

Article

Sociodemographic Disparities in Alcohol-Associated Emergency Department Visits Among Underage Individuals in the US Before and After the Onset of the COVID-19 Pandemic

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Abstract

Background: Sociodemographic and structural inequities shape the risk of alcohol-related harms among underage individuals. This study assessed disparities in alcohol-related emergency department (ED) visits, using the COVID-19 pandemic as a contextual backdrop to examine how these inequities shifted during a period of widespread disruption.

Methods: This repeated cross-sectional study used pooled Nationwide Emergency Department Sample (NEDS) data (January 2019–December 2021) for individuals aged 12–20, comparing pre-COVID-19 (January 2019–March 2020) and during-COVID-19 (April 2020–December 2021) periods. Alcohol-related visits were identified via ICD-10-CM codes. Survey-weighted multivariable logistic regression estimated adjusted odds ratios (ORs) and 95% confidence intervals (CIs), adjusting for demographic, socioeconomic, and geographic factors, with interaction terms assessing period-related changes in disparities.

Results: Sociodemographic disparities were the primary drivers of alcohol-related ED visits. Native American youth had markedly higher odds than White youth (OR = 3.68, 95% CI: 3.52–3.86), while Black, Hispanic, and Asian youth had lower odds. Uninsured (OR = 1.43) and charity-care youth also showed elevated odds. COVID-19 itself was not significantly associated with overall visits (OR = 1.03, $p = 0.053$), but disparities widened for Native American youth (OR = 1.20) and narrowed modestly for Black (OR = 1.04) and Medicaid-insured (OR = 1.05) youth, while other disparities remained unchanged.

Conclusions: Persistent structural disparities, particularly by race/ethnicity and insurance status, drive underage alcohol-related ED utilization far more than the pandemic itself, underscoring the need for equity-focused prevention strategies targeting systemic barriers to care.

Keywords: underage drinking; emergency department visits; COVID-19; race; health insurance; adolescent; alcohol



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1. Introduction

Alcohol consumption among underage individuals remains a persistent public health issue, contributing significantly to emergency department (ED) visits in the United States [1].

Among American youth, alcohol is the most widely used substance, surpassing both tobacco and marijuana in prevalence [2]. According to the 2022 Monitoring the Future (MTF) data, more than half (51.9%) of twelfth graders reported alcohol use in the past year, while nearly half reported drinking within the past 30 days [3]. Despite legal restrictions, many adolescents and young adults engage in high-risk drinking behaviors such as binge drinking [4], which often lead to injuries, alcohol poisoning, assaults, risky sexual behavior, and motor vehicle crashes [5]. These risks often lead underage drinkers to seek care in emergency departments, providing health care professionals an opportunity to identify and intervene with high-risk adolescents and young adults [6].

Socioeconomic factors play a significant role in shaping underage alcohol use. Research shows that older adolescents and males are more likely to engage in alcohol use and binge drinking than younger adolescents and females [7]. Family structure and socioeconomic status also play a crucial role; youth from single-parent households or lower-income families tend to have higher rates of alcohol consumption, often linked to reduced parental monitoring and greater exposure to stress [8]. Furthermore, racial and ethnic disparities and non-heteronormative sexual orientation correlate with differences in vulnerability to alcohol use, influenced by social norms, access, and exposure [9]. In addition, sexual minority adolescents are more vulnerable to alcohol use, as experiences of discrimination, stigma, and rejection, collectively known as minority stress, often drive them to use alcohol as a coping mechanism for emotional distress [10].

Additionally, health insurance status, as one of the widely used socioeconomic indicators, influences disparities in alcohol-related emergency department (ED) visits among underage individuals [11]. A person's insurance status (e.g., private insurance, public (such as Medicaid or Medicare) programs, or uninsured) greatly impacts the affordability and accessibility of emergency and follow-up care [12]. Research indicates that uninsured and publicly insured youths are more likely to depend on ED services for alcohol-related emergencies and are less likely to receive preventive or follow-up treatment than their privately insured counterparts [11]. The COVID-19 pandemic exacerbated insurance disparities: while the temporary continuous-coverage protections under Medicaid helped millions of children maintain insurance, the subsequent unwinding process saw meaningful losses of coverage, particularly among youth [13,14]. These fluctuations in insurance coverage highlight the vulnerability of underage populations to policy shifts that disrupt health-care continuity [14,15].

The onset of the COVID-19 pandemic in early 2020 introduced broad disruptions that reshaped adolescent behaviors, access to healthcare, and substance use patterns. Early in the pandemic (mid-March–mid-April 2020), overall, ED volumes fell, yet alcohol-related visits declined less sharply and subsequently rebounded, yielding higher alcohol-related visit rates per 10,000 ED encounters across all quarters of 2020 compared with 2018–2019 baselines in U.S. surveillance data [11]. Pediatric evidence similarly indicates that substance-use ED visits (including alcohol) rose during COVID-19 among youths aged 10–18 across 47 U.S. children's hospitals, especially for those with chronic medical conditions and with notable racial/ethnic patterning, underscoring that pandemic disruptions (isolation, school closures) concentrated risk among already vulnerable groups [16]. Complementing these U.S. patterns, international data show pandemic-era shifts in alcohol-related acute care (e.g., changes in emergency transports for acute intoxication), reinforcing the role of policy restrictions and reopenings in shaping youth harm presentations [17]. Longer-run pediatric trends also reveal a gradual, long-term decline in alcohol-related ED attendances among under-16s over 2011–2022 in England, occurring independently of short-term pandemic-related fluctuations with distinct sociodemographic profiles (e.g., gender differences, safeguarding

concerns), suggesting that pandemic-specific dynamics occurred against a backdrop of changing youth alcohol behaviors [18].

Despite growing awareness, few studies have examined how sociodemographic and insurance-related disparities in alcohol-related ED visits among underage individuals changed before and after the COVID-19 pandemic. Understanding these shifts is essential to inform equitable prevention and intervention strategies. Therefore, this study aims to examine trends and disparities in alcohol-related ED visits among underage individuals across the pre- and during COVID-19 onset, focusing on sociodemographic and insurance-related differences.

2. Materials and Methods

This repeated cross-sectional observational study used pooled data from the Nationwide Emergency Department Sample (NEDS) to examine alcohol-related emergency department (ED) visits among underage individuals (12–20 years) in the US between January 2019 and December 2021. To assess differences before and after the onset of the COVID-19 pandemic, ED visits were categorized into a pre-COVID-19 period (January 2019–March 2020) and a during COVID-19 period (April 2020–December 2021). The selection of April 2020 as the cutoff was determined a priori based on the timeline of the U.S. pandemic response; a national emergency was declared in mid-March 2020, and widespread state-level stay-at-home orders, school closures, and initial disruptions to routine healthcare utilization were fully implemented by April [19]. NEDS employs a stratified sampling design and includes encounter-level patient and hospital characteristics, enabling nationally representative estimates through survey-weighted analyses. The analytic sample included 7,491,585 ED visits of young adults, with a weighted total of approximately 32.2 million.

The primary outcome was alcohol-associated emergency department (ED) visit, defined as a binary variable indicating the presence of alcohol involvement based on approximately 1500 ICD-10-CM principal and secondary diagnosis codes, regardless of the reasons for the ED visit. The primary exposure was the COVID-19 period, coded as 0 (pre-COVID-19) and 1 (during COVID-19). Patient socioeconomic factors were defined as age, sex (i.e., male (reference) and female), race/ethnicity, health insurance status, median income by zip code, and rural area (non-rural area as the reference). Race or ethnicity was categorized as White (reference), Black, Hispanic, Asian, and Native American. Health insurance status was grouped as private insurance (reference), Medicaid, uninsured, and charity care. The median income by ZIP code was categorized as quartiles (75–100% quartile as the reference), while geographic.

Descriptive analysis was conducted to characterize the distribution of demographic, socioeconomic, insurance, and geographic variables. Bivariate comparisons of these characteristics between the pre-COVID-19 and during-COVID-19 periods were assessed using chi-square (χ^2) tests for categorical variables. Alcohol-related emergency department (ED) visits among underage individuals aged 12–20 years were analyzed using survey-weighted multivariable logistic regression models to compare outcomes before and after the onset of the COVID-19 pandemic. The weighted logistic regression models were used to estimate adjusted associations between the COVID-19 period and alcohol-related ED visits, accounting for the complex survey design of NEDS, including stratification, clustering, and discharge-level weights. Covariates were selected a priori based on their established associations with adolescent alcohol use and healthcare utilization in prior literature [18,20–23], as well as their conceptual relevance as indicators of sociodemographic and structural inequity. Models were adjusted for age, sex, race/ethnicity, primary payer (insurance status), ZIP code-level median household income quartile, rural–urban residence, and U.S. Census region of the treating hospital. Race/ethnicity and insurance status were

selected a priori as effect modifiers, given their well-documented role in shaping disparities in access to behavioral health care, and were therefore modeled as both covariates and interaction terms with the COVID-19 period, intended to measure potential changes after the COVID-19 period. In addition, hospital location (Northeast, Midwest, South (reference), West) was also controlled in the multivariable analysis. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. No substantial multicollinearities among the independent variables were detected. Model performance in terms of discrimination was good, as indicated by the concordance or c-statistic of 0.728. Statistical significance was defined at a two-sided α level of 0.05. All analyses incorporated survey weights to generate nationally representative estimates and to ensure appropriate variance estimation.

3. Results

This study examined alcohol-related emergency department (ED) visits among under-age individuals aged 12–20 years in the United States before and during the COVID-19 pandemic. The analytic sample included 7,491,585 ED visits, representing approximately 32.2 million weighted ED visits nationally.

3.1. Descriptive Characteristics of the Study Population

Table 1 presents the demographic, socioeconomic, and geographic characteristics of under-age ED visits before and during the COVID-19 pandemic. Alcohol-related visits accounted for 0.92% of ED visits before COVID-19 and 0.91% during COVID-19. The mean age of patients was 16.54 years (SD = 2.64). Females represented a slightly higher proportion of ED visits than males in both periods. The racial and ethnic distribution remained relatively stable, with White, Black, and Hispanic youth accounting for most visits. Medicaid and private insurance were the most common forms of coverage, although the proportion of uninsured visits decreased during the pandemic (11.39% to 8.85%). Geographic and income distributions showed minimal variation between the two periods (Table 1). Despite statistically significant chi-square results for nearly all variables, a consequence of the very large sample size, Cramer’s V effect sizes were negligible throughout ($V = 0.0001$ – 0.0488), indicating that the pre- and during-COVID distributions were substantively similar.

Table 1. Descriptive Characteristics of Patients Prior to and During the COVID-19 Pandemic ($N = 7,491,585$).

Variable	Category	Pre-COVID (%) ($n = 3,465,494$)	During COVID (%) ($n = 4,026,091$)	p -Value (χ^2) (df)	Effect Size (Cramer’s V)
Alcohol	No alcohol (0)	99.08	99.09	0.6963 (1)	0.0001
	Alcohol (1)	0.92	0.91		
Age	mean (std.)	16.54 (2.64)	---	---	
Sex	Male (0)	42.34	42.22	0.0006 (1)	0.0013
	Female (1)	57.66	57.78		
Race	White	48.79	49.02	<0.0001 (5)	0.0240
	Black	22.38	21.08		
	Hispanic	22.00	23.23		
	Asian	1.80	1.98		
	Native American	0.56	0.67		
	Other	4.47	4.01		

Table 1. Cont.

Variable	Category	Pre-COVID (%) (<i>n</i> = 3,465,494)	During COVID (%) (<i>n</i> = 4,026,091)	<i>p</i> -Value (χ^2) (df)	Effect Size (Cramer's V)
Health insurance	Medicaid	50.23	52.12	<0.0001 (4)	0.0473
	Private	34.12	34.80		
	Uninsured	11.39	8.85		
	Charity	0.46	0.23		
	Other	3.80	4.02		
Patient residence	Urban (0)	84.13	82.43	<0.0001 (1)	0.0227
	Rural (1)	15.87	17.57		
Median income by zip code	Q1 lowest	36.22	35.64	<0.0001 (3)	0.0090
	Q2	26.72	26.96		
	Q3	20.92	20.70		
	Q4 highest	16.14	16.70		
Hospital region	Northeast	17.13	14.42	<0.0001 (3)	0.0488
	Midwest	21.16	23.95		
	South	42.62	41.14		
	West	19.09	20.49		

Note: Values are presented as percentages unless noted. The pre-COVID period was defined as January 2019 to March 2020, and the COVID period as April 2020 to December 2021. *p*-values were calculated using chi-square (χ^2) tests to compare distributions between periods. Due to the large sample size (*N* = 7,491,585), small differences may be statistically significant but not clinically meaningful. Cramer's V was calculated for each categorical comparison; values are interpreted as negligible (<0.10), small ($\approx$ 0.10), medium ($\approx$ 0.30), or large ($\approx$ 0.50) per Cohen's conventions according to the perspective degrees of freedom (df = 1–5). All effect sizes in this table are negligible despite nearly all χ^2 results reaching statistical significance (with the exception of alcohol involvement, *p* = 0.6963).

3.2. Multivariable Associations with Alcohol-Related ED Visits

Results from a single survey-weighted multivariable logistic regression model are presented across three tables for ease of reference: Table 2 reports the main-effects model (adjusted associations between each covariate and alcohol-related ED visits), while Tables 3 and 4 report interaction terms describing how racial/ethnic and insurance-related disparities, respectively, changed during the COVID-19 period relative to before it. After adjustment for demographic, socioeconomic, insurance, and geographic characteristics, the COVID-19 period was not significantly associated with alcohol-related ED visits (OR = 1.03, 95% CI: 1.00–1.06, *p* = 0.053), indicating that the modest increase observed did not reach statistical significance at the population level. Age was a strong predictor of alcohol-related ED visits. Each additional year of age was associated with a 27% increase in the odds of an alcohol-related ED visit (OR = 1.27, 95% CI: 1.27–1.28, *p* < 0.001). Female patients had significantly lower odds of alcohol-related ED visits compared with male patients (OR = 0.61, 95% CI: 0.60–0.62, *p* < 0.001). The multivariable model demonstrated acceptable discrimination between individuals with and without an alcohol-related ED visit (c-statistic = 0.728). Although statistically significant, this association corresponded to a negligible standardized effect size (Cohen's *h* = 0.001), indicating that the COVID-19 period itself accounted for a very small shift in the probability of an alcohol-related ED visit at the population level.

Table 2. Adjusted Odds Ratios for Alcohol-Related Emergency Department Visits Among Underage Individuals—Main-Effects Model ($N = 7,491,585$).

Variable	Adjusted OR	95% CI	<i>p</i> -Value
Pre-COVID-19 period (ref)	1.00		
COVID-19 period	1.03	1.01–1.06	0.053
Age	1.27	1.27–1.28	<0.0001
Sex: Male (ref)	1.00		
Female	0.61	0.60–0.62	<0.0001
Black vs. White	0.41	0.40–0.42	<0.0001
Hispanic vs. White	0.79	0.78–0.81	<0.0001
Asian vs. White	0.91	0.87–0.95	<0.0001
Native American vs. White	3.68	3.52–3.86	<0.0001
Health insurance status [Private insurance (ref)]	1.00		
Medicaid vs. Private	0.76	0.74–0.79	<0.0001
Uninsured vs. Private	1.43	1.39–1.48	<0.0001
Charity vs. Private	1.16	1.05–1.27	0.0025
Median income by zip code: $\geq$ Q4 Highest (ref)	1.00		
Q3 (51–75%)	0.69	0.68–0.71	<0.0001
Q2 (26–50%)	0.62	0.60–0.63	<0.0001
Q1 Lowest (0–25%)	0.60	0.58–0.61	<0.0001
Patient residence: Urban (ref)	1.00		
Rural	0.85	0.82–0.87	<0.0001
Hospital region: South (ref)	1.00		
Northeast	1.72	1.68–1.76	<0.0001
Midwest	1.30	1.27–1.33	<0.0001
West	1.64	1.60–1.68	<0.0001

Note: OR = odds ratio; CI = confidence interval. Estimates are from a single adjusted multivariable logistic regression model that also produced the interaction estimates in Tables 3 and 4. Reference groups: pre-COVID-19 period; White; private insurance; Male; highest income quartile (Q4); urban; south region. Income quartiles are based on ZIP-code median household income. All *p*-values are two-sided.

Table 3. Changes in Racial/Ethnic Disparities in Alcohol-Related ED Visits During the COVID-19 Period (COVID-19 * Race Interaction Effects).

Variable	Adjusted OR	95% CI	<i>p</i> -Value
Black vs. White	1.04	1.01–1.06	0.0039
Hispanic vs. White	0.99	0.97–1.01	0.1873
Asian vs. White	0.86	0.82–0.89	<0.0001
Native American vs. White	1.20	1.15–1.25	<0.0001
Other vs. White	0.98	0.95–1.01	0.1451

Note: Values represent interaction terms indicating how the race/ethnicity-specific odds of an alcohol-related ED visit changed during the COVID-19 period relative to the pre-COVID period (using White youth as the reference group). Estimates are derived from the survey-weighted multivariable logistic regression model ($N = 7,491,585$). The overall joint test was statistically significant ($F = 21.56$, $p < 0.0001$).

Table 4. Changes in Insurance-Related Disparities in Alcohol-Related ED Visits During the COVID-19 Period (COVID-19 * Insurance Interaction Effects).

Variable	Adjusted OR	95% CI	p-Value
Medicaid vs. private insurance	1.05	1.02–1.07	0.0010
Uninsured vs. private insurance	1.00	0.97–1.03	0.8160
Charity vs. private insurance	1.03	0.94–1.13	0.4748
Other insurance vs. private insurance	1.00	0.96–1.04	0.8501

Note: Values represent interaction terms indicating how the insurance-specific odds of an alcohol-related ED visit changed during the COVID-19 period relative to the pre-COVID period (using Private Insurance as the reference group). Estimates are derived from the survey-weighted multivariable logistic regression model ($N = 7,491,585$). The overall joint test was statistically significant ($F = 46.03$, $p < 0.0001$).

3.3. Racial and Ethnic Disparities in Alcohol-Related ED Visits

Significant racial and ethnic disparities were observed in alcohol-associated ED visits. Compared with White youth, Black (OR = 0.41, 95% CI: 0.40–0.42), Hispanic (OR = 0.79, 95% CI: 0.78–0.81), and Asian youth (OR = 0.91, 95% CI: 0.87–0.95) had significantly lower odds of alcohol-associated ED visits. In contrast, Native American youth had substantially higher odds of alcohol-related ED visits (OR = 3.68, 95% CI: 3.52–3.86). Interaction analyses demonstrated significant changes in racial disparities during the COVID-19 period. The Black–White disparity narrowed by 4% (OR = 1.04, 95% CI: 1.01–1.06), whereas the Native American–White disparity widened by 20% (OR = 1.20, 95% CI: 1.15–1.25). The Hispanic–White disparity remained largely unchanged. Asian youth experienced a further reduction in alcohol-related ED visits relative to White youth during the pandemic (OR = 0.86, 95% CI: 0.82–0.89).

3.4. Insurance-Related Disparities in Alcohol-Related ED Visits

Insurance status was significantly associated with alcohol-related ED visits. Prior to COVID-19, Medicaid-covered youth had lower odds of alcohol-related ED visits than privately insured youth (OR = 0.76, 95% CI: 0.74–0.79). In contrast, uninsured youth (OR = 1.43, 95% CI: 1.39–1.48) and those receiving charity care (OR = 1.16, 95% CI: 1.05–1.27) had higher odds of alcohol-related ED visits. During the COVID-19 period, the disparity between Medicaid-covered and privately insured youth narrowed modestly (OR = 1.05, 95% CI: 1.02–1.07, $p = 0.0010$), whereas disparities involving uninsured (OR = 1.00, 95% CI: 0.97–1.03, $p = 0.816$) and charity-care (OR = 1.03, 95% CI: 0.94–1.13, $p = 0.475$) patients remained unchanged.

3.5. Income and Geographic Differences

Income level and place of residence were also associated with alcohol-related ED visits. Compared with youth residing in the highest-income ZIP code quartile, those living in lower-income quartiles had lower odds of alcohol-related ED visits, with odds decreasing progressively as income quartile declined (51–75% quartile: OR = 0.69, 95% CI: 0.68–0.71; 26–50% quartile: OR = 0.62, 95% CI: 0.60–0.63; 0–25% quartile: OR = 0.60, 95% CI: 0.58–0.61; all $p < 0.001$). Youth residing in rural areas had 15% lower odds of alcohol-related ED visits than urban youth (OR = 0.85, 95% CI: 0.82–0.87, $p < 0.001$).

4. Discussion

This study utilized a repeated cross-sectional observational design to evaluate the sociodemographic and structural determinants of alcohol-related emergency department (ED) visits among underage individuals between 2019 and 2021. Analyzing approximately 32.2 million weighted ED visits from facilities consistently contributing to the Nationwide

Emergency Department Sample (NEDS), our findings demonstrate that structural and sociodemographic determinants exerted a stronger influence on underage alcohol-related ED utilization than the pandemic itself, as evidenced by the substantially larger effect sizes observed for race/ethnicity (e.g., OR = 3.68 for Native American vs. White youth) and insurance status (OR = 1.43 for uninsured vs. privately insured youth) relative to the non-significant COVID-19-period effect (OR = 1.03, 95% CI: 1.00–1.06, $p = 0.053$). Therefore, the pandemic is best understood as a contextual stressor that operated against a larger backdrop of entrenched, systemic inequities in adolescent health, rather than as an independent driver of population-level change in alcohol-related ED utilization.

The absence of a statistically significant population-level increase in alcohol-related ED visits during the COVID-19 period is consistent with some prior research suggesting that, while overall ED visits declined sharply in the early pandemic phase, alcohol-related visits declined less markedly, temporarily elevating their proportion of total visits without necessarily reflecting a true rise in underlying alcohol-related harm [1,11]. This may reflect shifts in healthcare-seeking behavior, where individuals avoided the ED for less severe conditions while still seeking care for acute alcohol-related harms [24]. It is plausible that pandemic-related stressors, such as social isolation, economic instability, and disruption of daily routines, elevated risk for problematic alcohol use in some adolescents [25], but our data do not support a population-level increase in ED presentations large enough to be distinguished from chance. Any individual-level mechanisms linking pandemic-related psychological distress to alcohol use should therefore be interpreted as a plausible contributing pathway for the subgroups where disparities did widen (see below), rather than as an explanation for an aggregate increase that was not observed. Age emerged as one of the strongest predictors, with each additional year associated with a substantial increase in the odds of alcohol-related ED visits. This finding is consistent with developmental patterns of alcohol initiation and escalation during late adolescence [26,27]. Sex differences were also pronounced, with females having significantly lower odds compared to males, indicating a higher burden of alcohol-related ED visits among male youth. These findings align with established evidence that males are more likely to engage in higher-risk drinking behaviors and experience more severe alcohol-related consequences [1,28].

Substantial racial and ethnic disparities were observed. Compared with White youth, Black, Hispanic, and Asian individuals had significantly lower odds of alcohol-related ED visits, whereas Native American youth had markedly higher odds. Importantly, interaction analyses revealed nuanced patterns. While the interaction term indicated a clear escalation in odds for Native American youth during the pandemic period, the interaction for Black youth was close to null (OR = 1.04, 95% CI: 1.01 to 1.06). Given our massive sample size (~7.49 million unweighted observations), this finding is statistically significant but holds minimal clinical or public health magnitude, suggesting the disparity remained essentially stable. Furthermore, the interaction term for Hispanic youth was non-significant (OR = 0.99, 95% CI: 0.97–1.01, $p = 0.187$), indicating an inconclusive or null change in disparities across periods relative to White youth.

These patterns likely reflect broader racial disparities that existing literature links to structural inequities rather than individual behavior alone. For example, the markedly elevated odds observed among Native American youth have been frequently attributed in the literature to historical and intergenerational trauma, chronic underfunding of the Indian Health Service (IHS), and systemic inequities in healthcare access. These structural barriers frequently intersect with geographic challenges, such as rurality, which limit access to early intervention and drive higher rates of acute alcohol-related emergency presentations. Similarly, Black American populations have historically experienced disproportionate exposure to poverty and systemic barriers that elevate vulnerability to substance-related

harms [29,30]. In contrast, lower observed odds among Hispanic and Asian youth may reflect a combination of lower reported alcohol use in some groups and systemic barriers to accessing ED care, including financial constraints, linguistic or cultural barriers, and differential patterns of care utilization [31,32]. The pandemic likely intensified these inequities by disproportionately affecting marginalized communities through economic hardship, reduced access to support services, and disruptions in care [33]. Overall, these findings highlight that racial disparities in alcohol-related ED visits appear to be shaped by unequal social conditions, access to resources, and structural barriers within the healthcare system [34]. Engaging with structural frameworks requires resisting ‘healthism,’ which is the tendency to blame individual choices for adverse health outcomes while obscuring systemic environments [35]. By treating race as a proxy for policy-sustained inequities rather than an inherent individual attribute, our data underscore how structural conditions systematically pattern acute adolescent risk.

Insurance status further highlighted disparities in healthcare access and financial vulnerability. Compared with privately insured individuals, those receiving charity care and uninsured patients had significantly higher odds of alcohol-related ED visits, while Medicaid-covered youth had lower baseline odds but experienced a significant increase during the COVID-19 period (OR = 1.05, 95% CI: 1.02–1.07, $p = 0.0010$). Notably, the proportion of uninsured youth in our sample actually declined during the pandemic (from 11.4% to 8.9%; Table 1), while Medicaid coverage increased (from 50.2% to 52.1%)—a pattern plausibly linked to pandemic-era Medicaid continuous-enrollment provisions that limited coverage disenrollment. This compositional shift toward Medicaid, rather than an expansion of the uninsured population, is therefore unlikely to explain any change in alcohol-related ED utilization; indeed, the interaction term for the uninsured-private contrast was statistically non-significant (OR = 1.00, 95% CI: 0.97–1.03, $p = 0.816$), indicating that the relative gap in odds between these two groups did not undergo a conclusive shift across the two periods. However, in this context, insurance status should not be interpreted merely as a direct measure of healthcare access or a lack of preventative care. Rather, being uninsured serves as a broad proxy for multiple intersecting vulnerabilities, including lower socioeconomic status, limited health literacy, unstable family resources, and poorer baseline health. Importantly, health literacy serves as a vital mechanism linking these socioeconomic vulnerabilities to acute healthcare utilization patterns. Populations with lower health literacy often face reduced capacity to navigate complex preventive care systems, making them more likely to present to the emergency department only after an alcohol-related event has escalated to an acute crisis. Research suggests that economically vulnerable populations, including those with low socioeconomic position (SEP), faced barriers to preventive care and rely more heavily on ED services for alcohol-related conditions during the pandemic [36]. This is consistent with the alcohol harm paradox, where disadvantaged populations experience greater alcohol-related harm despite lower or similar levels of consumption [37]. Interestingly, our finding that youth in lower-income ZIP code quartiles exhibited lower odds of alcohol-related ED visits appears counterintuitive when compared to these insurance-based disparities. This observation likely reflects competing barriers to accessing emergency care rather than a true lower prevalence of alcohol emergencies. Youth in lower-income areas may face systemic obstacles such as a lack of transportation, fear of medical bills, or reliance on under-resourced local clinics. These barriers can lead to underdiagnosis or the avoidance of ED care entirely, ultimately resulting in artificially lower rates of recorded visits for these neighborhoods.

This study has several limitations. First, the use of administrative data limits the ability to capture detailed behavioral, psychosocial, and contextual factors associated with alcohol use, such as frequency, quantity, or motivations for drinking [38]. Second, relying

exclusively on ICD-10-CM diagnosis codes likely underestimates the true prevalence of alcohol-involved ED visits, as less severe intoxication often goes undocumented [39]. Consequently, our findings capture only the most severe acute presentations rather than the full spectrum of underage alcohol-related emergencies. Third, ED visits reflect healthcare utilization rather than the true prevalence of alcohol use. Crucially, the sharp drop in overall ED volume during the early pandemic fundamentally altered the composition of the analytic denominator. As patients avoided the ED for minor conditions, the overall case mix skewed toward higher acuity. Consequently, our observed proportional increase in alcohol-related visits may partially reflect the mathematical disappearance of lower-acuity non-alcohol visits from the denominator rather than a genuine absolute expansion of underage drinking-related harms. Fourth, the cross-sectional design precludes causal inference. Specifically, the binary COVID-19 period variable captures calendar time rather than a true causal exposure. Therefore, the modest increase observed during this period may be heavily conflated with secular trends, seasonal variation, or other unmeasured factors wholly unrelated to the pandemic itself, and unmeasured confounding may persist despite adjustment. In addition, grouping April 2020 through December 2021 into a single ‘COVID-19 period’ overlooks the heterogeneity of different pandemic phases, such as early lockdowns and subsequent reopenings. Consequently, our estimates reflect an average association over this 21-month span, which may mask phase-specific fluctuations in emergency department utilization. Finally, the analysis was limited to facilities consistently contributing to NEDS during 2019–2021, which may affect generalizability.

Collectively, these findings suggest that the COVID-19 pandemic had a negligible effect on the overall demographic composition of underage alcohol-related ED visits (Table 1; Cramer’s $V = 0.0001$ – 0.0488), indicating that the population presenting to the ED did not meaningfully shift during the pandemic. However, regression-adjusted interaction analyses revealed a selective widening of alcohol-related ED risk among specific subgroups—most notably Native American youth ($OR = 1.20$, 95% CI: 1.15–1.25)—even as the Black–White disparity narrowed modestly and the Hispanic–White disparity remained unchanged. This pattern indicates that the pandemic’s impact on disparities was not uniform but concentrated among the most structurally marginalized groups, reflecting underlying racial inequalities driven by structural inequities, including historical marginalization, limited access to care, and disproportionate exposure to social and economic stressors. In this context, effective reduction of underage drinking necessitates comprehensive, multi-level prevention and intervention strategies that operate across individual, familial, community, and policy domains and are sustained throughout the life course [40]. Crucially, interventions must move beyond individual or family-focused programs, which risk reinforcing healthism by placing the prevention burden entirely on vulnerable youth. Truly equity-oriented strategies must prioritize upstream structural modifications. This includes addressing neighborhood-level poverty concentration, mitigating housing instability, and correcting systemic imbalances in local health resource allocations. Given that Native American youth experienced the highest baseline risk ($OR = 3.68$, 95% CI: 3.52–3.86) and the most pronounced disparity widening during the pandemic ($OR = 1.20$, 95% CI: 1.15–1.25), policy interventions must immediately target structural drivers rather than generic strategies. Specifically, the federal government must address the historical underfunding of the Indian Health Service (IHS) by transitioning to mandatory, insulated funding streams. Levers should prioritize expanding permanent pediatric mental health and substance-use screening within IHS facilities, expanding tribal-managed rural telehealth, and correcting the geographic maldistribution of early-intervention providers in isolated rural sectors [41,42]. Furthermore, reducing underage alcohol consumption requires emergency preparedness planning that integrates substance use prevention and adolescent mental health response

frameworks into disaster and pandemic response systems to mitigate unintended behavioral health consequences among youth [43]. During future pandemics or large-scale public health crises, policymakers and public health agencies should prioritize continuity of mental health and substance use services through telehealth platforms, maintain school- and community-based support systems whenever feasible, establish targeted outreach programs for high-risk adolescents, and implement real-time surveillance systems to monitor trends in youth substance use and alcohol-related harms [44]. Future preparedness efforts should additionally address structural vulnerabilities exacerbated during crises, including food insecurity, housing instability, educational disruption, and limited access to healthcare services, particularly among racial and socioeconomic minority populations. Taken together, these findings emphasize the need for resilient, equity-oriented public health systems capable of addressing both the immediate and long-term behavioral health consequences of future pandemics while simultaneously reducing persistent disparities in underage alcohol-related harms.

5. Conclusions

This study demonstrates that alcohol-related emergency department (ED) visits among underage individuals in the US are strongly associated with sociodemographic factors and structural inequity. Age, sex, race/ethnicity, and insurance status emerged as the primary predictors of alcohol-related ED utilization, underscoring the critical role of these social and structural contexts. While the COVID-19 pandemic was not significantly associated with a change in the overall population-level rate of alcohol-related ED visits, it corresponded with a selective widening of risk among Native American youth, even as other disparities—including the Black–White and Medicaid–private insurance gaps—narrowed modestly over the same period. These findings suggest that acute underage alcohol-related ED presentations are driven less by short-term public health disruptions than by persistent systemic factors, with the pandemic’s disparate impact concentrated among the most structurally marginalized groups rather than distributed broadly across all vulnerable populations. Addressing this crisis requires comprehensive, equity-focused strategies that improve access to preventive care, strengthen community-based interventions, and directly confront structural barriers to health. Future research should examine longitudinal patterns and evaluate targeted interventions to reduce alcohol-related harm among high-risk youth populations.

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Informed Consent Statement: Patient consent was waived because the study used retrospectively collected, non-identifiable data.

Data Availability Statement: The data that support the findings of this study are available from the Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (AHRQ), through the Nationwide Emergency Department Sample (NEDS). Restrictions apply to the

availability of these data, which were used under license for the current study and are therefore not publicly available from the authors. The data may be obtained directly from HCUP upon completion of the required data use agreement and purchase procedures (<https://www.hcup-us.ahrq.gov>).

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Abbreviations

The following abbreviations are used in this manuscript:

AHRQ	Agency for Healthcare Research and Quality
CI	Confidence Interval
COVID-19	Coronavirus Disease 2019
ED	Emergency Department
HCUP	Healthcare Cost and Utilization Project
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
MTF	Monitoring the Future
NEDS	Nationwide Emergency Department Sample
OR	Odds Ratio
SEP	Socioeconomic Position
U.S.	United States

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