Increased Admissions of Older Adults to Substance Use Treatment Facilities and Associated Changes in Admission Characteristics, 2000–2017

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ABSTRACT

Objective: Although substance use disorder (SUD) among older adults is increasing, little has been documented about recent increases in admissions to treatment facilities and associated patient and population characteristics.

Methods: We used nationwide data from the Treatment Episode Data Set: Admissions to examine annual admissions to SUD treatment facilities between 2000–2001 and 2016–2017 among adults 55 years and older compared to those aged 21 to 54. Analyses addressed the impact on admission rates of increases in the general older adult population and in sociodemographic and clinical characteristics of those admitted using bivariate and multivariate logistic regressions.

Results: From 2000 to 2017, the number of older adults admitted to SUD treatment facilities increased by 203.7% as compared to 13.0% among younger adults. Admissions per 1,000 adults in the general population moderated these differences to 98.4% vs 7.2%. Older adults showed greater increases relative to younger adults in proportions admitted for cocaine/crack (odds ratio [OR], 5.35; 95% confidence interval [CI], 5.20–5.51) and cannabis (OR, 1.81; 95% CI, 1.72–1.91) use and a relative decrease in admission for opiates (OR, 0.76; 95% CI, 0.73–0.80) and alcohol (OR, 0.79; 95% CI, 0.78–0.80) along with changes in some demographics. Multivariate analysis showed that the OR for admission among older adults, as compared to younger adults, was 1.73 (95% CI, 1.65–1.80) in 2016–2017 compared to 2000–2001, adjusting for other factors.

Conclusions: The number and proportion of older adults admitted to SUD treatment facilities increased substantially from 2000 to 2017 and were associated with changes in both population numbers and patient characteristics, especially a relative increase among older adults in cocaine/crack and cannabis use and a relative decrease for use of alcohol and opioids.

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The US has a steadily aging population, including "baby boomers," born between 1946 and 1964, constituting a major cohort that has consistently reported high lifetime rates of substance use.[1,2] Substance use, initiated at younger ages in the baby boom cohort, is thus a likely risk factor for increasing rates of substance use disorders (SUDs) and a need for treatment in later years.[3] While it has been estimated that 4.4 million older adults may need treatment for SUDs by 2020, their actual use of services has not been documented.[4,5] Previous studies suggest that SUDs are often undetected or undertreated among older adults,[6] and actual service use for SUDs among older adults has become a major concern.[3,7] Further, reports from countries such as the United Kingdom and Australia highlighted SUD as a growing problem in older adults.[8,9]

In addition to the demographic shift in the general US population, parallel changes have occurred in the past two decades. For example, the types of substances used in the US have changed in recent years, reflecting a major epidemic of prescription opioid use, primarily among young or middle-aged adults[10]; legalization of cannabis use in many states[11]; and increased misuse of prescription drugs other than opioids (eg, benzodiazepines[12]). SUD treatment services are often provided by separate specialty service organizations, including stand-alone not-for-profit and government-operated facilities.[13] Most recently, the Affordable Care Act (ACA) of 2010, which was fully implemented in January 2014, expanded coverage of treatment services for SUDs among disabled and low income populations (eg, Medicaid beneficiaries and Medicare and Medicaid dual eligibles).[14] Thus, increased public funding as well as demographic and epidemiologic changes may have expanded access to SUD treatment specifically among both older and younger adults.

Previous studies analyzing the rates of admissions for SUD treatment have shown a steady increase in recent decades, but studies beyond 2008 are scarce. As a result, relatively little is known about more recent trends in admission numbers and presenting characteristics of older adults as compared to younger adults seeking SUD treatment.

We thus sought to answer three questions: (1) Did the number and proportions of admissions to SUD treatment among adults aged 55 and older increase relative to increases among younger adults from 2000 to 2017? (2)

Clinical Points

- The proportion of admissions to substance use disorder (SUD) treatment facilities among older adults (55 and older) per 1,000 US adult population increased from 8.8% in 2000–2001 to 15.1% in 2016–2017.
- Cocaine- and cannabis-related admissions increased but alcohol-related admissions decreased over time among older adults.
- Age-sensitive care (eg, medical comorbidities and polypharmacy) should be readily available for older adults requiring SUD treatment.

To what extent did these increases reflect increased numbers of older adults in the general population? and (3) How have differences in admission characteristics between older and younger admissions changed during these years, especially changes in the substances identified as the primary reason for admission? Older adults were defined as 55 years and older in accordance with previous studies that investigated similar questions using the same data set between the years 1998 to 2008[7] and to increase statistical power.

METHODS

Sources of Data and Study Sample

Primary data were derived from the 2000–2017 Treatment Episode Data Set: Admissions (TEDS-A), nationwide data of service users compiled annually by state-level substance treatment facilities and reported to the Substance Abuse and Mental Health Services Administration (SAMHSA). TEDS-A provides information on the sociodemographic and clinical characteristics of people 12 years and older who are admitted to state-licensed or certified SUD treatment centers receiving federal public funding. The sample used for analysis included admissions that occurred among adults 21 or older.

In addition to TEDS-A, we collected 2000–2017 annual population reports from the US Census Bureau.[15,16] These data included the proportion of adults in the general US population in each state from 2000– 2001 to 2016–2017.[17,18] This study was deemed exempt by the Institutional Review Board at Yale School of Medicine, as we used publicly available, deidentified data. Further descriptions of the data (eg, codebook and other technical reports) can be found on the SAMHSA website (https://www.samhsa.gov/data/data-we-collect/teds-treatment-episode-data-set).

Measures

Sociodemographic variables of admitted patients included age (older adults aged ≥ 55 vs adults aged 21–54), sex (male or female), race (non-Hispanic White, non-Hispanic Black, Hispanic, or non-Hispanic other), marital status (never married, currently married, separated, or divorced/widowed), education level (< high school or ≥ high school), employment status, veteran status, living arrangement (homelessness, dependent living, or independent living), primary source of income (wages/salary, public assistance, retirement/pension or disability, other, or none), and health insurance (private, Medicare, Medicaid, or none).

Clinical variables included service setting for the admission (ie, inpatient or residential detoxification; hospital, short-term, or long-term rehabilitation/residential programs; intensive outpatient, nonintensive outpatient, or ambulatory detoxification), treatment referral source (substance use care provider, other health care professional, school-based educational provider, employer/employee assistance program [EAP], other community referral, or court/criminal justice referral), number of previous substance use treatment episodes (none, 1, 2–3, or ≥ 4), and the primary type of substance use requiring admission (alcohol, cocaine/crack, cannabis, heroin, nonprescription methadone, other opiates and synthetics, or other).

Statistical Analysis

First, descriptive data were presented on the numbers of annual admissions stratified by age (21–54 years and ≥ 55 years) from 2000–2001 to 2016–2017. Data on the general population (by age and year) were presented, and admission rates among the general population per 1,000 persons were calculated. Absolute changes in (*a*) numbers of admissions, (*b*) admissions per 1,000 population, and (*c*) proportions of older adults among those admitted were estimated, along with relative percent changes in these measures for each age group.

For demographic and clinical characteristics, changes that may account for the increase in admissions among patients aged 55 and older were then examined for both age groups in 2000–2001 and 2016–2017, with changes within age group represented by risk ratios (RRs), the percentage of those with each characteristics in 2016–2017 divided by the percentage in 2000–2001.

In our preliminary analyses, we have previously examined the time trends by each year, and the patterns were linear. Since the goal of this study is to compare long-term trends, the most parsimonious approach was to compare utilization at the first and last years of the study. Given that our primary aims were to examine the relative increment of admissions in older adults compared to younger adults between 2 time points (2000 vs 2017), and how this increase reflects increased numbers of older adults in the general population, we chose two discrete 1-year periods (2000–2001 vs 2016–2017). Bivariate logistic regression analyses were then conducted to further examine factors that may account for the increase in older adults' admissions, with the number of admissions in 2016–2017 vs 2000–2001 as the dependent variable and main effects for age group (21–54 vs ≥ 55) and the specific sociodemographic or clinical characteristic as independent main effects along with the interaction of age group and each characteristic. The interaction term reflects the relative change in each characteristic by age group (≥ 55 vs 21–54 in 2016–2017 vs 2000–2001). Because of the very large sample sizes, virtually all terms were highly significant, and interaction terms with odds ratios (ORs)

Table 1. Trends in Total Substance Use Facility Admissions and General Population by Year, 2000–2017[a]

	2000–2001	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015	2016–2017	Absolute change[b]	% Change[c]
Total admissions											
21–54 y	2,884,981	3,061,686	3,062,491	3,503,740	3,591,627	3,316,960	3,140,575	3,005,431	3,258,752	373,771	13.0%
≥ 55 y	119,732	136,700	149,670	196,274	236,688	253,271	277,397	301,984	363,649	243,916	203.7%
% Older adults	4.0%	4.3%	4.7%	5.3%	6.2%	7.1%	8.1%	9.1%	10.0%	6.1%	151.9%
General population											
21–54 y	277,145,520	280,720,124	283,389,397	285,998,406	287,816,765	289,025,205	290,486,813	291,454,501	291,997,173	8,396,973	5.4%
≥ 55 y	119,662,780	126,098,013	132,799,918	140,048,365	147,963,459	156,168,440	165,612,045	174,535,389	183,220,043	63,557,263	53.1%
% Older adults	30.2%	31.0%	31.9%	32.9%	34.0%	35.1%	36.3%	37.5%	38.6%	8.4%	27.9%
Admissions per 1,000 population											
21–54 y	10.4	10.9	10.8	12.3	12.5	11.5	10.8	10.3	11.2	0.8	7.2%
≥ 55 y	1.0	1.1	1.1	1.4	1.6	1.6	1.7	1.7	2.0	1.0	98.4%
% Older adults	8.8%	9.0%	9.4%	10.3%	11.4%	12.4%	13.4%	14.4%	15.1%	6.3%	72.2%

[a]Data are from Treatment Episode Data Set: Admissions, 2000–2017.
[b]Refers to differences between 2000–2001 and 2016–2017.
[c]Refers to relative change (in percentage) between 2000–2001 and 2016–2017.

of ≥ 1.25 or ≤ 0.80 were considered to represent substantial differences in age groups across years.[19] ORs for the interaction terms ≥ 1.25 reflect greater relative increase in a characteristic among older adults in 2016–2017, while interaction terms ≤ 0.80 reflect greater relative decline in the characteristics among older adults in 2016–2017. To identify a more inclusive list of variables for inclusion in multivariable analyses, variables with ORs ≥ 1.25 or ≤ 0.80 in bivariate analyses for each set of comparisons were entered into these models.

A final multivariate hierarchical linear logistic regression analysis was conducted, again with year of admission as the dependent variable (2016–2017 vs 2000–2001), and independent variables reflecting (1) age at the time of each admission (≥ 55 vs 21–54), (2) the proportion of the general population ≥ 55 years old in the state of residence of each admission in 2000–2001 or 2016–2017 (representing changes in the general population at the state level), and (3) a term representing the interaction of admission age and each characteristic identified previously as having shown a substantial difference in change between age groups between 2000–2001 and 2016–2017. Because of the uniformity (ie, lack of variability) of the general population estimates within states and years, generalized estimating equation (GEE) analyses[20] were used with random effects for states.

RESULTS

Trends of Proportions of Older Adults Admitted to SUD Facilities and in the General Population

Addressing the first aim of our study, the number of older adults who were admitted to SUD treatment facilities increased from 119,732 in 2000–2001 to 363,649 in 2016–2017, a 203.7% increase as compared to an increase among those 21–54 of only 13.0%, from 2,884,981 in 2000–2001 to 3,258,752 in 2016–2017, a difference of 190.7% in the percent increase (Table 1). In other words, the proportion of older adults admitted to SUD treatment facilities increased from 4.0% in 2000–2001 to 10.0% in 2016–2017, with an absolute difference of 6.1% and a relative increase of 151.9%.

The second aim of our study was addressed by the following results. Between 2000–2001 to 2016–2017, the number of adults ≥ 55 in the general population increased by 53.1% as compared to 5.4% among those 21–54 (Table 1), and the proportion of older adults in the adult population increased from 30.2% to 38.6%, which is an absolute difference of 8.4%, or a 27.9% increase.

The proportion of SUD treatment admissions among older adults per 1,000 US adult population increased by 0.98/1,000, or a 98.4% increase, between 2000–2001 and 2016–2017 (Table 1), as compared to 0.75/1,000, or 7.2% increase, among those aged 21–54.

Main Effects and Interactions of Age Group and Year of Admission

Sociodemographic characteristics. Turning to the sociodemographic characteristics of admitted patients (Table 2), we first note that because of the very large sample size, virtually all statistical comparisons were highly significant, indicating only that they were not due to chance, and we focus instead on effect sizes reflected in ORs and RRs.

As an initial example, women were less likely to be in the older adults group (OR, 0.56; 95% CI, 0.56–0.57) (Table 2, column 8) but more likely to be admitted in 2016–2017 than 2000–2001 (OR, 1.28; 95% CI, 1.28–1.29) (Table 2, column 9). The RR over time for older females was 1.37 (Table 2, column 7), which was greater than the RR of 1.18 for younger women (Table 2, column 4), as reflected in the positive interaction term in Table 2, column 10. More specifically, the interaction term showed that older women were more common in later years than earlier years as evidenced by an OR of 1.17 (95% CI, 1.16–1.19) (Table 2, column 10).

Table 2. Interaction Analyses of Age (21–54 y vs ≥ 55 y) and Year (2000–2001 vs 2016–2017) on Sociodemographic Characteristics

	21–54 y			≥ 55 y			Odds ratio (95% CI)		
	2000–2001 (column 2)	2016–2017 (column 3)	Risk ratio (column 4)	2000–2001 (column 5)	2016–2017 (column 6)	Risk ratio (column 7)	≥ 55 y vs 21–54 y (column 8)	2016–2017 vs 2000–2001 (column 9)	Interaction (column 10)
Sex									
Female	30.8%	36.3%	1.18	20.0%	27.4%	1.37	0.56 (0.56–0.57)***	1.28 (1.28–1.29)***	1.17 (1.16–1.19)***
Male	69.2%	63.7%	0.92	80.0%	72.6%	0.91	1.78 (1.75–1.80)***	0.78 (0.78–0.78)***	0.85 (0.84–0.87)***
Race/ethnicity									
Non-Hispanic white	53.6%	60.1%	1.12	58.0%	52.1%	0.90	1.20 (1.18–1.21)***	1.30 (1.30–1.31)***	0.60 (0.60–0.61)***
Non-Hispanic Black	24.9%	15.4%	0.62	21.7%	28.3%	1.30	0.84 (0.82–0.85)***	0.55 (0.54–0.55)***	2.60 (2.56–2.64)***
Hispanic	13.1%	15.2%	1.16	11.5%	11.6%	1.01	0.86 (0.84–0.88)***	1.18 (1.18–1.19)***	0.85 (0.83–0.87)***
Non-Hispanic other	3.7%	6.3%	1.70	3.8%	5.4%	1.42	1.04 (1.00–1.07)*	1.76 (1.75–1.77)***	0.82 (0.79–0.85)***
Missing	5.3%	3.5%	0.66	5.5%	2.9%	0.53	1.05 (1.03–1.08)***	0.64 (0.64–0.65)***	0.78 (0.76–0.81)***
Marital status									
Never married	39.4%	48.3%	1.23	13.4%	26.9%	0.20	0.24 (0.23–0.24)***	1.44 (0.23–0.24)***	1.66 (1.63–1.69)***
Currently married	15.1%	9.9%	0.66	20.9%	13.0%	0.62	1.48 (1.46–1.50)***	0.62 (0.62–0.62)***	0.91 (0.89–0.93)***
Separated	6.3%	4.1%	0.65	6.0%	5.1%	0.85	0.95 (0.93–0.98)***	0.63 (0.63–0.63)***	1.33 (1.29–1.37)***
Divorced or widowed	16.6%	9.9%	0.60	32.9%	24.6%	0.75	2.47 (2.44–2.50)***	0.55 (0.55–0.55)***	1.21 (1.19–1.23)***
Missing	22.7%	27.9%	1.23	26.8%	30.4%	1.13	1.25 (1.23–1.27)***	1.32 (1.31–1.32)***	0.91 (0.89–0.92)***
Education									
< High school	33.4%	23.9%	0.72	35.1%	23.7%	0.68	1.08 (1.06–1.09)***	0.63 (0.62–0.63)***	0.91 (0.90–0.93)***
≥ High school	63.8%	69.8%	1.09	61.3%	69.9%	1.14	0.90 (0.89–0.91)***	1.31 (1.31–1.32)***	1.12 (1.10–1.13)***
Missing	2.9%	6.3%	2.17	3.6%	6.4%	1.78	1.27 (1.23–1.31)***	2.29 (2.27–2.31)***	0.80 (0.78–0.83)***
Employment									
Yes	31.7%	24.5%	0.77	21.3%	14.7%	0.69	0.58 (0.58–0.59)***	0.70 (0.70–0.70)***	0.91 (0.89–0.92)***
No	63.0%	69.1%	1.10	72.5%	78.4%	1.08	1.55 (1.53–1.57)***	1.31 (1.31–1.32)***	1.05 (1.03–1.07)***
Missing	5.3%	6.4%	1.21	6.2%	6.9%	1.11	1.18 (1.15–1.21)***	1.21 (1.20–1.21)***	0.93 (0.90–0.96)***
Veteran status									
Yes	4.0%	2.1%	0.53	12.7%	7.4%	0.58	3.52 (3.46–3.58)***	0.53 (0.52–0.53)***	1.04 (1.02–1.07)**
No	55.3%	86.2%	1.56	44.7%	81.7%	1.83	0.65 (0.65–0.66)***	5.05 (5.03–5.07)***	1.10 (1.08–1.11)***
Missing	40.7%	11.7%	0.29	42.6%	10.9%	0.26	1.08 (1.07–1.09)***	0.19 (0.19–0.19)***	0.85 (0.84–0.87)***
Living arrangement									
Homeless	9.7%	15.4%	1.59	11.1%	18.9%	1.70	1.16 (1.14–1.18)***	1.69 (1.69–1.70)***	1.10 (1.08–1.12)***
Dependent living	14.7%	16.0%	1.09	7.9%	11.2%	1.42	0.50 (0.49–0.51)***	1.11 (1.11–1.12)***	1.32 (1.29–1.35)***
Independent living	52.5%	61.8%	1.18	58.4%	63.8%	1.09	1.27 (1.25–1.28)***	1.46 (1.46–1.46)***	0.86 (0.85–0.87)***
Missing	23.1%	6.8%	0.29	22.6%	6.1%	0.27	0.98 (0.96–0.99)***	0.24 (0.24–0.24)***	0.92 (0.90–0.94)***
Primary source of income									
Wages/salary	20.4%	17.0%	0.83	13.7%	10.5%	0.77	0.62 (0.61–0.63)***	0.80 (0.80–0.81)***	0.92 (0.90–0.94)***
Public assistance	5.7%	5.3%	0.93	5.1%	5.6%	1.10	0.90 (0.87–0.92)***	0.94 (0.93–0.94)***	1.17 (1.14–1.21)***
Retirement/pension or disability	2.7%	3.2%	1.19	12.9%	14.9%	1.16	5.33 (5.23–5.42)***	1.18 (1.16–1.19)***	1.01 (0.98–1.03)
Other	10.2%	9.2%	0.90	14.9%	13.8%	0.93	1.54 (1.52–1.57)***	0.90 (0.89–0.90)***	1.02 (1.00–1.04)*
None	15.0%	20.4%	1.36	9.5%	12.8%	1.35	0.59 (0.58–0.60)***	1.45 (1.45–1.46)***	0.97 (0.97–0.99)**
Missing	46.1%	44.8%	0.97	44.0%	42.4%	0.96	0.92 (0.91–0.93)***	0.95 (0.95–0.95)***	0.99 (0.97–1.00)*
Health insurance									
Private	5.2%	3.5%	0.67	7.7%	3.9%	0.51	1.50 (1.47–1.54)***	0.65 (0.65–0.66)***	0.75 (0.73–0.77)***
Medicare	3.5%	3.2%	0.91	7.4%	4.8%	0.65	2.19 (2.14–2.24)***	0.90 (0.89–0.90)***	0.71 (0.69–0.73)***
Medicaid	6.8%	17.1%	2.51	5.9%	16.0%	2.71	0.86 (0.84–0.88)***	2.83 (2.82–2.85)***	1.08 (1.05–1.11)***
None	32.5%	14.8%	0.46	23.1%	11.9%	0.52	0.62 (0.61–0.63)***	0.36 (0.36–0.36)***	1.25 (1.23–1.27)***
Missing	52.0%	61.5%	1.18	56.0%	63.4%	1.13	1.18 (1.16–1.19)***	1.48 (1.47–1.48)***	0.92 (0.91–0.93)***

[a]Data are from Treatment Episode Data Set: Admissions, 2000–2017.
*P < .05. **P < .01. ***P < .001.

Table 3. Interaction Analyses of Age (21–54 y vs ≥ 55 y) and Year (2000–2001 vs 2016–2017) on Clinical Characteristics

	21–54 y			≥ 55 y			Odds ratio (95% CI)		
	2000–2001 (column 2)	2016–2017 (column 3)	Risk ratio (column 4)	2000–2001 (column 5)	2016–2017 (column 6)	Risk ratio (column 7)	≥ 55 y vs 21–54 y (column 8)	2016–2017 vs 2000–2001 (column 9)	Interaction (column 10)
Service setting at admission									
Detox, 24-hour, hospital inpatient	5.5%	3.4%	0.62	8.4%	5.5%	0.65	1.59 (1.55–1.62)***	0.61 (0.60–0.61)***	1.04 (1.01–1.07)**
Detox, 24-hour, free-standing residential	18.8%	17.4%	0.93	23.3%	21.1%	0.91	1.31 (1.29–1.33)***	0.91 (0.91–0.91)***	0.97 (0.95–0.98)***
Rehab/residential, hospital (non-detox)	0.9%	0.4%	0.44	1.5%	0.5%	0.33	1.65 (1.57–1.73)***	0.38 (0.37–0.39)***	0.89 (0.83–0.95)***
Rehab/residential, short-term (≤ 30 days)	8.3%	9.4%	1.13	6.8%	9.1%	1.34	0.81 (0.79–0.83)***	1.16 (1.15–1.16)***	1.19 (1.16–1.22)***
Rehab/residential, long-term (> 30 days)	8.1%	8.2%	1.01	4.8%	6.5%	1.35	0.57 (0.55–0.58)***	1.02 (1.01–1.02)***	1.37 (1.33–1.41)***
Ambulatory, intensive outpatient	8.8%	12.6%	1.43	6.7%	10.0%	1.49	0.74 (0.72–0.75)***	1.48 (1.48–1.49)***	1.05 (1.02–1.08)***
Ambulatory, nonintensive outpatient	46.6%	47.4%	1.02	44.9%	45.4%	1.01	0.93 (0.92–0.94)***	1.03 (1.03–1.03)***	0.99 (0.98–1.00)
Ambulatory, detoxification	3.0%	1.4%	0.47	3.7%	2.0%	0.54	1.24 (1.20–1.28)***	0.44 (0.44–0.45)***	1.19 (1.14–1.24)***
Treatment referral source									
Individual	37.0%	41.0%	1.11	39.5%	49.1%	1.24	1.11 (1.10–1.12)***	1.18 (1.18–1.19)***	1.25 (1.23–1.27)***
Alcohol/drug use care provider	11.7%	9.7%	0.83	12.5%	10.0%	0.80	1.08 (1.06–1.09)***	0.81 (0.80–0.81)***	0.97 (0.95–0.99)**
Other health care provider	7.3%	5.9%	0.81	11.4%	8.5%	0.75	1.64 (1.61–1.67)***	0.80 (0.79–0.80)***	0.91 (0.89–0.93)***
School-based educational provider	0.1%	0.0%	0.00	0.1%	0.0%	0.00	0.75 (0.61–0.92)**	0.41 (0.38–0.44)***	0.83 (0.62–1.11)
Employer/EAP	1.1%	0.4%	0.36	1.2%	0.6%	0.50	1.19 (1.13–1.26)***	0.38 (0.37–0.38)***	1.32 (1.23–1.41)***
Other community referral	8.8%	11.2%	1.27	6.5%	9.9%	1.52	0.73 (0.71–0.74)***	1.31 (1.30–1.31)***	1.20 (1.17–1.23)***
Court/criminal justice referral/DUI/DWI	31.2%	28.0%	0.90	25.2%	18.2%	0.72	0.74 (0.73–0.75)***	0.86 (0.85–0.86)***	0.77 (0.76–0.78)***
Unknown	2.8%	3.9%	1.39	3.5%	3.6%	1.03	1.25 (1.21–1.29)***	1.39 (1.38–1.40)***	0.74 (0.71–0.77)***
Number of previous substance use treatment episodes									
No prior treatment episodes	33.9%	30.7%	0.91	35.0%	27.0%	0.77	1.05 (1.03–1.06)***	0.86 (0.86–0.86)***	0.80 (0.79–0.81)***
1 prior treatment episode	18.7%	20.1%	1.07	15.7%	18.6%	1.18	0.81 (0.80–0.83)***	1.10 (1.09–1.10)***	1.12 (1.10–1.14)***
2–3 prior treatment episodes	16.6%	19.0%	1.14	13.7%	18.7%	1.36	0.79 (0.78–0.81)***	1.17 (1.17–1.18)***	1.24 (1.22–1.26)***
≥ 4 prior treatment episodes	15.0%	17.7%	1.18	16.3%	20.7%	1.27	1.10 (1.08–1.12)***	1.21 (1.21–1.22)***	1.10 (1.08–1.12)***
Unknown	15.8%	12.6%	0.80	19.4%	15.1%	0.78	1.28 (1.27–1.30)***	0.77 (0.77–0.78)***	0.96 (0.94–0.98)***
Primary substance use at admission									
Alcohol	47.1%	29.7%	0.63	74.4%	52.0%	0.70	3.27 (3.22–3.31)***	0.47 (0.47–0.47)***	0.79 (0.78–0.80)***
Cocaine/crack	15.4%	5.0%	0.32	5.0%	7.5%	1.50	0.29 (0.28–0.30)***	0.29 (0.29–0.29)***	5.35 (5.20–5.51)***
Cannabis	8.7%	10.1%	1.16	1.3%	2.8%	2.15	0.14 (0.13–0.15)***	1.19 (1.18–1.19)***	1.81 (1.72–1.91)***
Heroin	17.6%	28.3%	1.61	11.9%	22.9%	1.92	0.63 (0.62–0.64)***	1.84 (1.84–1.85)***	1.19 (1.17–1.21)***
Nonprescription methadone	0.1%	0.2%	2.00	0.1%	0.2%	2.00	0.94 (0.79–1.11)	1.53 (1.47–1.59)***	1.20 (0.99–1.44)
Other opiates and synthetics	2.0%	8.1%	4.05	1.6%	5.1%	3.19	0.79 (0.76–0.83)***	4.40 (4.36–4.44)***	0.76 (0.73–0.80)***
Other	7.7%	16.6%	2.16	3.9%	7.2%	1.85	0.48 (0.47–0.50)***	2.39 (2.37–2.40)***	0.81 (0.78–0.83)***
Unknown	1.4%	2.1%	1.50	1.8%	2.3%	1.28	1.26 (1.20–1.31)***	1.51 (1.49–1.52)***	0.88 (0.84–0.93)***

[a]Data are from Treatment Episode Data Set: Admissions, 2000–2017.
**$P < .01$. ***$P < .001$.
Abbreviations: detox = detoxification, DUI = driving under the influence of alcohol or drugs, DWI = driving while intoxicated, EAP = employee assistance program, rehab = rehabilitation.

Table 4. Multivariable-Adjusted Interaction Analysis of Age and Key Factors on Admission Period (2000–2001 vs 2016–2017)

	AOR	95% CI	*P*
Demographic factor			
Age	1.73	1.65–1.80	<.001
Older population by year and state (%)	2.83	2.83–2.84	<.001
Non-Hispanic Black	0.79	0.79–0.80	<.001
Age × non-Hispanic Black	2.20	2.09–2.31	<.001
Never married	0.85	0.84–0.86	<.001
Age × never married	3.30	3.13–3.47	<.001
Separated	0.49	0.48–0.50	<.001
Age × separated	1.56	1.42–1.71	<.001
Dependent living	3.46	3.41–3.50	<.001
Age × dependent living	1.56	1.42–1.71	.003
Private insurance	0.37	0.37–0.38	<.001
Age × private insurance	0.75	0.70–0.81	<.001
Medicare	0.34	0.33–0.35	<.001
Age × Medicare	0.74	0.65–0.84	<.001
No insurance	0.33	0.32–0.33	<.001
Age × no insurance	1.94	1.85–2.03	<.001
Clinical factor			
Self-referral	1.12	1.11–1.13	<.001
Age × self-referral	1.30	1.25–1.34	<.001
Employer/EAP-based referral	0.26	0.25–0.28	<.001
Age × employer/EAP-based referral	1.45	1.16–1.81	.001
Rehab/residential, long term (more than 30 days) treatment setting	0.82	0.81–0.83	<.001
Age × rehab/residential, long term (more than 30 days) treatment setting	1.20	1.13–1.27	<.001
Primary substance use			
Alcohol	0.29	0.28–0.29	<.001
Age × alcohol	0.88	0.85–0.92	<.001
Cocaine/crack	0.07	0.07–0.07	<.001
Age × cocaine/crack	6.26	5.67–6.91	<.001
Cannabis	0.40	0.40–0.41	<.001
Age × cannabis	1.57	1.37–1.79	<.001
Opiates and synthetics	0.56	0.55–0.58	<.001
Age × opiates and synthetics	1.43	1.28–1.60	<.001

[a]Data are from Treatment Episode Data Set: Admissions, 2000–2017.
[b]The model was estimated using a generalized estimating equation with random effect for state and year to account for multilevel observations (ie, individuals were nested in states by year).
Abbreviations: AOR = adjusted odds ratio, EAP = employee assistance program.

The most prominent main effects for the association of age group and sociodemographic characteristics demonstrated greater frequencies among older adults for being divorced or widowed, being a veteran, being retired or receiving a pension or disability, and having Medicare coverage. Older adults were less likely to have never been married or to be in a dependent living arrangement.

The most prominent positive main effects for year of admission and sociodemographic characteristics included non-veteran status and Medicaid coverage. Having no health insurance declined substantially, with an OR of 0.36 (95% CI, 0.36–0.36), likely reflecting the effect of the ACA expansion and specifically the related increase in Medicaid coverage (OR, 2.83; 95% CI, 2.82–2.85).

Our main focus is on the interaction of older adults group and year of admission and specifically interaction terms ≥ 1.25 or ≤ 0.80 indicating a substantial increase or decline in specific sociodemographic characteristics that may have fostered increased admissions among older adults. Table 2, column 10, shows that relative increases among older adults were observed among non-Hispanic Blacks and those with never-married or separated marital status, living in dependent settings, and having no health insurance. Sociodemographic characteristics that showed a relative decline among older adults compared to younger adults over time (interaction terms ≤ 0.80) were being non-Hispanic White, having private health insurance, and having Medicare coverage, which may also be a result of expansion of Medicaid under the ACA.

Clinical characteristics. The most common primary addictive substance among older adults was alcohol, while substances less likely to be used by older adults included cocaine/crack, cannabis, and other drugs (Table 3, column 8).

The most prominent clinical main effects for year of admission showed increased use of opiates and synthetics and other drug use (Table 3, column 9). Clinical main effects also showed less likelihood of admission for alcohol use over time and for cocaine/crack use, as well of admission from a number of institutional program types (eg, non-detoxification, hospital-based rehabilitation/residential settings, ambulatory detoxification settings, school-based educational referrals, employer/EAP referrals).

Bivariate interaction terms of ORs ≥ 1.25 indicated a substantial relative increase among older adults (Table 3, column 10), and they were admissions from long-term rehabilitation/residential settings, individual referrals, and employer/EAP referrals.

Interaction terms also suggest that older adults have increased use of cocaine/crack and cannabis relative to younger adults. In contrast, older adults showed a substantial relative decline in court/criminal justice referral and use of both alcohol and opiates and synthetics.

Multivariable-Adjusted Analyses

The third aim of the study was addressed with the multivariable-adjusted analyses. Examination of independent factors associated with admission in 2016–2017 vs 2000–2001 using a multivariable-adjusted GEE model revealed that, first, the adjusted main effect of age (≥ 55) showed a greater likelihood (OR = 1.73; 95% CI, 1.65–1.80) of being admitted in 2016–2017 as compared to 2000–2001 (Table 4). Main effects for the proportion of older adults in the general population of the state of residence of each admitted patient showed an adjusted OR of 2.83 (95% CI, 2.83–2.84), ie, that increases in the proportion of older adults in the general population resulted in a substantially greater likelihood of admission of older adults to SUD treatment facilities over time.

Admission characteristics that continued to have substantial interaction effects with older adults in multivariable analysis showed a relative increase in proportions of older non-Hispanic Blacks and of those who never married and in specific primary substances for which they were admitted, reflecting a relative increase among older as compared to younger adults in admission for use of cocaine/crack, cannabis, and opiates and synthetics. It

is notable that in bivariate analysis older adults showed a relative decline over time in use of opiates and synthetics but, in contrast, showed a relative increase in use of opiates after adjusting for other correlates of admission in 2016–2017.

DISCUSSION

The present study demonstrated that among adults admitted to SUD treatment facilities, the proportion of adults aged ≥ 55 increased substantially compared to the proportion of younger adults between 2000 and 2017, even after consideration of increases in older adults in the general population and multivariate adjustment for other changes in admission characteristics that may potentially confound the relationship of age group to increased likelihood of admission.

The substantial increase in the number of older adults admitted for substance use treatment is consistent with previous studies in the US,[7] as well as in other countries.[8] For example, in the UK, admissions of older adults related primarily to alcohol have risen by more than 100% from 2010–2011 to 2016–2017.[8] In our study, a demographic shift was observed among those admitted, with relative decrease among older adults in non-Hispanic Whites and relative increase in non-Hispanic Blacks. Proportions with private health insurance, Medicare coverage, and no health insurance declined among both older and younger adults, whereas those with Medicaid coverage increased substantially in both age groups, likely reflecting the implementation of the ACA in 2014. Of particular note, there was a relative increase in admission for cocaine/crack and cannabis among older adults, while there was a relative decrease in alcohol as the primary reason for admission in this group. Multivariable analyses showed that older adults were 1.7 times as likely to be admitted in 2016–2017 than in 2000–2001, net of other factors.

The racial shift among admissions may have been unexpected, given that the non-Hispanic White population in the general population has decreased from 69.1% in 2000 to 60.8% in 2017 and the proportion of Blacks remained stable.[16] Race/ethnicity may also be intertwined with the shift in the primary substance responsible for the admission. For example, it has been reported that alcohol use disorder and opioid use disorder tend to be lower among Blacks as compared to Whites,[21,22] while cannabis use disorder is found in comparable proportions across these racial/ethnic groups.[23] In our study, alcohol use showed a relative decline among older adults, whereas cannabis use showed a relative increase. On the contrary, cocaine/crack use has been reported to be higher in Blacks compared to Whites,[24] which may partially explain the relative increase in cocaine/crack use in older adults and decrease in younger adults.

Given the shift of racial/ethnic minorities admissions to the SUD treatment facilities, structured education to enhance cultural competence among health professionals may be needed. For example, non-Hispanic Blacks are less likely to receive mental health care by a specialist, and, even if they do, they report less adequate care and are more likely to drop out of treatment for various structural reasons.[25] Thus, provision of culturally sensitive treatment that considers cultural norms, attitudes, values, beliefs, and practices of racial/ethnic groups may be needed to improve treatment retention and outcomes among racial/ethnic minorities.[25,26]

In addition, there have been major societal changes that may have contributed to the shift in the substance identified as primarily responsible for the admission. For example, the opioid epidemic has emerged as a major public health crisis in the US since 1999, and studies have documented increased prevalence of opioid use disorder[27] and prescription opioid misuse[28] among older adults, although findings in this study were ambiguous, with relatively decreased opiate use among older adults in binary analyses but with increased opiate use after covarying for other factors. Further, cannabis has been legalized in 11 states since 2012, with subsequent increases in cannabis use among adults,[11] and especially older adults.[29] In this study, cannabis, heroin, and opiates showed increasing trends in both age groups, with relatively larger increase in cannabis-related admissions among older adults. There have been reports of a decline in cocaine use between 2005–2011 in the US[30]; however, recent data indicate a resurgence,[22] with an increase in cocaine- or methamphetamine-related deaths.[31,32] These are all consistent with the increase in drug-related admissions in our study among older adults, growing to 38.5% in 2016–2017 from only 19.9% in 2000–2001.

Treatment of older adults with SUD can be complicated by high prevalence and complexity of co-occurring medical illnesses.[33] Further, resultant polypharmacy is common in older adults and requires cautious management of drug initiation and titration by prescribers.[34] In addition to medical issues, studies suggest that older adults respond best to age-sensitive care with clinicians who are skilled at addressing late-life developmental issues.[35] Thus, SUD treatment in older adults should develop capacity to address these additional emerging treatment needs.

Our study has several limitations. First, the TEDS-A dataset does not capture information on services provided in physician offices or federally qualified health centers that do not specialize in SUD treatment. In addition, TEDS-A does not include data from non-publicly funded substance use treatment programs or from the Department of Veterans Health Administration (VHA). Given that veterans receiving services from the VHA tend to be older, with similar prevalence of SUD compared to veterans who do not receive services from the VHA,[36] it is possible that the results of our study have underestimated the increase in admissions of older adults. Second, the study design is cross-sectional in nature, and, thus, we cannot draw causal conclusions. Finally, each state may have different procedures or methods for collecting data from treatment facilities, which may have not been fully accounted for by our secondary analyses.

Notwithstanding these limitations, our study clearly demonstrates a substantial increase in admissions to SUD treatment among older adults along with a relative increase

in admissions related to drug use, specifically involving cocaine/crack and cannabis, with a relative decrease in admissions for alcohol. Overall, our findings suggest a possible need to better train clinicians in cultural sensitivity and aging-related issues that especially affect older adults with substance-related problems.

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