HHS Public Access

Author manuscript

J Natl Compr Canc Netw. Author manuscript; available in PMC 2024 June 20.

Published in final edited form as:

J Natl Compr Canc Netw. 2024 February ; 22(1): . doi:10.6004/jnccn.2023.7076.

Association Between Alcohol Use Disorder and Hospital Readmission Rates and Outcomes in Cancer Survivors: A Population Cohort Study

Jyun-Heng Lai, BPharm, MS[1,*], **Sola Han, PharmD, PhD**[1,*], **Chanhyun Park, PhD, MPharm, MEd**[1], **Anton L.V. Avanceña, PhD**[1,2]

[1]Health Outcomes Division, College of Pharmacy, The University of Texas at Austin, Austin, Texas,

[2]Department of Internal Medicine, Dell Medical School, The University of Texas at Austin, Austin, Texas.

Abstract

Background: Alcohol use disorder (AUD) is the most common substance use disorder and is characterized by heavy alcohol use and the inability to control drinking. This study sought to compare the rate, timing, length, and total costs of hospital readmissions among cancer survivors with and without AUD.

Methods: We used the Nationwide Readmissions Database in 2017 and 2018 in this cohort study. Cancer survivors with an AUD diagnosis during their index hospitalization were included in the exposure group. Propensity score matching was used to identify cancer survivors without AUD for the control group. The primary outcome was all-cause readmission, and secondary outcomes included days to, length of, and total cost of readmission. Outcomes were measured after 90 and 180 days of follow-up. Logistic regression was used to measure the likelihood of readmission, and negative binomial regression and gamma regression were used for the other outcomes.

Results: Of 485,962 cancer survivors, 13,953 (2.9%) had co-occurring AUD. Cancer survivors with AUD had slightly higher odds of 90-day (odds ratio, 1.14; 95% CI, 1.06–1.22) and 180-day (odds ratio, 1.11; 95% CI, 1.05–1.18) readmission compared with those without AUD. Cancer survivors with AUD who were readmitted after 90 days also had higher readmission costs ($3,785 vs $3,376; *P*=.03). No differences in time to and length of readmission were observed between groups. The odds of readmission were higher among cancer survivors with AUD irrespective of age and type of cancer. Male, but not female, cancer survivors with AUD were more likely than those without AUD to be readmitted in both follow-up periods.

Correspondence: Anton L.V. Avanceña, PhD, Health Outcomes Division, College of Pharmacy, The University of Texas at Austin, 2409 University Avenue, PHR 2.112, Austin, TX 78712. antonlv@utexas.edu.

*These authors contributed equally to this study.

Author contributions: *Study concept and design:* Park, Avanceña. *Data acquisition, analysis, or interpretation:* All authors. *Statistical analysis:* Lai, Han, Avanceña. *Administrative, technical, or material support:* Park, Avanceña. *Supervision:* Park, Avanceña. *Manuscript preparation:* Lai, Avanceña. *Critical revision for important intellectual content:* All authors.

See JNCCN.org for supplemental online content.

Disclaimer: Dr. Avanceña had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conclusions: This population-based cohort study of cancer survivors in the United States found that AUD is associated with higher 90- and 180-day readmission rates and higher related health care costs after 90 days of follow-up. Hospitalized cancer survivors with AUD may benefit from addiction treatment and discharge planning that addresses their co-occurring AUD.

Background

Substance use disorders (SUDs) among cancer survivors are a modifiable prognostic factor associated with poor cancer prognosis[1] and higher health care use and costs.[2] For example, previous research on Medicare patients with prostate cancer found that individuals with SUDs had significantly higher rates of inpatient, outpatient, and emergency department visits and health care costs compared with those without SUDs.[3,4] Similar findings have been reported among cancer survivors with comorbid SUDs in the Veterans Health Administration[5] and other groups.[6] These studies, however, have focused broadly on all SUDs, leaving significant gaps in our understanding of the health effects of specific forms of addiction on cancer survivors.

Alcohol use disorder (AUD) is a type of SUD that is characterized by heavy or frequent alcohol consumption and impaired control or inability to stop drinking despite the harmful consequences.[7] AUD is the most common SUD in the United States, affecting 29.5 million individuals aged ≥12 years or 64% of people with SUDs.[8] Aside from its effects on mental health and wellness, AUD poses unique risks to cancer survivors because of the relationship between alcohol and cancer. Alcohol is a well-established carcinogen in humans, and alcohol consumption during or after cancer treatment may contribute to cancer recurrence and second primary cancers.[9] Alcohol use during radiation therapy or surgery is also associated with more complications,[10–12] and may increase the risk of opportunistic infections due to alcohol's effect on immune function.[13,14] Alcohol consumption after a cancer diagnosis has been shown to predict all-cause mortality in patients with certain malignancies, such as cancers of the aerodigestive tract,[10,15–19] as well as breast cancer among postmenopausal women.[20] Despite these risks, many cancer survivors report higher rates of alcohol use and misuse than their peers without a history of cancer, which has been observed in both small[21,22] and population-based studies.[23–25] Although research is limited, diagnosed AUD is also likely to be as or more common among cancer survivors than the general public.[1,5]

The objective of this study was to explore the short-term effects of AUD on health care use and costs among cancer survivors. Using a national database of inpatients in the United States, we estimated and compared the rates, timing, length, and costs of readmissions among matched adult cancer survivors with and without AUD. Unlike previous research on AUD and cancer survivors, this study focuses on short-term health care outcomes, such as readmission, that have been shown to predict longer-term outcomes, including mortality.[26] Findings from this study can inform holistic behavioral health care for cancer survivors.

Methods

Data Source and Study Setting

We analyzed the Nationwide Readmissions Database (NRD) from 2017 to 2018. The NRD is one of the Healthcare Cost and Utilization Project (HCUP) databases maintained by the Agency for Healthcare Research and Quality. It contains nationally representative data on all-payer hospital stays in >20 US states and represents 35 million discharge records per year after weighting.[27] The NRD consists of >100 different variables for each hospital stay, including length of inpatient stay, ICD-10-CM codes, and total charges, which can be converted to costs using cost-to-charge ratios provided by HCUP.[28] Patients across hospitals within a state can be tracked using the verified linkage numbers, which were developed under rigorous privacy policies. Because this study uses publicly available and deidentified data and does not involve human subjects, it was exempt from ethics review.[29]

Study Population

We identified patients aged ≥18 years with a principal diagnosis of cancer (ICD-10-CM codes C00–C96) from January to June in 2017 and 2018 as the eligible cohort. Principal diagnosis in the NRD is the condition that led to a patient's hospitalization,[30] and we included all types of malignant cancers as defined by the SEER Program.[31] Cohort entry was based on the earliest date of index hospitalization. Patients were excluded if they were aged <18 years, had missing values in their length of stay or any characteristics at baseline, were discharged with <180 days of follow-up, or died during the cohort entry.

Main Exposure and Matching Approach

Cancer survivors were included in the exposure group if they had an AUD diagnosis on their index hospitalization date. AUD was identified using ICD-10-CM codes F10.1, F10.2, or F10.9. We constructed a propensity score (PS)–matched control group that included cancer survivors without an AUD diagnosis on their index hospitalization. The PS matching approach was used to control potential confounders and increase the comparability between exposure and control groups. Before estimating PS via multivariable logistic regression, we evaluated the relationships between each covariate (discussed in the "Covariates" section), AUD, and hospital readmission to ensure that no instrumental variables were included.[32] Patients with cancer and AUD were matched to those without AUD using a greedy nearest neighbor matching approach, wherein a matched control with an estimated PS closest to that of the exposure was selected without replacement in a 1:1 ratio through a caliper of 0.2 standard deviations of the logit of the PS.[33]

Outcomes

The primary outcome was all-cause hospital readmission after a 90- and 180-day follow-up period. Readmission was defined as any inpatient visit following cohort entry. Secondary outcomes included time to readmission (number of days until hospital readmission), length of readmission (number of days of rehospitalization), and total cost of readmission (based on total readmission charges in the NRD). All secondary outcomes were estimated at 90 and 180 days after the index hospitalization.

Covariates

To address potential confounders, we included several patient- and facility-level characteristics available in the NRD in our PS-matching algorithm. Patient-level characteristics included age, sex, socioeconomic status (median household income quintiles based on patient zip codes), health insurance coverage (Medicaid, Medicare, private insurance, and others), length of previous hospital stay, and disability status (minor, moderate, major, and extreme loss of functions).[30] Cancer survivors' overall disease severity was measured using the Elixhauser comorbidity index, which is based on ICD codes of >38 preexisting diseases and can be used to predict resource utilization and mortality in hospitals.[34] We also matched patients based on their history of metastatic cancer and 8 specific alcohol-related cancers, which include cancers of the oral cavity, pharynx, larynx, esophagus, colorectum, liver, breast, and stomach.[9,35,36] Cancer treatment was categorized into radiation, chemotherapy, and cancer surgery. Other covariates included comorbidities and lifestyle factors, such as obesity, drug abuse, and smoking. We also controlled for cancer survivors' likelihood of death, measured using the All Patient Refined Diagnosis Related Group risk of mortality subclass to minimize the impact of death and loss to follow-up on the rate of readmission.[37,38] For health facility–related characteristics, we included bed size of hospitals (small, medium, and large) and status as an academic medical center (metropolitan nonteaching, metropolitan teaching, and nonmetropolitan hospital).[30]

Statistical Analyses

Cancer survivors' baseline characteristics were compared between AUD and non-AUD groups using standardized mean difference (SMD), with a threshold of >0.1 representing meaningful differences.[39] We used a generalized linear model (GLM) with a binomial distribution and logit link (logit model) to evaluate the association between AUD diagnosis and all-cause readmission. After examining the distributions, means, and variances of time to readmission and length of readmission (supplemental eFigure 1, available with this article at JNCCN.org), we used zero-inflated negative binomial regressions to account for overdispersed count data and an excessive number of zeros in both outcomes. Readmission-related health care costs were analyzed using a GLM with a gamma distribution and log link due to the positively skewed probability distribution of cost data (see supplemental eFigure 1 for original data and supplemental eFigure 2 for log-transformed data). Data management and statistical analysis were performed using SAS 9.4 (SAS Institute Inc.) and Stata MP, version 17 (StataCorp LLC) from January to August 2023.

Subgroup and Sensitivity Analyses

We conducted sensitivity analyses to verify the robustness of the main findings. First, we used Kaplan-Meier curves with log-rank tests and Cox proportional hazard models to estimate the time to readmission after index hospitalization. Second, we conducted median time-to-event analyses to measure the median time until readmission among cancer survivors with and without AUD. Third, we performed linear regressions of the log-transformed health care costs. Finally, we conducted subgroup analyses by stratifying patients by age (≥65 vs <65 years), sex, and presence of prior alcohol-related cancers.

Variables with SMD >0.1 in the stratified analyses were further adjusted in the outcome models.

Results

Study Population and Characteristics

Of 1,003,467 patients with cancer in the NRD in 2017 to 2018, 485,962 were diagnosed with cancer and were eligible for inclusion in the study (Figure 1). A total of 13,953 (2.9%) cancer survivors were found to have comorbid AUD. Multiple baseline characteristics were significantly different (SMD >0.1) between cancer survivors with and without AUD, such as sex, insurance type, prior AUD-related cancers, and other comorbidities (Table 1). After PS matching, 13,937 AUD and non-AUD matched pairs were generated, and all measured covariates were balanced between the 2 groups (Table 1). Although we balanced the prevalence of prior AUD-related cancers between the exposure and control groups, the final analytical sample included individuals with >17 types of malignancies based on SEER categories. The mean age of the matched groups was approximately 62 years, and approximately 80% were male cancer survivors. Both groups had a median hospital stay of approximately 6 days. Approximately 68% of the matched pairs had public health insurance, specifically Medicare and Medicaid, and 79% of the patients had previously visited metropolitan teaching hospitals. More than 30% of the patients had a history of metastatic cancer, and nearly 20% of them had undergone cancer surgeries. Additionally, 80% of the patients had a smoking history.

Primary Outcome

Compared with those without AUD, cancer survivors with AUD were associated with a 14% increased odds of 90-day all-cause readmission (odds ratio [OR], 1.14; 95% CI, 1.06–1.22). A similar result was observed for the 180-day all-cause readmission. Cancer survivors with AUD were 11% more likely to be readmitted after discharge compared with those without AUD (OR, 1.11; 95% CI, 1.05–1.18) (Table 2).

Secondary Outcomes

After PS matching, the presence of AUD in cancer did not influence time to readmission after 90 days (incidence rate ratio [IRR], 1.02; 95% CI, 0.97–1.08) or 180 days (IRR, 0.97; 95% CI, 0.92–1.03) of follow-up (Table 3). Similarly, the presence of AUD did not extend the length of readmission among cancer survivors in either follow-up period compared with those without AUD. On the other hand, cancer survivors with AUD were shown to have 12% significantly higher health care costs during 90 days of follow-up than those without AUD (IRR, 1.12; 95% CI, 1.01–1.24; P=.03), but no association was found for the 180-day follow-up (Table 4).

Sensitivity Analyses

Supplemental eFigure 3 shows the Kaplan-Meier curves for time to readmission. There was no difference in time to readmission between cancer survivors with and without AUD. Association between AUD and risk of readmission was also not observed during the 2 follow-up periods using Cox proportional hazard models (supplemental eTable 1). The

median time-to-readmission analyses in supplemental eTable 2 also revealed similar median times for the exposure and control groups during both follow-ups (23 vs 22 days for the 90-day follow-up; 35 vs 34 days for the 180-day follow-up). A similar increase in health care costs for the 90-day follow-up was observed when using the linear regression model with log transformation ($\beta = 0.1532$; $P<.001$; supplemental eTable 3).

Subgroup Analyses

We stratified readmissions among cancer survivors with and without AUD by age, sex, and history of alcohol-related cancers (supplemental eTables 4–6). Cancer survivors with AUD experienced higher odds of readmission compared with those without AUD irrespective of age (≥65 or <65 years). However, female cancer survivors with AUD did not have a higher likelihood of readmission than those without AUD. By contrast, male patients with cancer and AUD were more likely to be readmitted in both follow-up periods (adjusted OR [aOR], 1.16; 95% CI, 1.08–1.25 for 90-day follow-up; aOR, 1.13; 95% CI, 1.06–1.21 for 180-day follow-up). Survivors with or without alcohol-related cancers did not alter the likelihood of readmission in both follow-ups.

Discussion

In this cohort study using a national database of inpatients in the United States, we found that cancer survivors with AUD had greater odds of readmission after a primary hospitalization than cancer survivors without AUD. Health care costs were also higher among cancer survivors with AUD after 90 days (but not after 180 days) of an initial hospitalization. By contrast, length of readmission did not vary between cancer survivors with and without AUD. These findings align with previous research that showed higher health care utilization and costs among survivors of different cancers with co-occurring SUDs.[2,6]

Using 2 different regression models (negative binomial and proportional hazards), we also found that time to readmission was not associated with AUD. Viewed with our other results, this finding suggests that cancer survivors with AUD may experience more, but not earlier, readmissions in the first 90 or 180 days of their initial hospitalization compared with their peers without AUD. Because many of the negative effects of alcohol on health (eg, liver or cardiovascular disease)[40] develop over a long time horizon, future studies should use extended follow-up periods to reevaluate the effect of AUD on time to readmission.

The predictors and consequences of readmissions among cancer survivors have been extensively studied, and the presence of specific or a greater number of comorbidities has been shown to be associated with readmissions.[41] However, to our knowledge, no study has explored the independent effect of comorbid AUD on readmissions among cancer survivors. One related study found that SUDs independently predicted 90-day readmission among patients who underwent surgical resection for brain tumors at a single institution (OR, 1.82 [95% CI, 1.12–2.89]; $P<.05$).[42] Among the general adult inpatient population in the United States, alcohol-related disorders are among the top 20 diagnoses with the highest number of 30-day all-cause readmissions.[43] This study adds to the literature and suggests

that cancer survivors with co-occurring AUD may benefit from behavioral health treatment and specialized discharge planning.

AUD may influence the short-term outcomes of cancer survivors in several ways, though the exact mechanisms are not fully understood. Alcohol use during radiation therapy or surgery is associated with higher rates of complications,[10–12] and it can dysregulate innate and adaptive immune responses that lead to infections and sterile inflammation.[13,14] Excessive alcohol use has been shown to interfere with metabolism, leading to malnutrition and nutrient deficiency.[44] Related to this, studies among cancer survivors show that infection and nutritional and metabolic disorders are among the primary reasons for readmission.[45–48] AUD may also affect the care received by cancer survivors. For example, patients who misuse alcohol are less likely to receive outpatient follow-up after being discharged from the hospital.[49] Like other SUDs, AUD may lead to negative interactions with hospital staff, inadequate management of pain or withdrawal symptoms, and substandard or premature inpatient discharge.[42] Despite these risks, some studies suggest that rates of AUD and alcohol misuse among cancer survivors may be comparable to or higher than the general public.[1,5] Cancer survivors may develop AUD and other SUDs to cope with life stressors, which has been referred to as “chemical coping.”[50]

Subgroup analyses found that cancer survivors with AUD across different ages and cancer types (ie, alcohol- and non–alcohol-related cancers) face higher odds of readmission. By contrast, we only found an association between AUD and 90- and 180-day readmission among male cancer survivors. This finding aligns with previous studies that have reported lower readmission rates among female patients compared with male patients.[41,51] All in all, these results suggest that most cancer survivors with AUD may face higher readmission risks after an initial hospitalization and could benefit from additional services that address their AUD. Aside from inpatient consultation with an addiction medicine specialist, proactive case management has been shown to increase abstinence and promote entry into community-based SUD treatment.[42,52] However, none of these interventions have focused on AUD or cancer survivors specifically, and tailored interventions are likely needed to address co-occurring AUD and cancer. Another opportunity may be to include AUD screening and treatment in nurse-led patient navigation programs, which have been shown to improve psychosocial care and satisfaction among cancer survivors.[53–55] Patient navigation may also be delivered remotely or via telemedicine, which could ensure broad access among cancer survivors,[56,57] though its effectiveness has not been systematically assessed.

This is the first study to evaluate the association between AUD and readmission rates and outcomes among cancer survivors. We included nearly 14,000 cancer survivors with AUD and applied a PS-matching approach to control for relevant confounding factors at baseline. Our study provides evidence that could inform holistic health care delivery for cancer survivors with AUD.

This study has several limitations. First, there may be unmeasured confounders that could lead to selection bias. We matched our exposed and unexposed patients using PS based on important factors that have been shown to predict readmission, but there may be other patient (eg, race and ethnicity, marital status), facility (eg, location), and community (eg,

availability of alcohol) characteristics that were omitted from the NRD and excluded from the analysis. Second, we were unable to measure various censoring conditions during the follow-up period in the NRD database, such as death, duration of AUD diagnosis, and time of disenrollment. These factors may have confounded our findings and led to misclassification of outcomes. However, we believe this bias was minimal because we controlled for variables such as the likelihood of dying, patient comorbidities, and disability status, all of which were balanced at baseline. Third, we did not disaggregate admissions according to planned and unplanned readmissions. Future studies should explore the association between AUD and unplanned or avoidable readmissions among cancer survivors. Fourth, we used 90- and 180-day readmission as our primary outcome, and future research should also use other intervals to determine the acute and longer-term (>1 year) effects of AUD. Fifth, because AUD and other SUDs are underdiagnosed, we may have underestimated the effect of alcohol use and misuse on the outcomes of cancer survivors; additionally, our reliance on diagnosed AUD as the exposure may have limited our analyses, because patients may be misusing alcohol but not meeting the criteria for AUD.

Conclusions

This large population-based cohort study of cancer survivors in the United States found that AUD is associated with higher rates of 90- and 180-day readmission and higher health care costs when patients are readmitted after 90 days. Cancer survivors with AUD who are hospitalized may benefit from addiction treatment and specialized discharge planning that addresses their co-occurring AUD. Additional research is needed to understand how AUD and alcohol misuse influence the short- and long-term outcomes of cancer survivors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosures:

The authors have disclosed that they have not received any financial consideration from any person or organization to support the preparation, analysis, results, or discussion of this article.

References

1. Yusufov M, Braun IM, Pirl WF. A systematic review of substance use and substance use disorders in patients with cancer. Gen Hosp Psychiatry 2019;60:128–136. [PubMed: 31104826]
2. Khushalani JS, Qin J, Cyrus J, et al. Systematic review of healthcare costs related to mental health conditions among cancer survivors. Expert Rev Pharmacoecon Outcomes Res 2018;18:505–517. [PubMed: 29869568]
3. Jayadevappa R, Chhatre S. Association between age, substance use, and outcomes in Medicare enrollees with prostate cancer. J Geriatr Oncol 2016;7:444–452. [PubMed: 27394148]
4. Chhatre S, Metzger DS, Malkowicz SB, et al. Substance use disorder and its effects on outcomes in men with advanced-stage prostate cancer. Cancer 2014;120:3338–3345. [PubMed: 25042396]
5. Ho P, Rosenheck R. Substance use disorder among current cancer patients: rates and correlates nationally in the Department of Veterans Affairs. Psychosomatics 2018;59:267–276. [PubMed: 29452704]

6. Edwards CV, Sheikh AR, Dennis MJ, et al. The impact of substance use on health care utilization, treatment, and outcomes in patients with non-small cell lung cancer. J Thorac Dis 2022;14: 3865–3875. [PubMed: 36389291]
7. Carvalho AF, Heilig M, Perez A, et al. Alcohol use disorders. Lancet 2019;394:781–792. [PubMed: 31478502]
8. Substance Abuse and Mental Health Services Administration. 2021 NSDUH annual national report. Accessed June 2, 2023. Available at: https://www.samhsa.gov/data/report/2021-nsduh-annual-national-report
9. Gapstur SM, Bandera EV, Jernigan DH, et al. Alcohol and cancer: existing knowledge and evidence gaps across the cancer continuum. Cancer Epidemiol Biomarkers Prev 2022;31:5–10. [PubMed: 34728469]
10. Paull DE, Updyke GM, Davis CA, et al. Complications and long-term survival for alcoholic patients with resectable lung cancer. Am J Surg 2004; 188:553–559. [PubMed: 15546569]
11. Graf SA, Zeliadt SB, Rise PJ, et al. Unhealthy alcohol use is associated with postoperative complications in veterans undergoing lung resection. J Thorac Dis 2018;10:1648–1656. [PubMed: 29707317]
12. Neuenschwander AU, Pedersen JH, Krasnik M, et al. Impaired postoperative outcome in chronic alcohol abusers after curative resection for lung cancer. Eur J Cardiothorac Surg 2002;22:287–291. [PubMed: 12142201]
13. Molina PE, Happel KI, Zhang P, et al. Focus on: alcohol and the immune system. Alcohol Res Health 2010;33:97–108. [PubMed: 23579940]
14. Szabo G, Saha B. Alcohol's effect on host defense. Alcohol Res 2015;37: 159–170. [PubMed: 26695755]
15. Mayne ST, Cartmel B, Kirsh V, et al. Alcohol and tobacco use prediagnosis and postdiagnosis, and survival in a cohort of patients with early stage cancers of the oral cavity, pharynx, and larynx. Cancer Epidemiol Biomarkers Prev 2009;18:3368–3374. [PubMed: 19959684]
16. Paull DE, Updyke GM, Baumann MA, et al. Alcohol abuse predicts progression of disease and death in patients with lung cancer. Ann Thorac Surg 2005;80:1033–1039. [PubMed: 16122481]
17. Chen YP, Zhao BC, Chen C, et al. Alcohol drinking as an unfavorable prognostic factor for male patients with nasopharyngeal carcinoma. Sci Rep 2016;6:19290. [PubMed: 26776301]
18. Kenyon CR, Tsoumanis A, Schwartz IS. A population's higher-risk sexual behaviour is associated with its average sexual behaviour—an ecological analysis of subpopulations in Ethiopia, Kenya, South Africa, Uganda and the United States. Epidemics 2016;15:56–65. [PubMed: 27266849]
19. Denissoff A, Huusko T, Ventelä S, et al. Exposure to alcohol and overall survival in head and neck cancer: a regional cohort study. Head Neck 2022;44:2109–2117. [PubMed: 35713171]
20. Park SH, Hoang T, Kim J. Dietary factors and breast cancer prognosis among breast cancer survivors: a systematic review and meta-analysis of cohort studies. Cancers (Basel) 2021;13:5329. [PubMed: 34771493]
21. MacDonald M, Shah S, Swanson J, et al. Substance use in uninsured cancer survivors: a multicenter cross-sectional study of free clinics. Cureus 2020;12:e10083. [PubMed: 33005507]
22. Cappelli C, Miller KA, Ritt-Olson A, et al. Binge drinking, tobacco, and marijuana use among young adult childhood cancer survivors: a longitudinal study. J Pediatr Oncol Nurs 2021;38:285–294. [PubMed: 34096807]
23. Ji X, Cummings JR, Mertens AC, et al. Substance use, substance use disorders, and treatment in adolescent and young adult cancer survivors—results from a national survey. Cancer 2021;127:3223–3231. [PubMed: 33974717]
24. Lyu J, Kaur M, Dibble KE, et al. A national study of alcohol consumption patterns among population-based U.S. cancer survivors compared with cancer-free individuals. Cancer Epidemiol 2022;77:102101. [PubMed: 35086062]
25. Sanford NN, Sher DJ, Xu X, et al. Alcohol use among patients with cancer and survivors in the United States, 2000–2017. J Natl Compr Canc Netw 2020;18:69–79. [PubMed: 31910381]
26. Stitzenberg KB, Chang Y, Smith AB, et al. Exploring the burden of inpatient readmissions after major cancer surgery. J Clin Oncol 2015;33:455–464. [PubMed: 25547502]

27. Agency for Healthcare Research and Quality. Introduction to the HCUP Nationwide Readmissions Database (NRD), 2019. Accessed June 2, 2023. Available at: https://hcup-us.ahrq.gov/db/nation/nrd/Introduction_NRD_2019.jsp
28. Agency for Healthcare Research and Quality. Cost-to-charge ratio for inpatient files. Accessed June 2, 2023. Available at: https://hcup-us.ahrq.gov/db/ccr/ip-ccr/ip-ccr.jsp
29. The University of Texas at Austin. Examples of activities that may or may not be human subjects research. Accessed June 5, 2023. Available at: https://research.utexas.edu/ors/human-subjects/for-researchers/examples-of-activities-that-may-or-may-not-be-human-subjects-research/
30. Agency for Healthcare Research and Quality. NRD description of data elements. Accessed May 1, 2023. Available at: https://hcup-us.ahrq.gov/db/nation/nrd/nrddde.jsp
31. National Cancer Institute. SEER cause of death recode 1969+ (03/01/2018). Accessed August 21, 2023. Available at: https://seer.cancer.gov/codrecode/1969_d03012018/index.html
32. Brookhart MA, Schneeweiss S, Rothman KJ, et al. Variable selection for propensity score models. Am J Epidemiol 2006;163:1149–1156. [PubMed: 16624967]
33. Austin PC. A comparison of 12 algorithms for matching on the propensity score. Stat Med 2014;33:1057–1069. [PubMed: 24123228]
34. Agency for Healthcare Research and Quality. User guide: Elixhauser comorbidity software, refined for ICD-10-CM diagnoses, v2022.1. Accessed June 2, 2023. Available at: https://hcup-us.ahrq.gov/toolssoftware/comorbidityicd10/CMR-User-Guide-v2022-1.pdf
35. Deng W, Jin L, Zhuo H, et al. Alcohol consumption and risk of stomach cancer: a meta-analysis. Chem Biol Interact 2021;336:109365. [PubMed: 33412155]
36. Yoo JE, Shin DW, Han K, et al. Association of the frequency and quantity of alcohol consumption with gastrointestinal cancer. JAMA Netw Open 2021;4:e2120382. [PubMed: 34406403]
37. McCormick PJ, Lin HM, Deiner SG, et al. Validation of the All Patient Refined Diagnosis Related Group (APR-DRG) risk of mortality and severity of illness modifiers as a measure of perioperative risk. J Med Syst 2018;42:81. [PubMed: 29564554]
38. Averill RF, Goldfield N, Hughes JS, et al. All Patient Refined Diagnosis Related Groups (APR-DRGs), methodology overview. Accessed May 15, 2023. Available at: https://hcup-us.ahrq.gov/db/nation/nis/APR-DRGsV20MethodologyOverviewandBibliography.pdf
39. Zhang Z, Kim HJ, Lonjon G, et al. Balance diagnostics after propensity score matching. Ann Transl Med 2019;7:16. [PubMed: 30788363]
40. Rehm J, Gmel GE Sr, Gmel G, et al. The relationship between different dimensions of alcohol use and the burden of disease-an update. Addiction 2017;112:968–1001. [PubMed: 28220587]
41. Bell JF, Whitney RL, Reed SC, et al. Systematic review of hospital readmissions among patients with cancer in the United States. Oncol Nurs Forum 2017;44:176–191. [PubMed: 28222076]
42. Jimenez AE, Cicalese KV, Chakravarti S, et al. Substance use disorders are independently associated with hospital readmission among patients with brain tumors. World Neurosurg 2022;166:e358–368. [PubMed: 35817348]
43. Agency for Healthcare Research and Quality. Overview of clinical conditions with frequent and costly hospital readmissions by payer, 2018. Accessed May 12, 2023. Available at: https://hcup-us.ahrq.gov/reports/statbriefs/sb278-Conditions-Frequent-Readmissions-By-Payer-2018.jsp
44. Lieber CS. Relationships between nutrition, alcohol use, and liver disease. Alcohol Res Health 2003;27:220–231. [PubMed: 15535450]
45. Ghiam MK, Langerman A, Sargi Z, et al. Head and neck cancer patients: rates, reasons, and risk factors for 30-day unplanned readmission. Otolaryngol Head Neck Surg 2018;159:149–157. [PubMed: 29787349]
46. Chen MM, Orosco RK, Harris JP, et al. Predictors of readmissions after head and neck cancer surgery: a national perspective. Oral Oncol 2017;71:106–112. [PubMed: 28688676]
47. Donzé JD, Lipsitz S, Schnipper JL. Risk factors and patterns of potentially avoidable readmission in patients with cancer. J Oncol Pract 2017;13:e68–76. [PubMed: 28084884]
48. Manzano JG, Luo R, Elting LS, et al. Patterns and predictors of unplanned hospitalization in a population-based cohort of elderly patients with GI cancer. J Clin Oncol 2014;32:3527–3533. [PubMed: 25287830]

49. Borg B, Douglas IS, Hull M, et al. Alcohol misuse and outpatient follow-up after hospital discharge: a retrospective cohort study. Addict Sci Clin Pract 2018;13:24. [PubMed: 30514357]
50. Del Fabbro E Assessment and management of chemical coping in patients with cancer. J Clin Oncol 2014;32:1734–1738. [PubMed: 24799476]
51. Solomon R, Egorova N, Adelson K, et al. Thirty-day readmissions in patients with metastatic cancer: room for improvement? J Oncol Pract 2019;15:e410–419. [PubMed: 30925070]
52. Gryczynski J, Nordeck CD, Welsh C, et al. Preventing hospital readmission for patients with comorbid substance use disorder: a randomized trial. Ann Intern Med 2021;174:899–909. [PubMed: 33819055]
53. Wagner EH, Ludman EJ, Aiello Bowles EJ, et al. Nurse navigators in early cancer care: a randomized, controlled trial. J Clin Oncol 2014;32:12–18. [PubMed: 24276777]
54. Tho PC, Ang E. The effectiveness of patient navigation programs for adult cancer patients undergoing treatment: a systematic review. JBI Database Syst Rev Implement Reports 2016;14:295–321.
55. Tan CH, Wilson S, McConigley R. Experiences of cancer patients in a patient navigation program: a qualitative systematic review. JBI Database Syst Rev Implement Reports 2015;13:136–168.
56. Mir O, Ferrua M, Fourcade A, et al. Digital remote monitoring plus usual care versus usual care in patients treated with oral anticancer agents: the randomized phase 3 CAPRI trial. Nat Med 2022;28:1224–1231. [PubMed: 35469070]
57. Emfield Rowett K, Christensen D. Oncology nurse navigation: expansion of the navigator role through telehealth. Clin J Oncol Nurs 2020;24:24–31. [PubMed: 32441701]

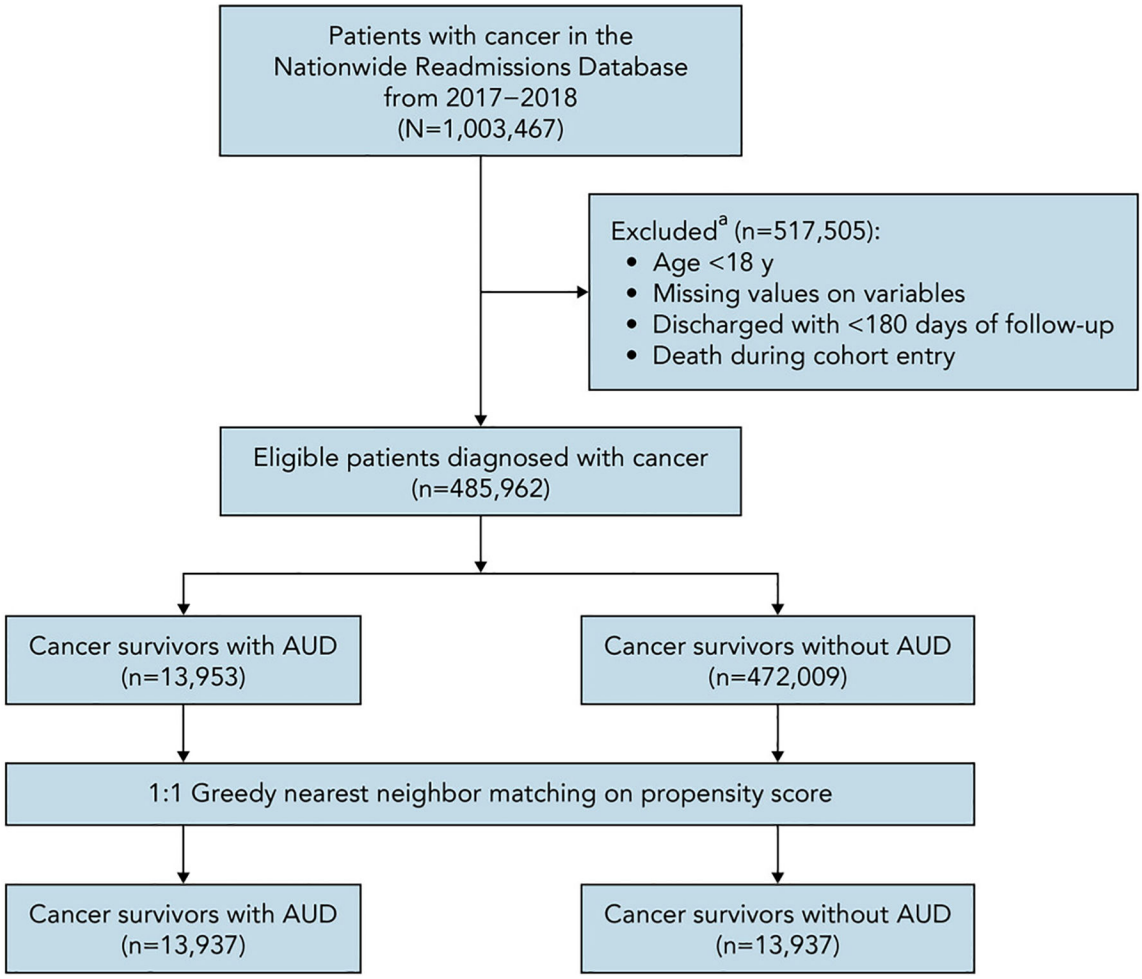

Figure 1.

Flow diagram of included participants.

Abbreviation: AUD, alcohol use disorder.

[a]Several patients met ≥2 exclusion criteria.

Table 1.

Clinical and Demographic Characteristics Among Cancer Survivors With or Without AUD Before and After PSM

Characteristic	Before PSM			After PSM		
	With AUD, % (n=13,953)	Without AUD, % (n=472,009)	SMD[a]	With AUD, % (n=13,937)	Without AUD, % (n=13,937)	SMD[a]
Age, mean [SD], y	62.2 [10.1]	65.0 [13.5]	0.2350	62.2 [10.1]	62.5 [13.2]	0.0216
Elixhauser comorbidity index, mean [SD]	6.7 [6]	5.3 [5.7]	0.2424	6.7 [6]	6.7 [6]	0.0029
Index length of hospital stay, median (IQR), d	6 (7)	4 (6)	0.2261	6 (7)	5 (7)	0.0048
Index health care cost, median (IQR), USD	$17,276 ($20,694)	$15,785 ($16,540)	0.1047	$17,278 ($20,694)	$16,911 ($19,922)	0.0049
Sex						
Female	21	48.6	0.6046	21.1	19.6	0.0357
Male	79	51.4		78.9	80.4	
Socioeconomic status[b]						
1st quintile	33.2	23.9	0.2077	33.2	32.8	0.0099
2nd quintile	27.6	26.1	0.0345	27.6	27.5	0.0019
3rd quintile	21.8	25.4	0.0851	21.8	22.1	0.0068
4th quintile	17.4	24.6	0.1788	17.4	17.6	0.0072
Insurance type						
Medicare	44.8	53.7	0.1793	44.8	45.6	0.0163
Medicaid	24.4	9.9	0.3918	24.3	23.7	0.0148
Private	22.5	32.3	0.2220	22.5	22.4	0.0021
Others	8.4	4.1	0.1771	8.4	8.3	0.0034
Disability status						
Minor loss of function	7.3	17.2	0.3070	7.3	7.1	0.0075
Moderate loss of function	29.8	37.3	0.1583	29.8	29.5	0.0086
Major loss of function	45.6	34.7	0.2227	45.5	45.7	0.0033
Extreme loss of function	17.4	10.8	0.1893	17.3	17.8	0.0111
APR-DRG: risk of mortality subclass						
Minor likelihood of dying	21.5	33.2	0.2641	21.6	21.2	0.0093
Moderate likelihood of dying	33.5	32.4	0.0233	33.4	33.3	0.0032

J Natl Compr Canc Netw. Author manuscript; available in PMC 2024 June 20.

Characteristic	Before PSM			After PSM		
	With AUD, % (n=13,953)	Without AUD, % (n=472,009)	SMD[a]	With AUD, % (n=13,937)	Without AUD, % (n=13,937)	SMD[a]
Major likelihood of dying	34.0	27.0	0.1510	34.0	34.2	0.0058
Extreme likelihood of dying	11.1	7.4	0.1261	11.1	11.3	0.0082
Hospital size[c]						
Small	11.5	11.4	0.0051	11.5	11.4	0.0052
Medium	24.6	22.9	0.0404	24.6	25.2	0.0129
Large	63.9	65.7	0.0394	63.8	63.5	0.0082
Hospital ownership						
Government, nonfederal	14.3	12.1	0.0653	14.3	14.2	0.001
Private, nonprofit	73.6	78.4	0.1133	73.6	73.7	0.0018
Private, investor-owned	12.2	9.5	0.0845	12.2	12.1	0.0013
Teaching hospital status						
Metropolitan nonteaching	17.2	16.5	0.0195	17.2	17.4	0.0053
Metropolitan teaching	79.3	80.2	0.0235	79.3	79.0	0.0076
Nonmetropolitan hospital	3.5	3.3	0.0117	3.5	3.6	0.0058
Alcohol-related cancer sites						
Oral cavity	4.7	1.5	0.1869	4.7	4.5	0.0072
Pharynx	2.8	0.7	0.1634	2.8	2.6	0.0116
Larynx	3.0	0.6	0.1830	3.0	2.9	0.0098
Esophagus	3.9	1.3	0.1637	3.9	4.0	0.0081
Colorectum	11.4	13.7	0.0688	11.4	11.7	0.0079
Liver	7.4	1.1	0.3135	7.3	6.7	0.0228
Breast	1.1	4.4	0.2032	1.1	1.0	0.0141
Stomach	2.7	1.8	0.0573	2.7	2.9	0.0139
Metastatic cancer	31.8	29.4	0.0521	31.9	32.5	0.0132
Cancer therapy						
Radiation	1.9	1.7	0.0149	1.9	2.0	0.0068
Chemotherapy	3.3	4.0	0.0411	3.3	3.4	0.006
Surgery	20.7	32.0	0.2590	20.7	21.2	0.0125

J Natl Compr Canc Netw. Author manuscript; available in PMC 2024 June 20.

Characteristic	Before PSM			After PSM		
	With AUD, % (n=13,953)	Without AUD, % (n=472,009)	SMD[a]	With AUD, % (n=13,937)	Without AUD, % (n=13,937)	SMD[a]
Comorbidities						
Hypertension	61.4	58.3	0.0626	61.4	61.5	0.0032
Hyperlipidemia	28.4	35.8	0.1596	28.4	28.8	0.0092
Diabetes	16.9	23.1	0.1558	16.9	16.7	0.0067
Liver disease	22.3	5.3	0.5067	22.2	21.1	0.027
Dementia	3.0	2.7	0.0153	3.0	3.0	0.0004
Depression	14.3	9.9	0.1349	14.3	14.3	0.0012
Peripheral vascular disease	7.5	4.8	0.11	7.5	7.7	0.0089
Lifestyle factors						
Obesity	9.0	13.8	0.1507	9.0	9.0	0.0023
Drug abuse	8.8	1.2	0.3538	8.7	8.1	0.023
Tobacco use	78.5	42.8	0.7847	78.4	80.0	0.0384

Abbreviations: APR-DRG, All Patient Refined Diagnosis Related Group; AUD, alcohol use disorder; PSM, propensity score matching; SMD, standardized mean difference.

[a]SMD was used to check the comparability between 2 groups, with a cutoff point >0.1 representing the significant differences.

[b]Median household income quintiles are based on patient zip codes.

[c]Hospital size is based on a hospital's region (Northeast, Midwest, Southern, and Western), rural or urban location, and teaching status (teaching or nonteaching). For specific definitions, see https://hcup-us.ahrq.gov/db/nation/nrd/nrddde.jsp.

Table 2.

Association Between AUD and Hospital Readmission in Cancer Survivors

	Before PSM				After PSM			
	With AUD (n=13,953) n (%)	**Without AUD (n=472,009) n (%)**	**OR (95% CI)[a]**	***P* Value**	**With AUD (n=13,937) n (%)**	**Without AUD (n=13,937) n (%)**	**OR (95% CI)[a]**	***P* Value**
All-cause readmission within 90 days of index hospitalization	2,190 (15.7)	46,006 (9.8)	1.72 (1.65–1.81)	<.001	2,186 (15.7)	1,959 (14.1)	1.14 (1.06–1.22)	<.001
All-cause readmission within 180 days of index hospitalization	2,826 (20.3)	61,052 (12.9)	1.71 (1.64–1.78)	<.001	2,820 (20.2)	2,585 (18.6)	1.11 (1.05–1.18)	<.001

Abbreviations: AUD, alcohol use disorder; OR, odds ratio; PSM, propensity score matching.

[a]OR was estimated by using generalized linear models with a binomial distribution and logit link (logit model).

Table 3.

Association Between AUD and Time to Readmission and Length of Readmission in Cancer Survivors

	Before PSM				After PSM			
	With AUD (n=13,953) Mean [SD]	**Without AUD (n=472,009) Mean [SD]**	**IRR (95% CI)[a]**	***P* Value**	**With AUD (n=13,937) Mean [SD]**	**Without AUD (n=13,937) Mean [SD]**	**IRR (95% CI)[a]**	***P* Value**
All-cause readmission within 90 days of index hospitalization								
Time to readmission	4.7 [14.4]	2.99 [11.92]	0.97 (0.94–1.01)	.177	4.69 [14.41]	4.11 [13.6]	1.02 (0.97–1.08)	.412
Length of readmission	1.30 [5.21]	0.77 [3.84]	1.07 (1.02–1.12)	.01	1.3 [5.21]	1.15 [5.03]	1.02 (0.95–1.09)	.588
All-cause readmission within 180 days of index hospitalization								
Time to readmission	10.68 [30.51]	7.19 [25.94]	0.95 (0.91–0.99)	.007	10.66 [30.49]	10.05 [30.27]	0.97 (0.92–1.03)	.333
Length of readmission	1.68 [6]	1.02 [4.39]	1.06 (1.02–1.11)	.007	1.67 [5.99]	1.51 [5.55]	1.02 (0.96–1.09)	.453

Abbreviations: AUD, alcohol use disorder; IRR, incidence rate ratio; PSM, propensity score matching.

[a]Incidence rate ratio was estimated by using zero-inflated negative binomial regression models.

Table 4.

Association Between AUD and Total Health Care Costs in Cancer Survivors

	Before PSM				After PSM			
Health Care Costs	**With AUD (n=13,953) Mean [SD]**	**Without AUD (n=472,009) Mean [SD]**	**Exponentiated β (95% CI)**	***P* Value**	**With AUD (n=13,937) Mean [SD]**	**Without AUD (n=13,937) Mean [SD]**	**Exponentiated β (95% CI)**	***P* Value**
All-cause readmission within 90 days of index hospitalization	$3,785 [$16,524]	$2,346 [$13,464]	1.61 (1.47–1.78)	<.001	$3,785 [$16,530]	$3,376 [$14,823]	1.12 (1.01–1.24)	.03
All-cause readmission within 180 days of index hospitalization	$5,028 [$19,652]	$3,245 [$16,177]	1.55 (1.43–1.68)	<.001	$5,022 [$19,646]	$4,676 [$17,743]	1.07 (0.98–1.18)	.122

Abbreviations: AUD, alcohol use disorder; PSM, propensity score matching.

[a]Exponentiated β was estimated by using generalized linear model with a gamma distribution and log link.