frontiers in Cancer Control and Society

TYPE Brief Research Report
PUBLISHED 11 February 2026
DOI 10.3389/fcacs.2026.1664435

OPEN ACCESS

EDITED BY
Hussain Gadelkarim Ahmed,
Prof. Medical Research Consultancy Center-MRCC, Sudan

REVIEWED BY
Ibrahim Abdelmageed Ginawi,
Ministry of Health, Saudi Arabia
Ahmed Abdalla Agab Eldour,
Kordofan University, South Sudan

*CORRESPONDENCE
Stephanie Knollhoff
knollhoffs@health.missouri.edu

RECEIVED 11 July 2025
REVISED 25 January 2026
ACCEPTED 27 January 2026
PUBLISHED 11 February 2026

CITATION
Gates C, Barry E, Dooley L and Knollhoff S (2026) Head and neck cancer in mid-Missouri: demographics, social determinants, and care patterns. *Front. Cancer Control Soc.* 4:1664435. doi: 10.3389/fcacs.2026.1664435

Head and neck cancer in mid-Missouri: demographics, social determinants, and care patterns

Carson Gates[1], Elsie Barry[2], Laura Dooley[3] and Stephanie Knollhoff[4]*

[1]University of Missouri School of Medicine, Columbia, MO, United States, [2]Department of Otolaryngology, Head and Neck Surgery, University of West Virginia School of Medicine, Morgantown, WV, United States, [3]Department of Otolaryngology-Head and Neck Surgery, University of Missouri, Columbia, MO, United States, [4]Department of Speech, Language, and Hearing Science, University of Missouri, Columbia, MO, United States

Introduction: The social determinants of health (SDOH), such as socioeconomic status, rurality, and healthcare access, are increasingly recognized as key factors in the care of head and neck cancer (HNC). In central Missouri, where rurality and socioeconomic disparities are prevalent, understanding these factors is essential for improving early diagnosis and outcomes.

Methods: Retrospective analysis of 880 patients diagnosed with primary HNC at the Ellis Fischel Cancer Center from 2006 to 2022. Demographic and tumor staging data were collected from electronic medical records. Socioeconomic status was assessed using Area Deprivation Index (ADI) scores, rurality was determined by Rural-Urban Commuting Area (RUCA) codes, and travel distance to care was estimated from patients' addresses. Associations between SDOH factors and stage at diagnosis were evaluated using chi-square tests, ANOVA, and multivariate logistic regression.

Results: Patients residing more than 100 miles from the cancer center had higher rates of stage IV presentation compared to local Boone County residents (53 vs. 28%; $p = 0.005$). Higher state ADI scores were significantly associated with advanced-stage disease ($p = 0.017$). In multivariate analysis, travel distance (OR = 1.24, 95% CI: 1.09–1.41, $p = 0.001$) and ADI (OR = 1.06, 95% CI: 1.01–1.11, $p = 0.02$) remained independently associated with a higher stage at diagnosis. RUCA classification ($p = 0.769$) and sex ($p = 0.312$) were not significantly associated with stage.

Discussion: Greater travel distance and higher socioeconomic deprivation were independently associated with advanced-stage HNC at diagnosis. These findings underscore the importance of addressing SDOH HNC care, particularly in rural and disadvantaged populations.

KEYWORDS
cancer staging, demographics, head and neck cancer, rural, social determinants of health

Introduction

Head and neck cancer (HNC) is comprised of several distinct tumor types that primarily arise from the epithelium of the oral cavity, oropharynx, nasopharynx, and larynx (1). Early identification is directly linked to improved outcomes and survival (2). Well-established risk factors for head and neck cancer are tobacco use, alcohol use, and human papillomavirus.

Equally important factors that are often excluded in this conversation are the social determinants of health (SDOH), which have been recognized as key influences on health outcomes (3). SDOH are the social, economic, and physical conditions that impact health (4). This includes economic status, healthcare access, neighborhood and environment, education access and quality, and community. Multiple studies have identified disparities in race, literacy level, rurality, and socioeconomic status that contribute to worse outcomes such as quality of life or overall survival in patients with head and neck cancer (5–7). With increasing emphasis for personalizing medical care, identifying disparities in SDOH is essential for care regimens and providing patients a chance to maximize their outcomes.

The Ellis Fischel Cancer Center (EFCC) at the University of Missouri-Columbia serves as the state's cancer facility, providing treatment to Missouri residents. It is the only academic center situated in central Missouri, which is surrounded by rural counties. According to the Missouri Department of Health and Senior Services, 86% of Missouri counties are rural (8). Furthermore, 45 of these rural counties are without an acute general care hospital, highlighting significant barriers to care for rural residents. This study examines the demographics of HNC patients treated at EFCC and evaluates how factors such as geographic location, travel distance, and socioeconomic disadvantage influence cancer stage at diagnosis and recurrence.

Methods

Institutional Review Board approval was obtained at the University of Missouri-Columbia. We retrospectively identified patients evaluated at Ellis Fischel Cancer Center (EFCC) with a diagnosis of a primary head and neck malignancy between 2006 and 2022. Patients were included if they had newly diagnosed, previously untreated head and neck cancers with complete demographic (age, sex, race, and ZIP code) and tumor (primary site, T/N/M classification, and overall AJCC stage) information available. Patients were excluded if they had prior head and neck surgical resection, radiation therapy, or chemotherapy before presentation, as these cases were considered recurrent disease. Patients were also excluded if they had missing key demographic or tumor staging information. After applying these criteria, a total of 880 patients were included in the final analysis. Baseline demographic and social determinant characteristics of the study cohort are summarized in Table 1. Only patients with complete ADI and RUCA data were included in respective analyses.

Socioeconomic status was assessed using Area Deprivation Index (ADI) scores, which takes into consideration income, education, employment, and housing quality (9). Rurality score was determined using Rural-Urban Commuting Area (RUCA) codes based on county of residence. Travel distance was estimated using the fastest driving route from the patient's county of residence to EFCC based on Google Maps. Patients were categorized by travel distance using Boone County, MO, the location of EFCC, residents as the reference group. Travel distance categories were selected to capture clinically meaningful geographic zones relative to the cancer center. Boone County residents served as the reference group (local access). The 0–50 mile category represents neighboring counties with reasonable same-day travel access. The 51–100 mile category captures patients requiring substantial but manageable travel (1–2 h). The 101–150 mile and 151+ mile categories represent patients facing significant travel burden requiring either very early departures or overnight stays. These thresholds were chosen based on Missouri's geographic distribution and prior literature suggesting that distances exceeding 50–100 miles create substantial access barriers in rural cancer care.

Tumor characteristics, such as primary site and TNM staging, were collected. Patients without TNM staging explicitly written in their chart were retrospectively staged using AJCC 8th edition guidelines based on pathology or tumor board reports.

Group comparisons were conducted using the Kruskal–Wallis test for non-parametric comparisons of RUCA scores, and ANOVA for differences in ADI scores across tumor stages. Bonferroni correction was applied for multiple comparisons. Statistical significance was set at $p < 0.05$.

TABLE 1 Patient demographics.

Characteristic	Value
Total patients	$n = 880$
Age, median (IQR), year	70 (63–77)
Age, range, year	22–103
Sex	
Male	660 (75.0%)
Female	220 (25.0%)
Travel distance	
Boone County (local)	150 (17.0%)
0–50 miles	287 (32.6%)
51–100 miles	323 (36.7%)
101–150 miles	99 (11.2%)
>150 miles	21 (2.4%)
Area deprivation index	
State ADI, mean (SD)	5.6 (2.6)
National ADI, mean (SD)	69.0 (18.7)
AJCC stage at diagnosis	
Stage 0	8 (0.9%)
Stage I	221 (25.1%)
Stage II	135 (15.3%)
Stage III	166 (18.9%)
Stage IV	350 (39.8%)

Univariate and multivariate ordinal logistic regression models were used to assess associations between social determinants (travel distance category, ADI, sex, and age) and cancer stage at diagnosis. Travel distance was treated as an ordinal variable with five categories. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). Multivariate analysis included all variables simultaneously to assess independent associations while adjusting for potential confounders.

In multivariate logistic regression, adjusting for travel distance, ADI, sex, and age, travel distance remained independently associated with higher cancer stage (OR = 1.24 per category increase, 95% CI: 1.09–1.41, $p = 0.001$). State ADI also remained significant (OR = 1.06 per 1-unit increase, 95% CI: 1.01–1.11, $p = 0.02$). Neither sex (OR = 1.26, 95% CI: 0.95–1.67, $p = 0.11$) nor age (OR = 1.01, 95% CI: 1.00–1.02, $p = 0.26$) were significantly associated with stage in the adjusted model (Table 2).

Results

A total of 880 patients met the inclusion criteria. Of these, 150 patients (17.0%) resided in Boone County, while 120 (13.6%) lived more than 100 miles from EFCC. Among Boone County residents, 37% presented with stage 1 disease and 28% with stage 4. In contrast, patients living more than 100 miles away had lower rates of early-stage presentation (21.7% stage I) and higher rates of advanced-stage disease (53.3% stage IV). This association between travel distance and stage was statistically significant ($p = 0.005$; Figure 1). Sex-based differences were observed but did not reach statistical significance ($p = 0.312$). Females presented with stage IV disease at a rate of 34.1% compared to 41.7% for males (Supplementary Figure S1). There were no statistically significant differences in tumor stage at presentation across RUCA classifications ($p = 0.769$). RUCA category 10 was the most common (27.0%), followed by RUCA category 1 (24.9%).

State-level ADI was significantly associated with tumor stage ($p = 0.017$). Patients in the highest ADI deciles (most deprived) showed higher proportions of stage IV disease (47.4% in decile 9, 45.7% in decile 10) compared to those in the lowest deciles (23.3% in decile 1; Figure 2).

Discussion

This study highlights the significance of geographic and socioeconomic disparities on stage at presentation in patients with HNC. That is, our findings support the association between longer travel distances and higher socioeconomic deprivation on late-stage HNC diagnoses and associated delays in care.

Patients residing more than 100 miles from the center had substantially higher rates of stage IV disease at presentation compared to local residents (53 vs. 28%). This association remained significant after adjusting for ADI, sex, and age (OR = 1.24, $p = 0.001$), suggesting that travel burden represents an independent barrier to timely diagnosis beyond socioeconomic factors alone. This data is consistent with previous studies, which have shown that increased travel time is associated with later-stage presentation, particularly among low-income populations (10). In Missouri specifically, rural infrastructure is limited, and healthcare access is unequally distributed. Thus, travel-related delays may be especially consequential. Interestingly, even among Boone County residents with minimal travel burden, 28% still presented with advanced-stage disease, suggesting that proximity alone does not eliminate barriers to early detection.

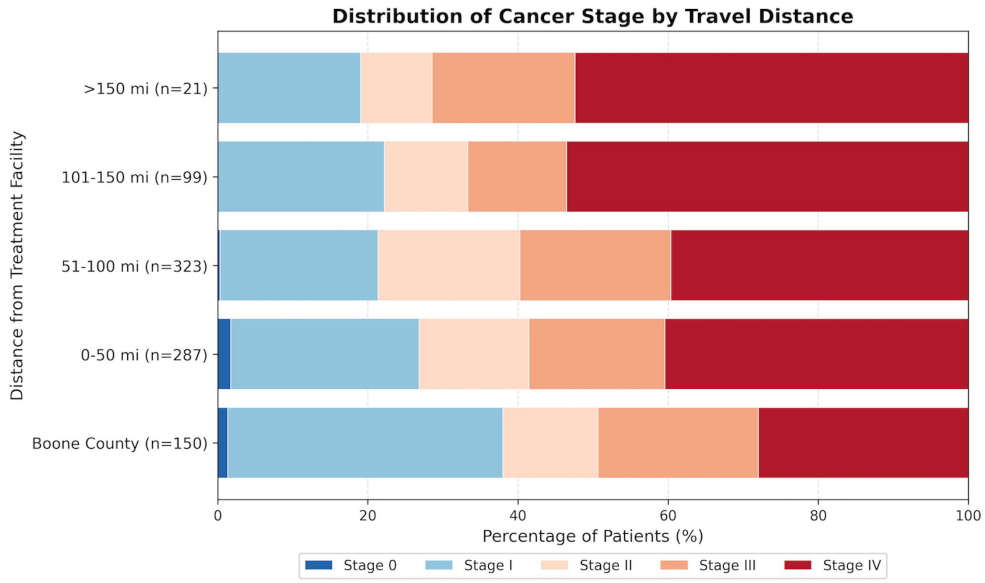

FIGURE 1
Tumor stage distribution by travel distance from Ellis Fischel Cancer Center. Stage distribution ($N = 880$) across five travel-distance categories from Ellis Fischel Cancer Center. The proportion of stage IV disease increases with travel distance, from 28.0% among Boone County residents to 52.4% among patients traveling >150 miles ($p = 0.005$).

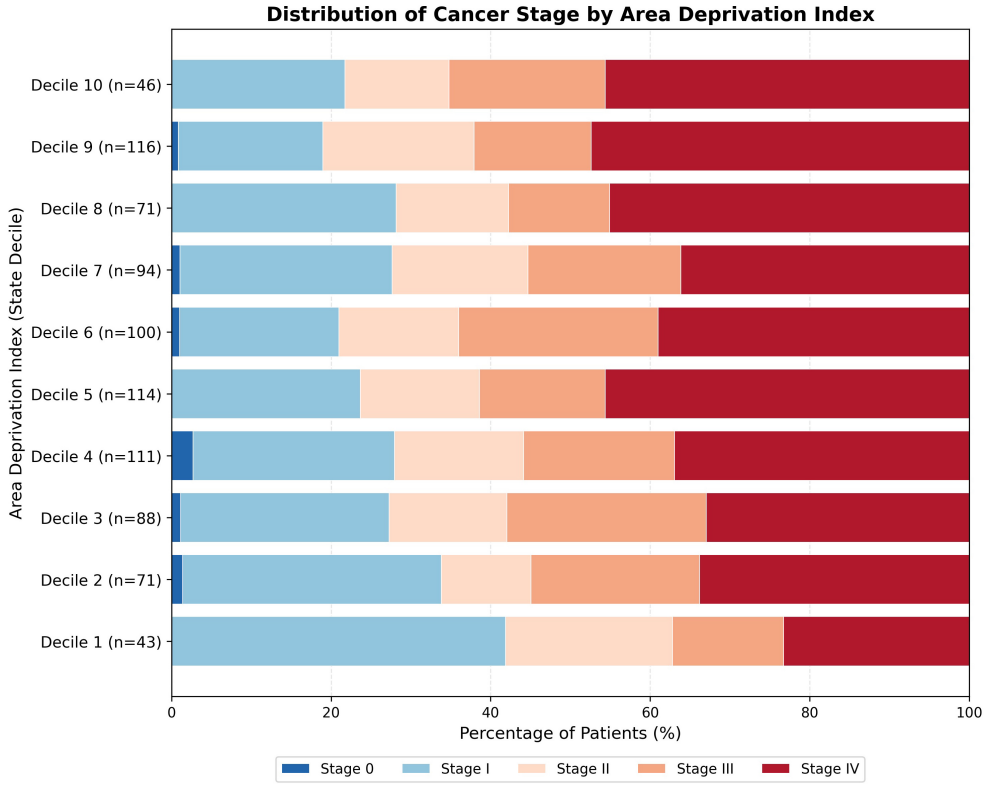

FIGURE 2
Tumor stage frequencies by state ADI decile. Stage distribution by state-level ADI decile (1 = least deprived, 10 = most deprived). Higher ADI was associated with a higher proportion of advanced-stage disease ($p = 0.017$).

While rurality is often cited as a risk factor for delayed diagnosis, our data did not show a statistically significant association between RUCA classification and tumor stage ($p = 0.769$). RUCA category 10 (the most rural classification) was the most represented group in our cohort, emphasizing both the large rural population served by our institution and the widespread challenges encountered by these communities. Previous research has shown that rural patients often have fewer specialty care options, greater transportation barriers, and more limited primary care access, factors not fully elucidated by RUCA codes alone (11, 12). Thus, rural classification may underestimate the complexity of healthcare access issues faced by these communities, especially in the context of early detection of HNC.

Socioeconomic deprivation, measured through both state- and national-level ADI, was significantly associated with advanced stage presentation. Patients with stage 4 disease had the highest mean ADI, consistent across both scales. Although the effect size was modest, it serves to reinforce previous findings that economic instability and social disadvantage contribute to poorer cancer outcomes (13, 14). High ADI areas often lack preventive services, such as routine screenings and smoking cessation programs, and face environmental exposures and healthcare shortages that increase risk and delay treatment (15, 16). The consequences of these findings are increasingly important in survivorship, as patients from disadvantaged backgrounds continue to experience lower survival rates even after treatment, highlighting concerns about equitable access to follow-up care and rehabilitation services (17). These disparities call for systemic changes in how care is delivered and accessed.

TABLE 2 Univariate and multivariable regression of factors associated with stage at diagnosis.

Variable	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p*-Value	OR (95% CI)	*p*-Value
Travel distance	1.27 (1.12–1.45)	<0.001	1.24 (1.09–1.41)	0.001
State ADI	1.08 (1.03–1.13)	0.002	1.06 (1.01–1.11)	0.02
Male sex (vs. female)	1.25 (0.94–1.65)	0.12	1.26 (0.95–1.67)	0.11
Age	1.00 (0.99–1.01)	0.54	1.01 (1.00–1.02)	0.26

Sex was not significantly associated with stage at diagnosis ($p = 0.312$), although males showed a non-significant trend toward presenting with more advanced disease. These trends reflect known behavioral and biological differences, including lower preventive care utilization among males, higher rates of tobacco and alcohol use, and possible differences in tumor aggressiveness (18–22).

This study has several limitations. First, it was conducted at a single institution in central Missouri, which may limit

generalizability to other regions with different healthcare infrastructure and demographics. Second, ADI is a neighborhood-level ecological measure that cannot capture individual-level socioeconomic factors; more specific measures such as personal income, educational attainment, insurance status, and access to transportation would provide additional characterization of disparities. Third, the retrospective design precluded assessment of time from symptom onset to diagnosis, which would more directly measure diagnostic delay. Fourth, inconsistent documentation prevented reliable assessment of smoking history and HPV status, which are important prognostic and etiologic factors in HNC. Fifth, while our multivariate model adjusted for several potential confounders, residual confounding from unmeasured variables (e.g., comorbidities, health literacy, social support networks) cannot be excluded. Finally, the relatively small number of patients in the most distant travel category (>150 miles, $n = 21$) limits the precision of estimates for this group and may underestimate the true effect of extreme travel burden.

Overall, the disparities identified in this study highlight the need to address structural and geographic barriers that may be disproportionately affecting underserved populations. Our research indicates that patients facing greater travel distances and higher levels of socioeconomic deprivation are more likely to present with advanced-stage disease. As efforts to improve cancer outcomes continue, integrating SDOH into clinical decision-making and care planning may be an important step closer to achieving more equitable care delivery.

Author's note

Elsie Barry contributed to this work while enrolled as a medical student at the University of Missouri School of Medicine.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Missouri International Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

CG: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. EB: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – review & editing. LD: Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. SK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. Portions of this manuscript were reviewed and edited using OpenAI ChatGPT-4 to improve clarity and grammar. All content was authored, verified, and is the responsibility of the named authors.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcacs.2026.1664435/full#supplementary-material

SUPPLEMENTAL FIGURE 1
Tumor stage distribution by sex. Relative frequency of each stage in male ($n = 660$) and female ($n = 220$) patients. Female patients more often present with early-stage disease and less often with stage IV disease than male patients ($p = 0.312$).

References

1. McMahon S, Chen AY. Head and neck cancer. *Cancer Metastasis Rev.* (2003) 22:21–4. doi: 10.1023/A:1022203816340

2. Hashim D, Genden E, Posner M, Hashibe M, Boffetta P. Head and neck cancer prevention: from primary prevention to impact of clinicians on reducing burden. *Ann Oncol.* (2019) 30:744–56. doi: 10.1093/annonc/mdz084

3. Centers for Disease Control and Prevention. *Social Determinants of Health (SDOH)*. Centers for Disease Control and Prevention (2024). Available online at: https://www.cdc.gov/about/priorities/why-is-addressing-sdoh-important.html (Accessed June 1, 2025).

4. World Health Organization. *Social Determinants of Health*. Geneva: World Health Organization (2025).

5. Nilsen ML, Moskovitz J, Lyu L, Harrison C, Randazza E, Peddada SD, et al. Health literacy: impact on quality of life in head and neck cancer survivors. *Laryngoscope*. (2020) 130:2354–9. doi: 10.1002/lary.28360

6. Virgen C, Renslo B, Sawaf T, Shnayder Y, Kakarala K, Bur AM, et al. Disentangling social determinants of health and rurality in head and neck cancer 2-year mortality. *OTO Open*. (2023) 7:e62. doi: 10.1002/oto2.62

7. Rogers SN, Lowe D, Kanatas A. Social determinants of health-related quality of life outcomes for head and neck cancer patients. *Oral*. (2021) 1:313–25. doi: 10.3390/oral1040031

8. Missouri Department of Health and Senior Services. *Rural Health Biennial Report* (2020). Available online at: https://health.mo.gov/living/families/ruralhealth/pdf/biennial2020.pdf (Accessed June 1, 2025).

9. Kind AJH, Buckingham WR. Making neighborhood-disadvantage metrics accessible—the Neighborhood Atlas. *N Engl J Med*. (2018) 378:2456–8. doi: 10.1056/NEJMp1802313

10. Farquhar DR, Masood MM, Lenze NR, McDaniel P, Mazul A, Sheth S, et al. Travel time to provider is associated with advanced stage at diagnosis among low-income head and neck squamous cell carcinoma patients in North Carolina. *Oral Oncol.* (2019) 89:115–20. doi: 10.1016/j.oraloncology.2018.12.029

11. Walker BB, Schuurman N, Auluck A, Lear SA, Rosin M. Socioeconomic disparities in head and neck cancer patients' access to cancer treatment centers. *Rural Remote Health*. (2017) 17:4210. doi: 10.22605/RRH4210

12. Bhatia S, Landier W, Paskett ED, Peters KB, Merrill JK, Phillips J, et al. Rural–urban disparities in cancer outcomes: opportunities for future research. *J Natl Cancer Inst.* (2022) 114:940–52. doi: 10.1093/jnci/djac030

13. McMaughan DJ, Oloruntoba O, Smith ML. Socioeconomic status and access to healthcare: interrelated drivers for healthy aging. *Front Public Health*. (2020) 8:231. doi: 10.3389/fpubh.2020.00231

14. Semprini J, Williams JC. Community socioeconomic status and rural/racial disparities in HPV-/+ head and neck cancer. *Tech Innov Patient Support Radiat Oncol.* (2023) 26:100205. doi: 10.1016/j.tipsro.2023.100205

15. Vučičević Boras V, Fučić A, Baranović S, Blivajs I, Milenović M, Bišof V, et al. Environmental and behavioural head and neck cancer risk factors. *Cent Eur J Public Health*. (2019) 27:106–9. doi: 10.21101/cejph.a5565

16. Chu KP, Habbous S, Kuang Q, Boyd K, Mirshams M, Liu FF, et al. Socioeconomic status, human papillomavirus, and overall survival in head and neck squamous cell carcinomas in Toronto, Canada. *Cancer Epidemiol.* (2016) 40:102–12. doi: 10.1016/j.canep.2015.11.010

17. Taylor DB, Osazuwa-Peters OL, Okafor SI, Boakye EA, Kuziez D, Perera C, et al. Differential outcomes among survivors of head and neck cancer belonging to racial and ethnic minority groups. *JAMA Otolaryngol Head Neck Surg.* (2022) 148:119–27. doi: 10.1001/jamaoto.2021.3425

18. Viera AJ, Thorpe JM, Garrett JM. Effects of sex, age, and visits on receipt of preventive healthcare services: a secondary analysis of national data. *BMC Health Serv Res.* (2006) 6:15. doi: 10.1186/1472-6963-6-15

19. White AM. Gender differences in the epidemiology of alcohol use and related harms in the United States. *Alcohol Res.* (2020) 40:01. doi: 10.35946/arcr.v40.2.01

20. Park JO, Nam IC, Kim CS, Park SJ, Lee DH, Kim HB, et al. Sex differences in the prevalence of head and neck cancers: a 10-year follow-up study of 10 million healthy people. *Cancers.* (2022) 14:2521. doi: 10.3390/cancers14102521

21. Barsouk A, Aluru JS, Rawla P, Saginala K, Barsouk A. Epidemiology, risk factors, and prevention of head and neck squamous cell carcinoma. *Med Sci.* (2023) 11:42. doi: 10.3390/medsci11020042

22. Beaudoin PL, Anchouche S, Gaffar R, Guadagno E, Ayad T, Poenaru D. Barriers in access to care for patients with head and neck cancer in resource-limited settings: a systematic review. *JAMA Otolaryngol Head Neck Surg.* (2020) 146:291–7. doi: 10.1001/jamaoto.2019.4311