Farahmand et al., 2020), but also altered social capital from segregation of social networks and intergenerational transfer of health liabilities (Gee & Ford, 2011; Shim,

2021). These social structures can limit attendance or acceptance of SUD treatment as a positive force. However, treatment outcomes can be improved through accessing clients' culturally aligned social assets (Bellamy et al., 2021; Jordan et al., 2021). By focusing on clients' biopsychosocial assets, beneficial characteristics for SUD treatment can be identified. These beneficial characteristics can be conceptualized as recovery capital (Granfield & Cloud, 2001; Hennessy, 2017).

Recovery capital consists of client strengths associated with recovery (Best et al., 2015; Granfield & Cloud, 2001; Kelly, 2017; Laudet, 2012). These resources positively contribute to client health and quality of life (Jetten et al., 2010). Recovery capital consists of 10 factors of (1) substance use and sobriety, (2) global psychological health, (3) global physical health, (4) citizenship and community involvement, (5) social support, (6) meaningful activities, (7) housing and safety, (8) risk-taking, (9) coping and life functioning, and (10) recovery experience (Groshkova et al., 2013). Aspects of recovery capital associated with substance use reduction are identified as higher SES, education, employment, and mutual-help group attendance (Cummings et al., 2014; Kelly et al., 2020; Sahker et al., 2019; Saloner & Lê Cook, 2013).

Black clients demonstrate the poorest post-treatment substance use reduction (hereinafter referred to as improvement) compared to White and Latino clients, which is meaningfully moderated by age, employment, problem substance, and referral source (Sahker et al., 2020). However, more clinical utility may be garnered through discovering factors that support Black client improvement. Additionally, identifying improvement variations across states would contribute to identifying model treatment settings and areas in need of improvement. Thus, the present study sought to answer the following questions in an exploratory approach. What client, treatment, and recovery capital factors collected by state reporting agencies support Black client

improvement at SUD treatment conclusion? Is there an association between state and Black

client improvement? The present study explored available factors associated with post-treatment

improvement and state-level differences in client-level characteristics.

2. Methods

2.1. Data sources

The Substance Abuse and Mental Health Services Administration (SAMHSA) collects all

SUD treatment data from facilities that receive public funding. These data are made available as

the Treatment Episode Datasets – Discharge (TEDS-D) (Substance Abuse and Mental Health

Services Administration, 2021). The present study used data for the years 2015-2019 (n =

5,784,506). Following existing studies (Stahler et al., 2016), only outpatient service settings were

included for the present investigation (n = 3,554,303). Inpatient and detoxification modalities

were not included, as they consist of different interventions and populations. For admissions,

TEDS-D includes all episodes unlinked to individual clients. The number of episodes from one

client cannot be determined. Because the present study is investigating client characteristics, the

analysis focused on individual clients. Including only first-time admission episodes reduced the

analytic sample to a non-duplicative set of individuals (n = 2,239,197). Because improvement

was the outcome of interest, data were further limited to clients with complete data for the

frequency of substance use at both admission and discharge for state-level improvement

comparisons. This brought the final sample to N = 1,555,207. For the primary investigation,

analyses were focused on Black clients (N = 277,726). Of note, the proportion of Black clients

with missing use frequency data was relatively large (30.1%, n = 124,691). Thus, findings are

biased by individual programs' ability to collect use frequency data, and a series of post hoc tests

were conducted to further explore this limitation. These data represent deidentified existing

public records and no informed consent or university Institutional Review Board was required. Data are defined as non-human by the US definition of human subjects in research.

2.2. Improvement

Improvement was the outcome of interest and created by calculating a reduction in substance use frequency from admission to discharge. Treatment providers collect use frequency information at admission and discharge. Frequency is measured with varied assessments selected by the states and by individual treatment providers. TEDS collects state-level data and recategorizes them into a simple three-level variable: no use in the past month (1), some use (2), and daily use (3) at both admission and discharge. Aligned with existing statistical approaches with the TEDS data (Pro et al., 2020), admission and discharge frequencies were recoded into a dichotomous improvement variable (improved or not improved). If frequency decreased from admission to discharge, or no use remained no use, this was coded as improved. All other shifts were coded as not improved. While this is a rather simplistic evaluation, it is helpful to assess national outcomes in improvement.

2.3. Client and treatment variables

Client and treatment variables (see Table 2) are all categorical and were conceptualized in three domains of demographic, recovery capital, and treatment characteristics. Demographic characteristics included sex, age, race, and ethnicity. Recovery capital characteristics included education, employment, and mutual-help group attendance. Treatment characteristics included primary problem substance, number of problem substances, age at first use, referral source, program length of stay, and state. Sex and Latino ethnicity are dichotomous variables. Latino ethnicity represents Black Latinos and Black non-Latinos. For state-level comparisons, race was dichotomized as Black and non-Black. Age was categorized by SAMHSA for confidentiality

purposes and recategorized into developmental groupings to enable the inclusion of minors (ages 12-17), emerging adults (ages 18-24), and young adults (ages 25-34), 35-44, 45-54, and 55 and older. Mutual-help group attendance reflects any mutual aid/support groups (e.g., Alcoholics Anonymous or Smart Recovery) in the 30 days prior to discharge. Program length of stay was recorded as a count variable for the first 30 days, then as six irregular intervals up to more than one year. These were recoded into 30-day intervals up to more than four months. During 2015-2019, 48 states, Washington D.C., and Puerto Rico provided data to SAMHSA. The states of Oregon and West Virginia provided no information and are not represented in the data. In adjusted models, Mississippi was not represented due to non-collection of Mutual-help group attendance.

2.4. Data analysis

All data analyses were conducted using SAS 9.4 (SAS Institute, Cary, NC). First, state-level improvement was compared using the absolute risk difference (RD) and its 95% confidence intervals (CI) represented in a forest plot. Due to the low frequency of outcome events in multiple states, the absolute difference (RD) was analyzed. For example, New Mexico (n = 10), North Dakota (n = 43), and Montana (n = 60) had low Black client discharges with improvement data. RD is an absolute measure of effect, is the inverse of the number needed to treat (NNT), and is sometimes referred to as a risk reduction or absolute risk reduction (Grissom & Kim, 2012). Next, Black client factors supporting success were investigated. Descriptive tables of client demographics, recovery capital, and treatment characteristics were generated for Black clients, stratified by improvement status. All covariates were assessed initially using chi-square tests. A multivariable logistic regression model was constructed to investigate client characteristics associated with improvement. A second adjusted model was used, which included

the addition of state to assess state-level differences in treatment outcomes. For state-level

estimates, the regression model included all variables available in the dataset that had sufficient

sample sizes for model convergence, and that were aligned with constructs of demographic,

recovery capital, and treatment characteristics. Model 1 included all covariates providing

adjusted odds ratios (aOR) and Model 2 combined state as an additional control (state aOR).

Finally, a simple bivariate model with state predicting improvement was conducted to generate

crude state odds of Black improvement. This was used to compare state odds in the full

multivariable model, controlling for all factors in the full model. All odds are accompanied by

their 95% CI, representing effect sizes for predictor variable subcategories.

Because 30% of the outcome for Black clients was excluded due to missing outcome

values for the frequency of use variables (n = 124,691), a post hoc test of association was

conducted comparing the states with missing percentage of improvement data and the states'

overall odds of improvement for both Black and non-Black subgroups. This post hoc test was

designed to provide further information about our analytic sample, while also bringing to

attention a modest methodological limitation of this study. Due to the large sample size, the

analysis was powered to detect inconsequentially small group differences from the theoretical

null which were statistically significant. Therefore, to avoid misidentifying trivial significance

and to reduce Type I error, $p < 0.001$ was set as alpha. Statistically significant ORs and RDs

were considered clinically meaningful when their point estimates were greater than 2 (or less

than 0.5) and greater than 5 (or less than -5), respectively, aligned with previous research (Sahker

et al., 2019).

3. Results

3.1. State-Level Differences in Improvement by Race

Table 1 shows the absolute differences between Black and non-Black client improvement by state. Kansas had the highest Black client improvement (93.0%), which was not significantly different than non-Black client improvement (93.6%). Kansas is also missing a large proportion of Black client improvement data, and missing data tended to be not improved. South Dakota was the only state in which Black clients demonstrated an improvement percentage that was meaningfully higher compared to non-Black clients (RD = 6.35, 95% CI = 1.00, 11.71). Figure 1 shows how the states compare to each other. Estimates that have both confidence interval bounds to the left of zero have unequal percentages with greater non-Black client improvement. Of these, 20 states demonstrate a significant and clinically meaningful racial disparity with lower Black client improvement.

3.2. Predictors of Black Improvement

All Black client characteristics are presented in Table 2. Clients were mostly male (71.5%), between the age of 25-34 (30.7%), and Black non-Latino (95.4%). Overall, 46.95% of Black clients improved at treatment discharge. Clients who were unemployed, had not attended a mutual-help group, were self-referred to treatment, and had a shorter length of stay between 1-30 days were less likely to reduce the frequency of their substance use by discharge. Noticeably large differences that represent a higher likelihood of improvement were seen among clients who were full-time employed and remained in services for more than 120 days.

The multivariable logistic regression controlling for all variables (see Table 2) was significant (Wald $\chi^2_{[44]}$ = 18846.63, p < 0.0001). When controlling for state differences, the model remained significant (Wald $\chi^2_{[92]}$ = 32024.36, p < 0.0001). However, sex and ethnicity were no longer significant and some changes in odds were observed. Length of stay and mutual-help group attendance demonstrated clinically meaningful effect sizes controlling for all other

variables and state. Clients who attended mutual-help groups 4-7 times a month (state aOR =

2.43, 95% CI = 2.30, 2.56) and 8-30 times per month (state aOR = 2.54, 95% CI = 2.43, 2.64)

were much more likely to report improvement at treatment discharge, compared to those who did

not attend mutual-help groups. Additionally, Black clients with longer outpatient stays were

much more likely to improve compared to those remaining in treatment for 0-30 days (state aOR

= 2.50, 95% CI = 2.44, 2.56).

3.3. State-Level Black Improvement

Table 3 shows the odds of Black client improvement by state. DC was chosen as the

comparator because it was demonstrated the greatest reliable disparity with a Black client

disadvantage. In the bivariable model, state significantly predicted Black client improvement

(Wald $\chi 2[49]$ = 39868.74, p < 0.0001) and this adjusted model remained significant (Wald

$\chi 2[48]$ = 18394.77, p < 0.0001). The adjusted odds were compared, controlling for all variables

in the full model, with notable variability between the states. Some states show marked increases

in odds while others show decreases. In a post-hoc investigation, the association of Black client

outcomes and the states' black population was investigated (United States Census Bureau, 2020).

There was a negative correlation between the states' Black population percentage and

improvement (r = -0.36, p < 0.05)."

3.4. Influence Missing Outcome

Because a significant proportion of improvement data were missing, post-hoc analyses

were needed before evaluating state-level differences in improvement. It was found that missing

data were equally missing for Black and non-Black clients (30.99% versus 30.45%,

respectively). To determine if missingness was a function of race we compared the state odds of

improvement with the state percent of missing improvement data. Figure 2 shows that as the

odds of improvement increase, so does the percent of missing improvement data, and the pattern is extremely similar for both Black and non-Black clients. This finding suggests missingness is not due to race, and the available outcome data are likely made up of a biased subset of clients with greater improvement than the true population. Thus, generalizability may be limited to less severe clients and state-level factors of available data can be reasonably compared by race. For Black clients with missing improvement data (124,691), 31.08% successfully completed treatment, 45.06% dropped out, 23.61% were terminated by the facility, and 0.25 died. The discharge reason significantly varied by state (Wald $\chi^2_{[48]}$ = 19458.9205, p < 0.0001). Compared to DC, Arizona was dramatically more likely to miss collecting improvement data for successful discharges (OR = 242.57, 95% CI = 179.63, 327.55), while Louisiana was much less likely (OR = 0.381, 95% CI = 0.27, 0.52).

4. Discussion

In this study, we found that state-level differences are important for understanding racial disparities for Black client improvement. Only one state, South Dakota, showed meaningfully greater absolute improvement percentages for Black clients. A few states like Washington, Texas, and Massachusetts showed smaller differences favoring Black clients. Many states demonstrated no difference, but most states showed lower Black improvement compared to all other clients. Furthermore, a comparison of a state's crude and adjusted odds of improvement demonstrated notable changes in odds what accounting for client and treatment factors. We also found that the overall Black client improvement percentage was 46.95%, with noticeably significant absolute differences for clients who were employed full-time and who had longer lengths of stay of 120 days or more. There were several factors supporting Black client improvement. However, because these results represent a biased set of clients who tend to

perform better in treatment, and the analysis is powered so highly, clinical meaningfulness was set at a very conservative level in effect sizes. Thus, clinically meaningful factors of mutual-help group attendance and length of stay are likely to be meaningful factors associated with Black improvement. Even so, the states show decidedly different outcomes in Black client improvement.

Different state SUD treatment systems are associated with disparate treatment completion percentages for Black clients (Arndt et al., 2013). The present results extend Arndt and colleagues' (2013) findings by evaluating state improvement percentages. One important finding was that the odds of improvement vary markedly after controlling for all client and treatment variables in the full model. This finding suggests that in different states, specific client factors are associated with improvement, while in other states these factors were not associated. This finding may represent differential community standards held by the clients and the importance they place on these factors in their recovery. Only one state was associated with a greater clinically meaningful Black improvement RD, 23 states and Puerto Rico demonstrated no difference, and 23 states and DC had lower Black improvement. Many SUD treatment facilities have initiated culturally responsive and culturally competent treatment protocols, but more work is needed at the state policy level to ensure equitable access to quality treatment and better outcomes. The present study adds to the literature by identifying states with the greatest racial disparities, creating an opportunity for policy-based public health initiatives to target resources towards the most historically oppressed communities in the poorest performing states.

Further adding to state differences, missing improvement data for Black clients significantly varied by state in terms of treatment completion. In some states, Black clients successfully completed treatment but were missing improvement data, while in other states, this

was not the case. These findings are not surprising considering the conflicting definitions of

treatment success between clients and providers (Sahker et al., 2021). Interestingly, state Black

population demonstrated a negative association with Black improvement percent. This suggests

that in states with a greater percent of Black residents, Black SUD treatment clients tend to

improve less after completing treatment. This may reflect an overall negative Black community

perspective on treatment, as an artifact of structural racism (Gee & Ford, 2011). Perhaps the

mutual-help group community can counteract this relationship.

As a result of structural inequities, Black clients seek treatment less often, experience less

access to treatment, and are less likely to complete treatment than White clients (Cummings et

al., 2014; Grant et al., 2015; Sahker et al., 2020; Stahler et al., 2016). Structural racism and

interpersonal bias are factors that exacerbate negative outcomes for racial and ethnic minoritized

people with SUDs (Farahmand et al., 2020). Research suggests social structures altered from

systematic racism can be improved by focusing of support groups with a culturally shared

interest (Bellamy et al., 2021). The present results extend these findings by identifying mutual-

help groups as one option to improve Black client SUD improvement. The present study found

that the odds of improvement increased as clients attended more mutual-help group meetings.

Formal mutual-help groups serve as an important recovery resource for some people with SUDs.

Mutual-help group attendance can contribute to recovery capital by increasing social support and

community involvement and is demonstrated to facilitate greater improvement (Best et al., 2012;

Kelly et al., 2020). Several studies suggest that Black clients (mostly men) may participate more

in mutual-help groups compared to White clients (Zemore et al., 2021). Black clients are also

increasingly participating in internet support groups for substance use or mental health-related

issues (Hai et al., 2021). This suggests that even if groups are unavailable (e.g., rural settings),

telehealth support groups may be beneficial. Several factors have been proposed for the

relatively strong participation of Black clients in mutual-help group activities, including

religiosity, workplace or criminal justice coercion, and influence from healthcare providers,

family, or friends (Avalos & Mulia, 2012; Zemore et al., 2021). Black clients may garner greater

benefits from their individual social networks. For instance, Black group members are more

likely to report abstinence than non-attending participants of all races/ethnicities (Avalos &

Mulia, 2012). Increasing access and attendance to ancillary mutual-help groups during traditional

SUD treatment may help to improve Black client outcomes.

Treatment duration may be a particularly important issue for Black clients in SUD

treatment programs. Although Black non-Latino clients are no more likely than White or Latino

clients to remain in treatment for more than 90 days, this does not translate into an enhanced

treatment completion rate (Mennis et al., 2019). This same study found that the racial disparity in

treatment completion persisted after controlling for length of stay, highlighting the pivotal role of

socioeconomic and cultural factors in determining treatment completion rates (Mennis et al.,

2019). Consequently, Black clients take longer to complete treatment (Mennis et al., 2019) and

are also less likely to complete treatment compared to White or Latino patients after controlling

for age, sex, SES, and substance of choice (Mennis & Stahler, 2016). These earlier findings also

support our observation that greater improvement occurs with a treatment duration greater than

120 days. However, the cost of treatment needs to be accounted for when trying to increase

retention, especially if younger or older clients on limited or fixed incomes are the intervention

target populations. If clients are not attending treatment purely due to clinical need, it may serve

as greater community cohesion supporting greater improvement for Black clients.

Limitations

The present study has limitations of note. Our outcome of improvement is a simple instrument that misses subtleties of improvement. While we would prefer a continuous measure or a more complex ordinal measure of frequency, this is the best option to measure changes in use with these data. In addition, we followed previous methods investigating improvement (Pro et al., 2020; Sahker et al., 2020). Second, not all states report treatment data to SAMHSA every year. For 2015-2019, Oregon and West Virginia did not report data. Thus, the final sample only included data from 47 states, Washington DC, and Puerto Rico. While this affects generalizability, the TEDS data are the most comprehensive dataset in the US and are generally considered representative population data. Additionally, our data were restricted to first-time admissions to maintain an assumption of independence. This limits generalizability to improvement only for Black clients in their first treatment experience. This is simultaneously a limitation, but also adjusting for bias of including dependent observations of clients with multiple admissions during the five-year period, which could bias the sample. Finally, absolute effect sizes comparing improvement percentages are limited by missing improvement outcome data. A significant proportion of improvement data were missing for Black and non-Black clients (30.99% versus 30.45%, respectively). While we found a pattern demonstrating missingness was not a function of race, findings appear to be a biased subset of clients with greater improvement than the true population. Thus, generalizability is limited to these less severe clients in absolute effects.

4.1. Conclusion

Clinically meaningful factors that support Black client SUD improvement include ancillary mutual-help group attendance and increased treatment retention. These factors may be more critical in states with larger racial disparities in improvement. About half of the states

demonstrated no difference between Black and non-Black improvement, and the remaining half

of states demonstrated lower improvement percentages among Black clientele. In general,

treatment providers increasing access to mutual-help groups, and adjusting program

inclusiveness and motivational factors for retention, would make strides in increasing

improvement outcomes for Black clients. States with demonstrated racial disparities may

consider redirecting resources at specific factors known to be associated with Black client

improvement.

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Table 1. State improvement percentages and absolute effect sizes

	Non-Black N	Black N	Black Improvement (n = 277,726)	non-Black Improvement (n = 1,277,481)	RD	95% CI
Alabama	7344	3175	60.85	67.93	-7.08	-9.09, -5.08
Alaska	7648	231	52.38	46.82	5.56	-0.98, 12.10
Arizona	73578	5032	41.40	41.64	-0.24	-1.65, 1.16
Arkansas	13117	3350	56.84	60.42	-3.58	-5.46, -1.71
California	98319	11012	64.71	69.57	-4.86	-5.80, -3.92
Colorado	27556	2022	83.09	84.58	-1.49	-3.18, 0.19
Connecticut	48679	12956	42.44	44.82	-2.38	-3.34, -1.42
Delaware	7886	2689	40.83	41.53	-0.70	-2.85, 1.46
DC	358	1046	60.04	82.40	-22.36	-27.30, -17.43
Florida	38039	11040	64.72	65.70	-0.98	-1.99, 0.03
Georgia	12728	8489	33.51	43.32	-9.81	-11.13, -8.49
Hawaii	12857	364	72.80	73.67	-0.87	-5.50, 3.76
Idaho	12409	188	77.66	80.57	-2.91	-8.91, 3.08
Illinois	22753	13502	42.49	55.68	-13.19	-14.25, -12.14
Indiana	7056	1339	55.56	60.74	-5.18	-8.07, -2.28
Iowa	27515	2839	68.30	68.96	-0.66	-2.46, 1.14
Kansas	5093	790	93.04	93.64	-0.60	-2.50, 1.30
Kentucky	139830	10506	38.76	49.81	-11.06	-12.02, -10.09
Louisiana	947	565	36.11	37.49	-1.38	-6.40, 3.64
Maine	8017	212	69.34	74.67	-5.33	-11.61, 0.95
Maryland	23523	12183	26.92	28.55	-1.63	-2.60, -0.65
Massachusetts	9369	1406	83.85	79.25	4.60	2.51, 6.70
Michigan	39596	11026	64.82	65.42	-0.60	-1.60, 0.41
Minnesota	29461	5024	77.71	80.76	-3.05	-4.29, -1.82
Mississippi	7230	3488	38.68	44.09	-5.42	-7.40, -3.44
Missouri	32309	6380	59.11	72.04	-12.94	-14.24, -11.64
Montana	6122	60	66.67	77.12	-10.45	-22.42, 1.53
Nebraska	3796	406	51.72	52.79	-1.07	-6.18, 4.05
Nevada	4553	932	25.43	38.83	-13.40	-16.54, -10.27
New Hampshire	5037	148	65.54	74.31	-8.77	-16.52, -1.02
New jersey	16111	8482	25.18	27.30	-2.12	-3.27, -0.97
New Mexico	710	10	40.00	68.31	-28.31	-58.87, 2.25
New York	94064	32064	62.02	68.78	-6.76	-7.37, -6.15
North Carolina	168152	52815	17.94	20.28	-2.34	-2.72, -1.96
North Dakota	1061	43	60.47	54.67	5.80	-9.12, 20.72
Ohio	18491	6168	57.08	58.91	-1.82	-3.25, -0.40
Oklahoma	33420	4547	59.34	67.44	-8.10	-9.61, -6.59
Pennsylvania	19981	3334	50.54	54.72	-4.18	-6.01, -2.35
Rhode Island	8058	555	63.60	68.95	-5.35	-9.47, -1.22
South Carolina	19881	10990	81.74	81.71	0.03	-0.87, 0.93
South Dakota	15212	325	61.23	54.88	6.35	1.00, 11.71
Tennessee	10521	4238	70.17	71.99	-1.81	-3.44, -0.19
Texas	29262	8033	68.87	66.62	2.24	1.10, 3.39
Utah	19816	670	69.40	69.55	-0.15	-3.69, 3.40
Vermont	11101	349	46.70	58.12	-11.42	-16.73, -6.10
Virginia	27658	9981	38.38	43.54	-5.16	-6.28, -4.04
Washington	28307	1941	31.22	28.70	2.52	0.40, 4.65
Wisconsin	12692	563	78.15	79.80	-1.65	-5.13, 1.84
Wyoming	6553	154	69.48	71.78	-2.30	-9.66, 5.05
Puerto Rico	3705	64	29.69	31.96	-2.27	-13.56 9.02

Note. RD = risk difference; CI = confidence interval; DC = District of Colombia

Table 2. Black client characteristics predicting improvement at treatment discharge.

	Not Improved	Improved	Difference	aOR	95% CI	State aOR	95% CI
Sex*							
Male	70.81	70.17	-0.64	0.95	0.93, 0.97	1.00	0.98, 1.03
Female	29.19	29.83	0.64	REF		REF	
Age*							
12-17	6.50	8.39	1.89	1.00	0.96, 1.05	0.73	0.69, 0.77
18-24	16.80	18.30	1.50	0.96	0.93, 0.98	0.93	0.90, 0.96
25-34	29.88	31.59	1.71	REF		REF	
35-44	18.87	18.36	-0.51	0.98	0.95, 1.01	1.00	0.97, 1.03
45-54	17.59	14.37	-3.22	0.91	0.88, 0.94	0.98	0.95, 1.01
55+	10.36	8.98	-1.38	0.95	0.91, 0.99	1.03	0.98, 1.07
Ethnicity*							
Black Latino	96.04	94.58	-1.46	0.78	0.74, 0.81	1.02	0.97, 1.07
Black Non-Latino	3.96	5.42	1.46	REF		REF	
Education*							
< HS	33.92	34.02	0.10	0.90	0.85, 0.95	0.86	0.81, 0.91
HS	46.83	45.13	-1.70	0.93	0.88, 0.98	0.90	0.85, 0.95
Some college	16.15	17.02	0.87	0.97	0.92, 1.03	0.89	0.84, 0.94
College +	3.11	3.83	0.72	REF		REF	
Employment							
Full-Time	16.84	23.65	6.81	REF		REF	
Part-Time	9.58	9.96	0.38	0.81	0.78, 0.84	0.85	0.81, 0.88
Unemployed	47.67	36.48	-11.19	0.75	0.73, 0.77	0.83	0.80, 0.85
Not in Labor Force	25.91	29.91	4.00	0.99	0.97, 1.03	0.91	0.88, 0.94
Mutual-Help Group Attendance*							
None	85.21	72.93	-12.28	REF		REF	
1-3 times/month	4.85	8.09	3.24	1.83	1.76, 1.90	1.83	1.76, 1.91
4-7 times/month	2.52	5.88	3.36	2.62	2.49, 2.76	2.43	2.30, 2.56
8-30 times/month	5.59	9.39	3.80	2.16	2.08, 2.24	2.54	2.43, 2.64
unknown frequency	1.82	3.71	1.89	1.97	1.86, 2.09	1.71	1.61, 1.82
Problem Substance*							
Alcohol	27.34	30.22	2.88	REF		REF	
Cocaine	10.99	9.70	-1.29	0.78	0.76, 0.81	0.97	0.93, 1.01
Marijuana	37.53	44.81	7.28	0.93	0.91, 0.95	1.04	1.01, 1.06
Heroin	12.42	7.18	-5.24	0.54	0.51, 0.56	0.75	0.72, 0.79
Rx Opioids/Synthetics	4.11	2.70	-1.41	0.67	0.63, 0.71	0.86	0.81, 0.92
Hallucinogens	0.82	0.88	0.06	0.78	0.70, 0.86	0.94	0.85, 1.04
Methamphetamine	1.81	2.64	0.83	1.10	1.03, 1.18	0.97	0.90, 1.05
Other Stimulants	0.34	0.51	0.17	1.34	1.15, 1.55	1.35	1.16, 1.58
Other Sedatives	0.45	0.48	0.03	1.07	0.93, 1.23	1.31	1.13, 1.52
Other	4.19	0.88	-3.31	0.46	0.42, 0.50	0.70	0.64, 0.76
Number Problem Substances*							
1	53.58	57.55	3.97	0.98	0.95, 1.01	1.11	1.07, 1.15
2	30.23	30.98	0.75	1.03	1.00, 1.07	0.99	0.96, 1.03
3	12.80	11.45	-1.35	REF		REF	
Age at First Use*							
≤ 11	7.79	6.43	-1.36	0.72	0.69, 0.76	0.80	0.76, 0.85
12-14	20.51	20.58	0.07	0.81	0.78, 0.85	0.90	0.86, 0.95
15-17	26.81	28.64	1.83	0.92	0.88, 0.96	1.04	0.99, 1.08
18-20	17.59	19.10	1.51	1.04	1.00, 1.09	1.14	1.09, 1.20
21-24	10.77	11.67	0.90	1.05	1.01, 1.10	1.13	1.08, 1.19
25-29	7.18	6.34	-0.84	1.04	0.99, 1.10	1.11	1.05, 1.17
30+	9.34	7.23	-2.11	REF		REF	

				aOR	CI	State aOR	State CI
Referral Source*							
Self	37.87	24.28	-13.59	0.68	0.66, 0.69	0.68	0.66, 0.70
SUD Provider	2.60	2.94	0.34	1.02	0.96, 1.08	0.81	0.76, 0.86
Healthcare	9.67	4.87	-4.80	0.56	0.54, 0.58	0.55	0.53, 0.58
School	0.93	1.35	0.42	1.00	0.90, 1.10	0.94	0.85, 1.04
Employer	0.42	1.10	0.68	1.54	1.38, 1.73	1.01	0.90, 1.13
Community Agency	11.68	14.05	2.37	0.89	0.95, 1.01	0.79	0.76, 0.81
Criminal Justice	36.83	51.41	14.58	REF		REF	
Length of Stay*							
0-30 days	42.70	20.45	-22.25	0.35	0.34, 0.35	0.40	0.39, 0.41
31-60 days	14.38	15.20	0.82	0.64	0.62, 0.66	0.62	0.60, 0.64
61-90 days	10.92	14.59	3.67	0.77	0.75, 0.80	0.77	0.75, 0.80
91-120 days	9.09	13.49	4.40	0.94	0.91, 0.97	0.91	0.88, 0.95
121+ days	22.92	36.27	13.35	REF		REF	

Note. aOR = adjusted odds ratio for all covariates included in the Table; State aOR = addition of state; CI = confidence interval; REF = referent with aOR of 1.00; HS = high school; Rx = prescription; SUD = substance use disorder. Mississippi did not collect data for Mutual-help group attendance and was therefore removed from the adjusted model.
* $p < 0.0001$, χ^2 test for difference

Table 3. Relative odds of Black client improvement by state

	OR	95% CI	aOR	95% CI	Change
Alabama	1.04	0.89, 1.19	1.26	1.02, 1.54	0.22
Alaska	0.73	0.55, 0.98	0.78	0.55, 1.10	0.05
Arizona	0.47	0.41, 0.54	0.67	0.56, 0.81	0.20
Arkansas	0.88	0.76, 1.01	1.00	0.83, 1.20	0.12
California	1.22	1.07, 1.39	1.20	0.99, 1.45	-0.02
Colorado	3.27	2.75, 3.88	3.52	2.87, 4.32	0.25
Connecticut	0.49	0.43, 0.56	0.52	0.44, 0.62	0.03
Delaware	0.46	0.39, 0.53	0.57	0.46, 0.71	0.11
DC	REF		REF		0.00
Florida	1.22	1.07, 1.39	1.43	1.20, 1.69	0.21
Georgia	0.34	0.29, 0.38	0.54	0.45, 0.66	0.21
Hawaii	1.78	1.37, 2.32	1.88	1.39, 2.54	0.10
Idaho	2.31	1.60, 3.33	1.62	0.97, 2.69	-0.69
Illinois	0.49	0.43, 0.56	0.58	0.48, 0.69	0.09
Indiana	0.83	0.70, 0.98	0.81	0.65, 0.99	-0.03
Iowa	1.43	1.23, 1.66	1.62	1.34, 1.94	0.18
Kansas	8.89	6.58, 12.01	7.42	5.31, 10.36	-1.47
Kentucky	0.42	0.37, 0.48	0.66	0.55, 0.78	0.24
Louisiana	0.38	0.30, 0.47	0.61	0.44, 0.83	0.23
Maine	1.51	1.09, 2.07	1.86	1.29, 2.67	0.35
Maryland	0.25	0.21, 0.28	0.35	0.29, 0.41	0.10
Massachusetts	3.46	2.86, 4.17	3.73	2.96, 4.69	0.27
Michigan	1.23	1.07, 1.40	1.27	1.06, 1.50	0.04
Minnesota	2.32	2.01, 2.67	2.36	1.97, 2.84	0.04
Mississippi	0.42	0.36, 0.48	†		
Missouri	0.96	0.84, 1.10	1.08	0.90, 1.29	0.12
Montana	1.33	0.76, 2.31	1.36	0.75, 2.45	0.03
Nebraska	0.71	0.56, 0.90	0.99	0.75, 1.31	0.28
Nevada	0.23	0.18, 0.28	0.40	0.30, 0.51	0.17
New Hampshire	1.27	0.88, 1.82	1.38	0.88, 2.15	0.12
New jersey	0.22	0.19, 0.26	0.24	0.19, 0.29	0.01
New Mexico	0.44	0.12, 1.58	0.49	0.08, 2.88	0.05
New York	1.09	0.95, 1.23	1.17	0.98, 1.38	0.08
North Carolina	0.15	0.12, 0.17	0.20	0.16, 0.24	0.05
North Dakota	1.02	0.54, 1.90	1.02	0.16, 6.25	0.01
Ohio	0.89	0.77, 1.01	0.84	0.70, 1.00	-0.05
Oklahoma	0.97	0.84, 1.11	0.90	0.75, 1.07	-0.07
Pennsylvania	0.68	0.59, 0.78	0.88	0.72, 1.07	0.20
Rhode Island	1.16	0.94, 1.44	1.36	1.03, 1.77	0.20
South Carolina	2.98	2.60, 3.40	2.87	2.39, 3.44	-0.11
South Dakota	1.05	0.81, 1.36	1.26	0.94, 1.68	0.21
Tennessee	1.57	1.36, 1.80	2.85	2.31, 3.52	1.29
Texas	1.47	1.29, 1.68	1.22	1.02, 1.45	-0.26
Utah	1.51	1.22, 1.86	1.49	1.16, 1.90	-0.02
Vermont	0.58	0.45, 0.74	0.68	0.50, 0.93	0.10
Virginia	0.42	0.36, 0.47	0.34	0.28, 0.40	-0.08
Washington	0.30	0.25, 0.35	0.56	0.45, 0.69	0.26
Wisconsin	2.38	1.88, 3.01	2.73	2.03, 3.68	0.35
Wyoming	1.52	1.05, 2.18	1.58	1.05, 2.36	0.06
Puerto Rico	0.28	0.16, 0.49	0.34	0.17, 0.65	0.06

Note. OR = odds ratio; aOR = adjusted odds ratio for sex, age, race, ethnicity, education, employment, mutual-help group attendance, primary problem substance, number of problem substances, age at first use, referral source, and program length of stay; CI = confidence interval; REF = referent with odds of 1.00.
† Mississippi did not collect data for Mutual-help group attendance and was therefore removed from the adjusted model.
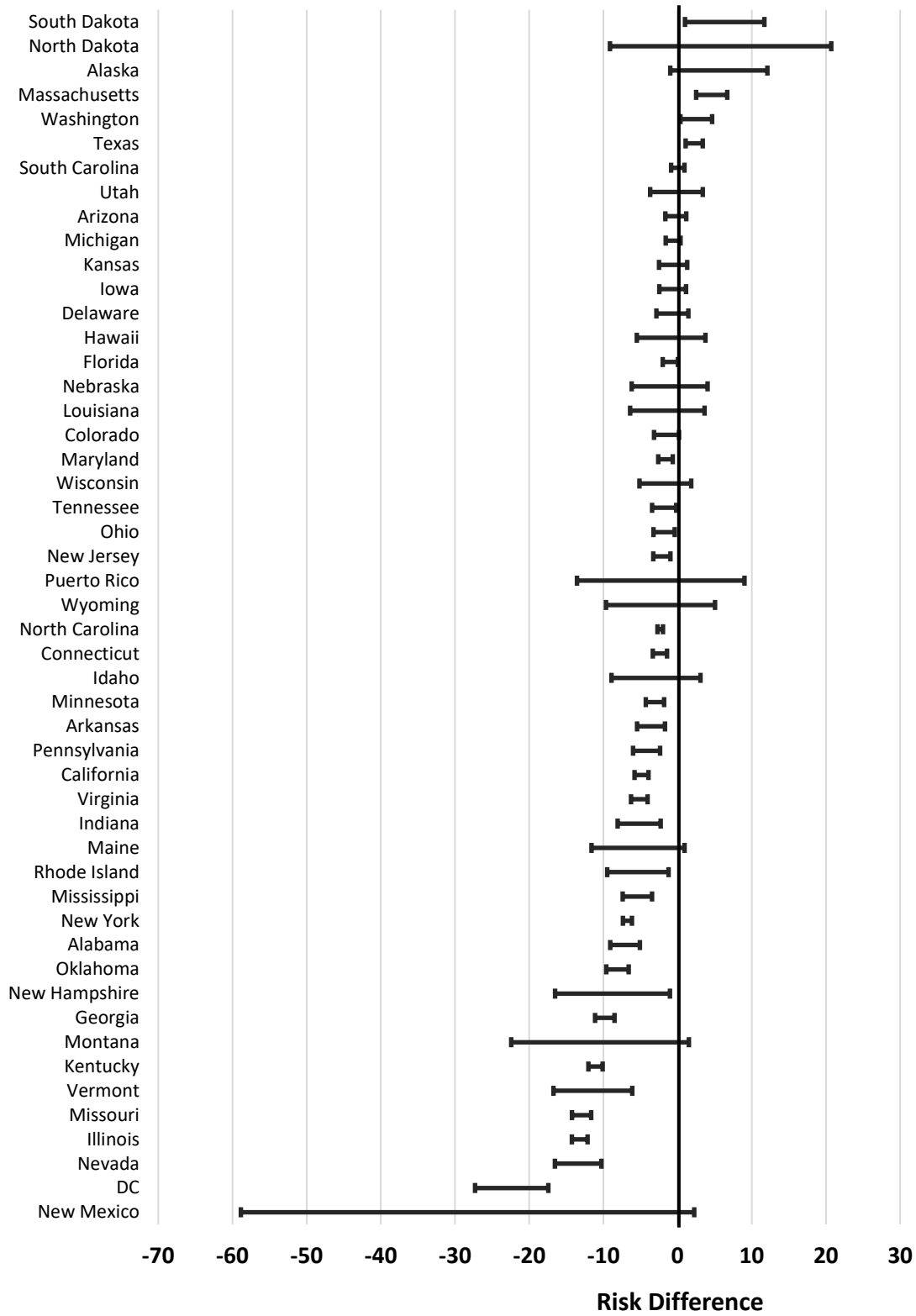
Figure 1. Forest plot comparing state improvement differences between Black and non-Black substance use disorder treatment clients.

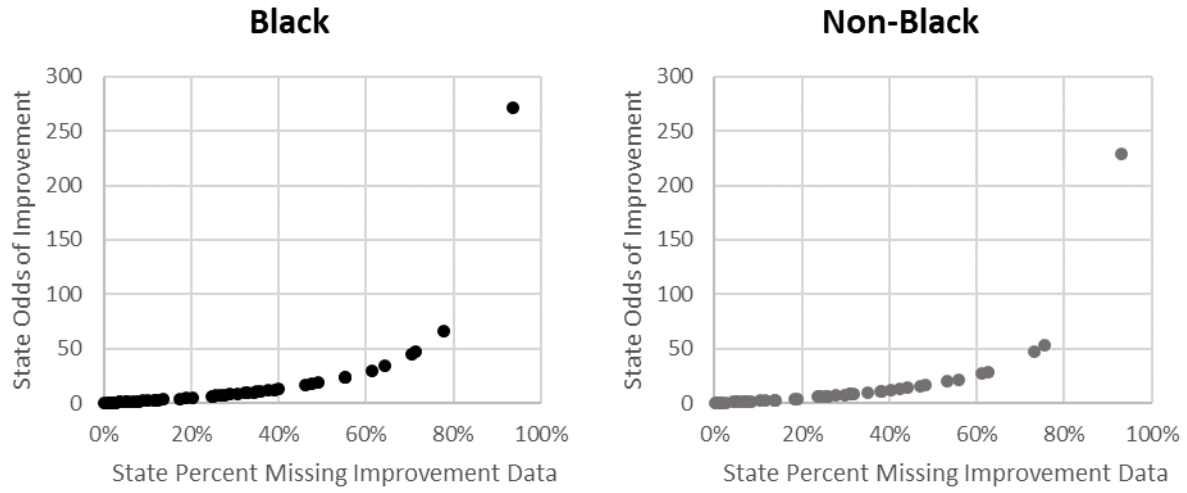**Figure 2.** Association of state outcome data missingness and states predicted improvement odds.