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Young Adult Substance Use and Healthcare Use Associated With Screening, Brief Intervention and Referral to Treatment in Pediatric Primary Care

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A B S T R A C T

Purpose: Screening, brief intervention, and referral to treatment (SBIRT) may impact future comorbidity and healthcare utilization among adolescents screening positive for substance use or mood problems.
Methods: In a randomized trial sample, we compared an SBIRT group to usual care for substance use, mental health, medical diagnoses, and healthcare utilization over 7 years postscreening.
Results: In logistic regression models adjusting for patient characteristics, the SBIRT group had lower odds of any substance (Odds Ratio[OR] = 0.80, 95% Confidence Interval [CI] = 0.66–.98), alcohol (OR = 0.69, 95% CI = 0.51–0.94), any drug (OR = 0.73, 95% CI = 0.54–0.98), marijuana (OR = 0.70, 95% CI = 0.50–0.98), and tobacco (OR = 0.83, 95% CI = 0.69–1.00) diagnoses, and lower odds of any inpatient hospitalizations (OR = 0.59, 95% CI = 0.41–0.85) compared with usual care. Negative binomial models examining number of visits among adolescents with at least one visit of that type found that those in the SBIRT group had fewer primary care (incidence rate ratio [iRR] = 0.90, $p < .05$) and psychiatry (iRR = 0.64, $p < .01$) and more addiction medicine (iRR = 1.52, $p < .01$) visits over 7 years compared with usual care. In posthoc analyses, we found that among Hispanic patients, those in the SBIRT group had lower odds of any substance, any drug and marijuana use disorder diagnoses compared with usual care, and among Black/African American patients, those in the SBIRT group had lower odds of alcohol use disorder diagnoses compared with usual care.
Discussion: Beneficial effects of adolescent SBIRT on substance use and healthcare utilization may persist into young adulthood.

IMPLICATIONS AND CONTRIBUTION

This study of the long-term outcomes among adolescent patients in an SBIRT trial in pediatric primary care found significantly fewer substance use disorders and less healthcare utilization at 7 years among those exposed to SBIRT. This suggests that SBIRT may provide significant and lasting benefits to vulnerable adolescents well into young adulthood.

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Adolescent substance use and mental health problems are a significant public health concern and exact a considerable toll on individuals, and their families and communities. They often result in serious academic [1,2], employment [3], legal [4] consequences for young people, and high societal costs (estimated at over half a trillion dollars annually in the U. S.) [5]. Research shows that adolescent substance use and mental health problems are associated with adult substance use disorders, and psychiatric and chronic medical conditions [6]. Early intervention during adolescence is effective in helping young people avoid future problems.

While adolescent substance use has decreased in recent decades, it has increased for certain drugs in recent years—specifically, marijuana, vaping, and opioids. The gradual decreases in alcohol use and binge drinking have leveled off, while amphetamine, cough syrup, and inhalant use among younger adolescents has increased [7]. According to a recent national survey, in the U.S., over 400,000 adolescents and 3,400,000 young adults have alcohol use disorders, and over 600,000 and 2,600,000, respectively, have a drug use disorder, with many more reporting problematic use [8,9]. Recent research also shows increased nonfatal drug overdoses in 59 jurisdictions among 47 states for youth aged 0–14 years old [10].

Equally concerning is that fewer than half of adolescents needing treatment for substance use or mental health problems receive it [11]. Specialty treatment rates are particularly low for substance use and depressive disorders, and treatment initiation rates are particularly low among youth of color, who face many logistical, financial, and historical/cultural barriers to seeking specialty treatment [12]. Primary care is less stigmatizing than specialty addiction or psychiatry treatment [13], and most adolescents, both privately and publicly insured, have access to primary care [14], making it an opportune setting for preventing and intervening early in behavioral health problems and for laying the groundwork for substance use behaviors—healthy or problematic—in future years. Screening, brief intervention, and referral to treatment (SBIRT) are delivered to U.S. adolescents most frequently in pediatric primary care settings as a public health approach to preventing substance use and mental health symptoms [15,16]. There is a growing evidence base on the efficacy and effectiveness of SBIRT for adolescents in healthcare settings. A pilot in Brazilian pediatric primary care clinics found that those who received brief interventions were less likely to report intention to use cannabis, and reported using it less often compared to usual care [17]. In a quasi-experimental study of computer-facilitated screening and pediatrician-delivered brief advice, conducted in the U.S. and Czech Republic primary care clinics, Harris et al. found less alcohol use and any substance use, at 3 and 12 months among U.S. intervention group adolescents compared to controls, and less cannabis use at 3 and 12 months among the Czech intervention arm adolescents, compared to controls [18]. A randomized trial examining therapist and computer-delivered BIs, conducted with cannabis-naïve adolescents in several Federally Qualified Health Centers (FQHC), found lower rates of cannabis and other drug use, lower rates of delinquent behavior, and lower alcohol use severity, compared to usual care [19]. A similar randomized clinical trial, with adolescents already using cannabis, found significantly less other drug use, cannabis-related consequences, and occurrences of cannabis-related driving under the influence among those receiving the interventions compared to usual care [20]. Other studies using nonphysicians to deliver screening and brief intervention to adolescents have also shown promising results [21–27]. There are also several systematic reviews and meta-analyses, which have found that brief interventions for substance use in adolescents, in healthcare and nonhealthcare settings alike, can be effective in reducing use and related consequences [16,28–33].

Although these findings are encouraging, there is still much research needed on SBI/SBIRT in primary care to broaden the evidence on the basis of its efficacy and effectiveness among adolescents. Moreover, most research has focused on short-term outcomes [18,34], and to our knowledge, no studies have examined the effectiveness of a range of important outcomes as patients progress into young adulthood.

This study used electronic health record (EHR) data to examine substance use, mental health, medical and healthcare utilization outcomes over 7 years among adolescents from a randomized clinical trial [35,36] that compared modalities of delivering SBIRT in pediatric primary care with usual care. We hypothesized that patients exposed to SBIRT would have lower rates of substance use, mental health, and medical comorbidities, and lower rates of ED and inpatient utilization than those receiving usual care.

Method

Setting and design

The study was conducted at Kaiser Permanente Northern California (KPNC), an integrated healthcare delivery system serving a diverse population of over four million members, with "carved-in" mental health and addiction medicine services available to members as covered benefits. The study sample draws from a pragmatic, randomized hybrid clinical trial at KPNC's Oakland Pediatrics Department, which assessed three modalities for delivering SBIRT to adolescents ages 12–18 years. Clinic pediatricians were randomized to one of three trial arms, including two brief intervention (BI) arms: (a) pediatrician-only arm (pediatricians were trained to assess patients following the screening, and where indicated, deliver BIs and refer to specialty substance use or mental health treatment); (b) embedded behavioral clinician arm (pediatricians assessed patients, and if needed, referred them to an embedded behavioral clinician for further assessment, BI, and referral to treatment); and (c) a usual care arm (pediatricians had EHR screening tools but no formal SBIRT training). Following screening for any past year alcohol and drug use (Y/N) and past two-week mood symptoms, conducted as part of a comprehensive health screening instrument administered at all adolescent well visits, adolescents who endorsed alcohol or drug use or mood symptoms were eligible for a brief intervention from their pediatrician or the behavioral health clinician, depending on the intervention arm to which their pediatrician was randomized, or treatment as usual. The trial compared implementation and patient outcomes of the three modalities delivered during routine pediatric primary care to adolescents at wellness visits. Trial details, including the pediatrician and embedded clinician training protocols, screening and assessment items, and clinical workflows, have been previously described elsewhere [15,37,38]. Studies of outcomes at 1 and 3 years found that SBIRT was associated with reduced substance use, mental health, medical diagnoses, and mental healthcare utilization, and similar results among

Table 1
Multilevel logistic/negative binomial regression analyses examining mental health and substance use diagnoses and medical comorbidity over 7 years postindex among all eligible patients (n = 1,871)

	Any behavioral health diagnosis		Depression disorder diagnosis		Anxiety disorder diagnosis		Substance use disorder diagnosis		Charlson comorbidity index	
	OR	*p*-value	OR	*p*-value	OR	*p*-value	OR	*p*-value	iRR	*p*-value
Intercept	6.57 (2.10–20.60)	.001	3.58 (1.22–10.51)	.021	0.83 (0.23–2.95)	.768	0.06 (0.02–0.19)	<.001	0.04 (0.01–0.24)	<.001
SBIRT Group (vs. Usual Care)	1.02 (0.87–1.19)	.804	0.83 (0.61–1.12)	.215	1.04 (0.86–1.25)	.700	0.80 (0.66–0.98)	.027	0.76 (0.59–0.98)	.032
Female (vs. Male)	1.78 (1.41–2.25)	<.001	1.93 (1.54–2.44)	<.001	2.29 (1.86–2.82)	<.001	0.69 (0.56–0.86)	.001	1.15 (0.87–1.50)	.326
Age	0.82 (0.77–0.87)	<.001	0.81 (0.76–0.86)	.000	0.86 (0.81–0.91)	<.001	1.05 (0.98–1.13)	.193	1.01 (0.95–1.09)	.683
Race/Ethnicity (reference: White)										
Asian	0.66 (0.44–0.98)	.042	0.82 (0.52–1.31)	.409	0.71 (0.47–1.07)	.103	0.61 (0.35–1.06)	.082	0.97 (0.53–1.78)	.923
Black/African American	0.56 (0.42–0.75)	<.001	0.65 (0.46–0.93)	.018	0.46 (0.34–0.61)	<.001	1.46 (1.15–1.85)	.002	1.49 (0.98–2.26)	.059
Hispanic	0.80 (0.59–1.08)	.146	0.65 (0.47–0.90)	.010	0.71 (0.53–0.94)	.018	1.16 (0.92–1.46)	.205	1.64 (1.12–2.40)	.010
Missing/Unknown	0.51 (0.34–0.77)	.001	0.56 (0.34–0.90)	.017	0.68 (0.36–1.27)	.226	1.04 (0.59–1.83)	.899	1.27 (0.70–2.28)	.432
Medicaid Insurance[a] (vs. No Medicaid Insurance)	1.20 (0.76–1.89)	.430	0.91 (0.63–1.33)	.640	1.35 (0.90–2.02)	.144	0.76 (0.43–1.32)	.328	1.43 (0.86–2.36)	.169
Membership months	1.02 (1.01–1.02)	<.001	1.01 (1.01–1.02)	<.001	1.02 (1.01–1.03)	<.001	1.01 (1.01–1.02)	<.001	1.01 (0.99–1.04)	.169
Diagnosis in year prior[b]	8.61 (5.70–13.02)	<.001	8.44 (5.38–13.24)	<.001	10.96 (6.25–19.24)	<.001	4.31 (2.36–7.90)	<.001	3.21 (2.56–4.02)	<.001

	Alcohol disorder diagnosis		Any drug disorder diagnosis		Marijuana disorder diagnosis		Tobacco disorder diagnosis	
	OR	*p*-value	OR	*p*-value	OR	*p*-value	OR	*p*-value
Intercept	0.02 (0.00–0.13)	<.001	0.05 (0.01–0.37)	.003	0.08 (0.01–0.74)	.026	0.01 (0.00–0.03)	<.001
SBIRT Group (vs. Usual Care)	0.69 (0.51–0.94)	.017	0.73 (0.54–0.98)	.036	0.70 (0.50–0.98)	.037	0.83 (0.69–1.00)	.046
Female (vs. Male)	0.68 (0.44–1.05)	.079	0.77 (0.56–1.05)	.103	0.78 (0.57–1.09)	.145	0.63 (0.48–0.83)	.001
Age	1.05 (0.93–1.18)	.426	1.01 (0.90–1.13)	.863	0.99 (0.87–1.12)	.819	1.13 (1.06–1.21)	<.001
Race/Ethnicity (reference: White)								
Asian	0.40 (0.16–0.98)	.045	0.95 (0.43–2.10)	.902	0.81 (0.33–2.01)	.657	0.59 (0.36–0.97)	.038
Black/African American	0.52 (0.28–0.96)	.038	1.94 (1.44–2.62)	<.001	1.79 (1.21–2.65)	.003	1.26 (0.90–1.75)	.174
Hispanic	1.60 (1.06–2.41)	.027	1.70 (1.06–2.71)	.026	1.52 (0.95–2.42)	.078	1.02 (0.79–1.32)	.853
Missing/Unknown	1.37 (0.54–3.43)	.508	1.20 (0.59–2.43)	.622	0.81 (0.40–1.64)	.559	1.10 (0.61–2.01)	.748
Medicaid Insurance[a] (vs. No Medicaid Insurance)	1.32 (0.65–2.67)	.441	0.55 (0.23–1.33)	.184	0.58 (0.24–1.40)	.227	0.84 (0.44–1.59)	.584
Membership months	1.01 (1.00–1.02)	.008	1.01 (1.01–1.01)	<.001	1.01 (1.00–1.01)	.010	1.01 (1.01–1.02)	<.001
Diagnosis in year prior[b]	7.79 (2.29–6.42)	.001	7.32 (3.58–14.98)	<.001	6.94 (3.72–12.98)	<.001	4.20 (0.64–27.68)	.136

Note: iRR = incidence rate ratio; OR = Odds Ratio.
[a] Any Medicaid coverage in the year prior to index.
[b] Corresponding diagnoses/score made in the year prior to index.

adolescents endorsing both substance use and mood symptoms at the initial screening [35,36]. The study was approved by the IRBs of KPNC and the University of California, San Francisco.

Although the original trial compared pediatrician-delivered and behavioral health clinician-delivered SBIRT to each other and usual care, in real-world practice, many primary care practices have adopted flexible, hybrid SBIRT staffing and workflows, using both SBIRT-trained pediatricians *and* nonphysician behavioral clinicians to deliver SBIRT [39]. In the trial, we found that both SBIRT modalities produced better patient outcomes than usual care. In the current study, we have the opportunity to examine the effects of access to SBIRT, regardless of the clinician providing it, on long-term outcomes, and thus, we combined patients from both SBIRT intervention arms into a single SBIRT group.

Study sample

This study sample consists of a subset of adolescents aged 12–18 who endorsed either substance use or mental health symptoms when screened during an adolescent wellness visit between November 1, 2011 and October 31, 2013, and/or were deemed eligible for further assessment, BI and/or referral to specialty treatment by their pediatrician (n = 1,871). The index date was the date on which the adolescent screened positive for substance use and/or mood symptoms. Additional details of the study protocol and the screening instrument are described elsewhere [15,38].

Measures

Treatment groups. A dichotomous indicator was created to determine patients in the SBIRT arm (pediatrician-delivered or embedded behavioral clinician-delivered) and usual care (=1 if SBIRT group; 0 if usual care).

Patient characteristics. The EHR was used to extract patient sex, age at index date, race/ethnicity (White, Black/African American, Hispanic, Asian, and other/unknown), Medicaid coverage in the year prior to index (1 = any Medicaid coverage, 0 otherwise) as a proxy for socioeconomic status, and length of enrollment calculated as the number of member months in the health plan over the 7 years postindex.

Health services utilization. The EHR provided all outpatient and inpatient services use over 7 years postindex, which included utilization within Kaiser and utilization outside of KPNC paid for by the health plan. Indicator and count measures were created for each type of utilization (primary care, psychiatry, addiction medicine, ED, and inpatient utilization).

Diagnoses. We examined diagnoses recorded in the EHR during patient visits over 7 years postindex. Specifically, we looked at *any behavioral health diagnoses,* which included any mental health or substance use diagnoses (ICD-9 codes: 290, 293–302, 306–319; ICD-10 codes: F01–F09, F20–F99) and separate indicators for *depression* (ICD-9: 296.2, 296.3, 296.82, 298.0, 300.4, 301.12, 309.0, 309.1, 309.28, 311; ICD-10: F32, F33, F34.1, F43.21, F43.23); *anxiety* (ICD-9: 300.00, 300.02, 300.09, 300.2, 300.3, 308.3, 309.21, 309.24, 309.81, F40, F41.1, F41.3, F41.8, F41.9, F43.22, F43.0, F43.1); and *substance use disorders* (ICD-9: 291, 292, 303–305; ICD-10: F10–F19). Substance use disorders were disaggregated to *alcohol* (ICD-9: 291, 303, 305.0; ICD-10: F10), *any drug* (ICD-9: 292, 304, 305.2, 305.3, 305.4, 305.5, 305.6, 305.7, 305.8, 305.9; ICD-10: F11–F17, F18–F19), *marijuana* (ICD-9: 304.3, 305.2; ICD-10: F12), *tobacco* (ICD-9: 305.1; ICD-10: F17) and *opioid* (ICD-9: 304.0, 304.7, 305.5; ICD-10: F11) diagnoses. The Charlson comorbidity score was calculated based on diagnosis codes made in the year prior to index, and used to account for medical comorbidity and disease severity where a higher score is associated with worse outcomes (ranging from 0-6) [40].

Statistical analysis

We used chi-squared and t-tests to examine differences between categorical and continuous measures, respectively, and the SBIRT and usual care groups. Measures included demographic characteristics (age, sex, race/ethnicity), substance use and mental health diagnoses, medical comorbidity and primary care, psychiatry, addiction medicine, ED, and inpatient utilization. Multilevel multivariate logistic regression models with patients nested within providers were used to examine the dichotomous outcomes (e.g., any behavioral health diagnoses, any inpatient utilization), and multilevel negative binomial regression models were used to examine Charlson score and visit counts. We examined visit counts among a subsample of patients with at least one visit of the corresponding type of utilization (e.g., number of psychiatry visits was examined among patients with at least one psychiatry visit). In these models, the exponent of the coefficient for the treatment variable represents the odds ratio (OR) and incidence rate ratio (iRR) for the logistic and negative binomial regressions, respectively, for the SBIRT group relative to usual care. Models adjusted for patient age, sex, race/ethnicity, Medicaid insurance coverage in the year prior to index, length of membership in months, and an indicator for the presence of the corresponding comorbidity or utilization in the year prior to index (e.g., an indicator for inpatient utilization in the year prior to index was include in models examining inpatient utilization). We conducted posthoc analyses examining all mental health and substance use diagnosis outcome models stratifying by race/ethnicity, and separately, by sex. Models were run as described above, excluding the indicator for Medicaid insurance, which had to be excluded due to sample size issues for some of the race/ethnicity categories. All analyses were performed using SAS© 9.3 (SAS Institute Inc., Cary, NC).

Results

Among the 1,871 adolescents, 55.7% were female, the average age was 15.8 years, 6.4% had Medicaid insurance coverage in the year prior to the index, 23.8% were Hispanic, 33.5% were Black/African American, 11.3% were Asian, 25.2% were White, and 6.1% had other/unknown race/ethnicity. The SBIRT group had more females (59.5% vs. 48.1%, $p < .001$), more Black/African American (35.6% vs. 29.2%) and Hispanic (24.9% vs. 21.6%) patients and fewer White patients (22.1% vs. 31.7%; $p < .001$). Age and insurance type did not differ between groups. Membership retention during the 7-year study period was quite high, with the average length of enrollment being 69.7 months (SD = 23.0 months); 55% had complete membership across all 7 years. Membership did not significantly differ between groups (SBIRT group, mean (SD) = 69.1 (23.6); usual care, 71.1 (21.7); $p > .05$) (Table A1).

Bivariate comparisons of substance use and mental health diagnoses and healthcare utilization by the group over 7 years

Fewer patients in the SBIRT group had anxiety (4.1% vs. 6.5%; <.05), alcohol- (.4% vs. 1.8%; <.01), and marijuana-related (1.2% vs. 2.8%; $p < .05$) diagnoses in the year prior to index compared with usual care; other diagnoses and types of utilization did not differ in the year prior to index (see Table A2).

Over the 7-year period, the SBIRT group had fewer substance use (19.0% vs. 24.0%, $p < .05$), alcohol- (4.8% vs. 7.8%, $p < .01$), and any drug use-related (10.6% vs. 13.8%, $p < .05$) diagnoses compared to usual care. Mental health diagnoses and average Charlson score did not differ between groups. Eight percent of the sample had visits outside of the health plan, which were covered and captured by Kaiser. The SBIRT group had a higher prevalence of psychiatry visits (47.4% vs. 39.9%, $p < .01$), and fewer patients in the SBIRT group had addiction medicine visits (4.9% vs. 7.8%, $p < .05$) or inpatient hospitalizations (13.3% vs. 18.2%, $p < .01$), over the 7-year period compared to usual care. Primary care and ED utilization did not differ between groups. Among those who had at least one visit of that type, the average number of psychiatry visits (mean[SD] = 10.3[17.4] SBIRT group, 18.2[30.8] usual care, $p < .01$) was lower in the SBIRT group compared with usual care; the number of inpatient hospitalizations, addiction medicine visits, primary care, and ED visits did not differ between groups (Table A2).

Multivariate models

Substance Use and mental health diagnoses. The SBIRT group had lower odds of having any substance use, alcohol-, any drug-, marijuana-, and tobacco-related diagnoses compared with usual care. The SBIRT group also had lower Charlson Comorbidity scores at 7 years compared with usual care. Mental health diagnoses did not differ between the SBIRT and usual care groups.

In these same logistic regression models, females had higher odds of any behavioral health, depression, and anxiety disorders and lower odds of any substance use and tobacco-related diagnoses compared with males; there were no significant differences by sex in alcohol, any drug, or marijuana-related diagnoses. Older patients had lower odds of any behavioral health, depression, and anxiety diagnoses; substance use disorders did not differ across age with the exception of tobacco use, whereas older patients had higher odds of a tobacco diagnosis. Compared with White patients, Asians had lower odds of any behavioral health,

Table 2
Multilevel logistic regression analyses examining utilization[c] over 7 years postindex among all eligible patients (n = 1,871)

	Any psychiatry visits		Any addiction medicine visits		Any ED visits		Any inpatient hospitalizations	
	OR	*p*-value	OR	*p*-value	OR	*p*-value	OR	*p*-value
Intercept	16.70 (2.60–107.4)	.003	0.08 (.02–.32)	<.001	0.82 (0.27–2.48)	.724	0.05 (0.01–0.24)	<.001
SBIRT Group (vs. Usual Care)	0.71 (0.13–4.02)	.703	0.87 (0.64–1.19)	.380	1.04 (0.85–1.27)	.725	0.59 (0.41–0.85)	.005
Female (vs. Male)	1.43 (1.20–1.69)	<.001	0.47 (0.37–0.59)	<.001	1.01 (0.84–1.22)	.898	1.89 (1.41–2.52)	<.001
Age	0.82 (0.77–0.87)	<.001	0.95 (0.87–1.05)	.321	0.91 (0.86–0.96)	.001	1.01 (0.91–1.12)	.864
Race/Ethnicity (reference: White)								
Asian	0.56 (0.39–0.80)	.002	0.52 (0.24–1.13)	.097	0.55 (0.40–0.77)	<.001	0.81 (0.50–1.33)	.407
Black/African American	0.65 (0.47–0.89)	.007	0.68 (0.46–1.01)	.056	1.84 (1.39–2.43)	<.001	1.44 (1.15–1.80)	.002
Hispanic	0.69 (0.50–0.95)	.023	1.50 (1.05–2.14)	.025	1.42 (1.08–1.87)	.012	1.56 (1.06–2.31)	.025
Missing/Unknown	0.61 (0.42–0.89)	.011	0.34 (0.11–1.03)	.056	1.02 (0.60–1.71)	.954	1.26 (0.71–2.25)	.426
Medicaid Insurance[a] (vs. No Medicaid Insurance)	0.85 (0.57–1.28)	.443	0.38 (0.13–1.13)	.083	3.04 (1.81–5.08)	<.001	1.58 (0.96–2.61)	.071
Membership months	1.01 (1.01–1.02)	<.001	1.02 (1.01–1.02)	<.001	1.03 (1.02–1.03)	<.001	1.01 (1.01–1.02)	<.001
Diagnosis in year prior[b]	1.27 (1.18–1.37)	<.001	1.07 (1.01–1.14)	.026	2.30 (1.84–2.86)	<.001	3.34 (1.50–7.44)	.003

Note: OR = odds ratio.
[a] Any Medicaid coverage in the year prior to index.
[b] Corresponding diagnoses/score made in the year prior to index.
[c] 99.8% patients had at least one primary care visit by 7 years postindex, model would not converge.

alcohol- and tobacco-related diagnoses. Black/African Americans had lower odds of having any behavioral health, depression, anxiety, and alcohol-related diagnoses, but higher odds of any substance use and marijuana-related diagnoses compared with White patients. Hispanic patients had lower odds of depression and anxiety disorders and higher odds of any substance use- and alcohol-related diagnoses, and higher Charlson scores at 7 years compared with White patients. Medicaid insurance coverage was not significant in any of the models (Table 1).

Healthcare utilization - any versus None

In logistic regression models examining any utilization for each type (e.g., hospitalizations, psychiatry, addiction medicine, primary care, ED) over 7 years, the SBIRT group had lower odds of any hospitalizations compared with usual care; no differences were found between SBIRT groups in the odds of psychiatry, addiction medicine or ED visits after adjusting for patient characteristics; since almost all patients (n = 1,867) had at least one primary care visit over 7 years, logistic regression was deemed unnecessary.

In the same logistic regression models, patient characteristic findings included females having higher odds of psychiatric utilization and hospitalizations and lower odds of addiction medicine utilization compared with males. Older patients had lower odds of psychiatric and ED utilization, and patients with any Medicaid coverage in the year prior to index had higher odds of an ED visit compared to those without any Medicaid coverage during that time period. Asians had lower odds of psychiatry and ED utilization compared with White patients. Black/African American and Hispanic patients had lower odds of psychiatry utilization and higher odds of ED and inpatient utilization compared with White patients (Table 2).

Healthcare utilization - visit counts

Visit counts were examined among patients with at least one visit for the corresponding type of utilization over the 7-year period (n = 1,867 primary care model; n = 841 psychiatry model; n = 110 addiction medicine model; n = 1,142 ED model; n = 279 inpatient model). Negative binomial models examining the number of visits over 7 years found that among those with at least one visit of that type, adolescents in the SBIRT group had fewer primary care, psychiatry visits, and more addiction medicine visits compared with usual care; no differences were found in the number of emergency department visits or hospitalizations.

Patient characteristic findings from the same models found that females had more primary care and ED visits. Older patients had fewer primary care and psychiatry visits; the number of addiction medicine, ED, and inpatient visits did not differ. Those with Medicaid coverage in the year prior to the index had more primary care visits and fewer addiction medicine visits. Asian patients had fewer primary care and addiction medicine visits compared with White patients. Black/African American patients had fewer psychiatry and addiction medicines and more ED visits compared with White patients. Hispanic patients had fewer psychiatry visits and more ED visits compared with White patients (Table 3).

Posthoc and sensitivity analyses

Posthoc analyses examined all mental health and substance use diagnosis outcomes stratified by race/ethnicity, and separately, by sex. Among Asian patients, those in the SBIRT group had lower odds of any mental health, depression, and anxiety diagnoses compared with usual care. Among Hispanic patients, the SBIRT group had higher odds of an anxiety diagnosis and lower odds of any substance, other drugs, and marijuana use disorder diagnoses compared with usual care, and among Black/African American patients, the SBIRT group had lower odds of alcohol use disorder diagnoses. Among White patients, those in the SBIRT group had higher odds of any mental health diagnosis compared with usual care (See Table A3). There were no differences in the diagnosis outcomes between SBIRT groups when examining models stratified by sex (not shown).

A sensitivity analysis was conducted, reexamining all models only among the subset of patients with continuous membership across the 7-year time period (n = 1,033, n = 671 SBIRT group, n = 362 usual care). The findings in these models mirrored what was

Table 3
Multilevel multinomial regression examining number of visits over 7 years postindex among patients with at least one visit of the same type

	Primary care visits (n = 1,867)		Psychiatry visits (n = 841)		Addiction medicine visits (n = 110)		ED visits (n = 1,142)		Inpatient hospitalizations (n = 279)	
	iRR	*p*-value	iRR	*p*-value	iRR	*p*-value	iRR	*p*-value	iRR	*p*-value
Intercept	6.10 (3.80–9.78)	<.001	85.93 (25.11–294.1)	<.001	3.72 (0.13–110.4)	.447	1.75 (0.87–3.52)	.119	1.33 (0.27–6.58)	.726
SBIRT Group (vs. Usual Care)	0.90 (0.82–0.99)	.025	0.64 (0.51–0.79)	<.001	1.52 (1.14–2.03)	.004	0.93 (0.79–1.09)	.376	0.89 (0.70–1.13)	.341
Female (vs. Male)	1.53 (1.40–1.68)	<.001	1.04 (0.81–1.34)	.738	1.51 (0.88–2.58)	.132	1.42 (1.25–1.61)	<.001	0.95 (0.75–1.20)	.653
Age	0.96 (0.94–0.98)	<.001	0.86 (0.81–0.91)	<.001	1.11 (0.94–1.31)	.216	0.99 (0.96–1.04)	.802	1.01 (0.93–1.10)	.765
Race/Ethnicity (reference: White)										
Asian	0.89 (0.80–1.00)	.042	1.17 (0.77–1.78)	.472	0.25 (0.08–0.83)	.024	0.97 (0.78–1.21)	.768	1.00 (0.71–1.41)	.985
Black/African American	0.95 (0.87–1.04)	.247	0.71 (0.54–0.93)	.013	0.35 (0.17–0.69)	.003	1.62 (1.37–1.93)	<.001	1.20 (0.84–1.72)	.325
Hispanic	0.97 (0.89–1.06)	.492	0.67 (0.46–0.96)	.029	0.72 (0.37–1.41)	.332	1.51 (1.23–1.85)	<.001	1.39 (0.99–1.95)	.057
Missing/Unknown	0.93 (0.80–1.08)	.346	0.82 (0.54–1.24)	.348	0.71 (0.25–2.00)	.519	1.20 (0.92–1.56)	.172	1.37 (0.91–2.05)	.130
Medicaid Insurance[a] (vs. No Medicaid Insurance)	1.26 (1.08–1.46)	.004	0.89 (0.54–1.47)	.653	0.04 (0.01–0.09)	<.001	1.30 (0.97–1.74)	.078	1.22 (0.61–2.42)	.576
Membership months	1.02 (1.01–1.02)	<.001	1.01 (1.00–1.01)	<.001	1.00 (.98–1.01)	.716	1.00 (1.00–1.01)	.026	1.00 (0.99–1.01)	.822
Diagnosis in year prior[b]	1.10 (1.08–1.11)	<.001	1.04 (1.03–1.05)	<.001	1.01 (1.01–1.02)	<.001	1.33 (1.23–1.43)	<.001	1.67 (0.93–3.02)	.087

Note: iRR = incidence rate ratio.
[a] Any Medicaid coverage in the year prior to index.
[b] Corresponding diagnoses/score made in the year prior to index.

found among the full sample, with few exceptions. Among the sample of patients with continuous membership, no differences were found between the SBIRT and usual care groups in the odds of tobacco-related and alcohol-related diagnoses, and among those with complete membership who had at least one visit of that type, there were no longer differences in the number of primary care or addiction medicine visits between groups. An additional sensitivity analysis was conducted to examine differences between the usual care group and only those patients in the SBIRT group who actually received a brief intervention in the original trial (21.3% of patients in the SBIRT group received a brief intervention). When examining models among only SBIRT group patients who received a BI (n = 267) and all eligible usual care patients (n = 616), there were no longer significant differences between groups in the odds of a substance use, alcohol, or any drug or tobacco diagnoses over 7 years. The SBIRT group that received a BI had higher odds of addiction medicine utilization (OR = 1.46, 95% CI = 1.24–1.70) compared with usual care, whereas there were no significant differences in addiction medicine utilization between groups among the full sample. Additionally, there were no significant differences in hospitalizations between the SBIRT Group who received a BI and usual care, but in models examining the full sample, the SBIRT group had lower odds of hospitalizations. Among patients with at least one visit of that type, there were no significant differences between groups in the number of primary care visits; however, the SBIRT group who received a BI had fewer inpatient hospitalizations than the usual care group (iRR = 0.77, 95% CI = 0.59, 1.00); the groups did not differ when examining the full sample (See Table A4).

Discussion

The field of adolescent SBIRT research is relatively new and has heretofore examined more proximal outcomes - usually up to 12 months postintervention; our 7-year outcome data address a gap in the evidence base. In this study of the long-term outcomes of adolescents participating in an SBIRT trial in pediatric primary care, we examined outcomes important to adolescent development: subsequent substance use and other mental health disorders and medical comorbidity. We also examined how access to SBIRT affected potentially costly healthcare outcomes, which is particularly salient to health policymakers. We found lasting effects on the development of future disorders and on healthcare utilization well into young adulthood. To our knowledge, this is the first study of SBIRT for adolescents to examine these critical outcomes longitudinally into young adulthood (patients ranged from 19 to 25 years by study's end), and it expands the growing literature on the benefits of SBIRT for adolescents.

Young adults in the SBIRT group during their adolescence were less likely to develop any substance use disorder, including a diagnosis of alcohol, marijuana, or tobacco use disorder, over the seven years after original screening. Moreover, they were less likely to experience inpatient hospitalizations, and those with a psychiatry and/or an addiction medicine visit had fewer psychiatry visits but more addiction medicine visits. These findings suggest that the referral to treatment or "RT" component of SBIRT may help facilitate specialty addiction treatment engagement for those in need of it. This is among very few studies to demonstrate the positive impact of adolescent SBIRT on specialty treatment initiation.

Research examining drinking patterns among adolescents transitioning to adulthood suggests that many adolescents "mature out" of these problems. On the other hand, it is well-known that health behavior patterns established in adolescence, both good and risky, often persist into young adulthood [41,42], and risky behaviors, if not addressed, can significantly affect future health outcomes [43–45]. As most adult substance use disorders originate in adolescence, this is the ideal time to intervene to prevent adolescent use entirely or prevent mild problems from progressing. SBIRT in pediatric primary care is especially important in the U.S. where adult health insurance

coverage is not guaranteed; however, most adolescents *are* covered with access to primary care. The U.S. Preventive Services Task Force recently decided against recommending screening for unhealthy drug use among adolescents. Our study shows the benefits of SBIRT among adolescents who screen positive for substance use. We found benefits to the SBIRT group even after 7 years, which makes a strong case for making adolescent screening and subsequent BI, when needed, an important vital sign metric during well-check visits in this group.

Recent research suggests that half of children and adolescents with behavioral health problems do not receive treatment for them [46]; pediatric primary care-based SBIRT can increase access to appropriate treatment interventions and may be advantageous for reducing racial and ethnic disparities in care among adolescents of color, and with Medicaid Managed Care enrollees in healthcare systems with "carved-out" behavioral healthcare benefits [47]. The disparities in substance use treatment-seeking and initiation [48] are well documented, and these youth are already less likely to receive behavioral health services [12]. Healthcare disparities are also exacerbated over time because these patients are more likely to lose health insurance coverage as they age into adulthood [49–51]. The adult SBIRT literature provides some evidence that primary care-based SBIRT may be especially beneficial for historically under-served populations [52], because the setting may be consistent with patients' preferences for nonspecialty care mental health services [53]. Findings from posthoc analyses examining outcomes stratified by race/ethnicity suggest that SBIRT can be effective, especially for Hispanic and Black/African American adolescents. Providing SBIRT in pediatric primary care, which most children and adolescents have access to, may help to improve access to groups historically under-served in specialty behavioral health treatment and reduce care disparities.

Limitations

The study has several limitations. It was conducted in an integrated healthcare system with an insured population, and our findings may not be generalizable to public health systems or uninsured populations. However, the health system membership is representative of the Northern California population, including a sizeable Medicaid population. Because this was an intent-to-treat analysis, all eligible patients were included in the study, regardless of whether they received a BI or had continued membership over 7 years. However, membership was adjusted for using a count of member months over the 7-year period, and we also report the results of sensitivity analyses examining: (a) only those with continuous membership and (b) including only those in the SBIRT group who received a brief intervention. While the recommended workflow was such that pediatricians with patients who endorsed alcohol or drug use or mood symptoms at screening were encouraged to either deliver a BI or refer to the behavioral health clinician, as we found out, only a minority of those patients actually received a BI. Although we could not ascertain the severity of those who did or did not receive a BI due to the pragmatic nature of the trial, we can assume with some confidence that those who did were likely more severe than those who did not (which seems to be reflected in the fact that more of those in the SBIRT group who received a BI also went on to have higher odds of specialty treatment utilization). This was a pragmatic trial, and we relied on diagnoses documented during regular clinical care rather than self-reported use or symptoms, and thus may be missing lower severity substance use and mental health symptoms. However, examining use disorder diagnoses associated with more severe substance use problems expands the range of developmentally salient outcomes examined in the literature, which more typically examines self-reported use. Because we used the health system's EHR and administrative databases to examine services utilization, we only captured services provided within, or paid for the health plan, and thus, we may not have captured all out-of-system utilization, particularly informal services such as self-help groups. However, there is nothing to suggest that there would be a difference in outside utilization between the two groups. The SBIRT group had more girls than boys at baseline, and girls were more likely to report mental health symptoms and diagnoses, which may have dampened the effects of access to SBIRT on subsequent mental health diagnoses in that arm. While we had promising findings regarding SBIRT's impact on healthcare utilization, additional cost-effectiveness and cost-benefit studies are needed to assess the magnitude of the economic impact of SBIRT on youth and young adult outcomes.

Conclusions

Our findings add to the growing evidence base on the beneficial effects of providing SBIRT for adolescents in pediatric primary care and extend the existing literature by demonstrating clinically significant effects on the development of substance use disorders and healthcare utilization into young adulthood. Like many other integrated behavioral health approaches [54–56], SBIRT may provide significant and lasting benefits to vulnerable adolescents as they mature into young adulthood. This is particularly compelling because young adults are an age group that often "falls through the cracks" of the healthcare system as they transition from pediatric care to adult medicine. They are less likely to have a primary care physician than adolescents or older adults and more likely to use the ED for their healthcare, and these disparities are especially the case for vulnerable racial, ethnic, unemployed, and under-insured sub-populations of young adults [57]. Providing an intervention during their adolescence that can lay a strong preventative foundation could have a significant impact on the trajectory of their adult health and wellbeing. It is important that future studies examine the longitudinal effects of SBIRT for youth across a broad range of not only substance use outcomes but also medical and mental health conditions and other outcomes essential to youth health and wellbeing.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2021.11.033.

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