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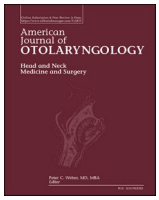

Association of alcohol use with olfactory function among older adults☆

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ABSTRACT

Background/purpose: Olfactory dysfunction (OD) has been recognized as an early biomarker for neurodegenerative diseases. Identifying behaviors that increase the risk of OD is crucial for early recognition of neurogenerative diseases. Alcohol consumption can potentially impact olfaction through its neurotoxic effects. This study aims to examine the relationship between alcohol consumption and OD, using data from the National Social Life, Health, and Aging Project (NSHAP).

Methods: This cross-sectional study was conducted on data for 2757 adults from Round 1 of NSHAP. OD was defined as correctly identifying 0–3 odors in the 5-item Sniffin' Sticks test while normal olfactory function was defined as correctly identifying 4–5 odors. Multivariable logistic regression was utilized to examine the association between alcohol consumption and OD, controlling for age, race, and comorbidities. Analyses were weighted to account for the sampling design.

Results: OD was present in 23.1 % of adults. The average age among those with OD was 71.2 ± 7.8 years, compared to 66.9 ± 7.2 years in those with normal olfaction. In terms of alcohol consumption, 31.1 % of adults with OD were light-to-moderate drinkers and 7.7 % were heavy drinkers, compared to 35.6 % light-to-moderate and 7.7 % heavy drinkers in the normal olfaction group. After adjusting for age, gender, race, and education, neither light-to-moderate drinking (aOR: 0.99; 95 % CI: 0.76–1.29) nor heavy drinking (aOR: 1.24; 95 % CI: 0.83–1.85) were significantly associated with OD.

Conclusion: Alcohol consumption was not associated with OD after controlling for covariates. While this study provides insight into the relationship between alcohol consumption and OD, further research is needed due to conflicting results in previous studies.

1. Introduction

Deficits in the sense of smell have historically been overlooked by patients and physicians, particularly when compared to deficits in vision and hearing [1]. Beyond its critical role in detecting hazardous gas leaks and enhancing the enjoyment of food [2], an emerging body of literature suggests that olfactory deficits may serve as early indicators of neurodegenerative diseases [3]. It is therefore crucial to identify risk factors associated with olfactory dysfunction (OD), defined as a diminished or absent sense of smell. Understanding these risk factors could facilitate earlier interventions and provide valuable insights into the pathogenesis of neurodegenerative diseases, potentially leading to more effective treatment strategies.

Several factors, including head trauma, toxin exposure, and upper respiratory tract infections, have been implicated in the onset of OD [2]. However, the effect of alcohol consumption on olfactory function remains uncertain. While the neurotoxic effects of alcohol are well-documented [4] and could potentially influence olfactory function, studies offer conflicting results. Some link alcohol-dependence, indicative of excessive alcohol consumption, to worsened olfactory function [5], others suggest that light to moderate consumption may reduce the prevalence of olfactory impairment [6], and yet some studies reveal no clear relationship between alcohol consumption and olfactory function [7]. This study aims to utilize data from the National Social Life, Health,

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and Aging Project (NSHAP) [8] to further examine the relationship between alcohol consumption and OD.

2. Methods

Data from Round 1 of the National Social Life, Health, and Aging Project (NSHAP) was used to conduct the analysis in this cross-sectional study. Because NSHAP is a de-identified public dataset, this study was determined exempt by the local institutional review board.

NSHAP is a national, population-based study of health and social factors among older, community-dwelling Americans, with data collected via face-to-face interview, biomeasurement via physical specimens such as blood and saliva, and cognitive function testing [8]. Our study included individuals who participated in the 5-item Sniffin' Sticks odor identification module and who have data available on the study outcome, exposure, and covariates that may influence olfactory function based on prior literature, such as age, gender, race/ethnicity, education (as a proxy for socioeconomic status), past stroke, diagnosed dementia or Alzheimer's disease, Parkinson's disease, diabetes, smoker status, self-rated mental health, and usage of any nasal medications [6,9–14]. Any individual with missing data was excluded from the study.

2.1. Variables and measures

The 5-item Sniffin' Sticks identification test is an abbreviated version of the original 16-item test, which is a validated psychosocial tool for evaluating an individual's olfactory performance [15,16]. Based on existing standards, olfactory dysfunction (OD) was defined as identifying 0–3 odors correctly on the 5-item Sniffin' Sticks test, and normal olfactory function as identifying 4–5 odors correctly [16,17]. To investigate the effect of alcohol consumption on olfaction, each individual's self-reported drinking behavior was classified into one of three categories: non-drinker, light-to-moderate drinker, or heavy drinker, based on established criteria [18,19]. Non-drinkers were defined as any individual who reported 0 drinks per week on average, light-to-moderate drinkers were defined as between 1 and 7 drinks per week for women and 1 to 14 drinks per week for men, and heavy drinkers were defined as 8 or more drinks per week for women and 15 or more drinks per week for men. NSHAP participants were asked to report their drinking behavior for the three months prior to their survey.

2.2. Statistical analysis

All statistical analyses were weighted using NSHAP-provided survey weights to account for sampling design. Baseline characteristics were calculated and compared across the normal olfaction and OD groups, and p-values were calculated using chi-square or *t*-test, as appropriate. Bivariate analysis was also conducted to determine crude odds ratios. Covariates that were statistically significant in bivariate analysis examining associations of these covariates with OD or alcohol consumption were included in the multivariable logistic regression model to determine adjusted odds ratios (aOR) for the association of alcohol consumption with OD. For all statistical tests, a p-value of <0.05 was used to denote statistical significance. Statistical analysis was conducted using R, version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

Round 1 of NSHAP includes a total of 3005 participants, from which we identified 2778 individuals who participated in the 5-item Sniffin' Sticks test. Of these, 11 participants were omitted due to missing race/ethnicity data, 9 were omitted due to refusal to self-report mental health status, and 1 was omitted due to refusal to report cigarette use. The remaining 2757 individuals were included in our study, of whom 638 (23 %) had OD, 953 (34.6 %) were light-to-moderate drinkers, and 212 (7.7 %) were heavy drinkers. Among this population of 2757, the weighted mean age was 67.9 years, 80.5 % identified as White, and 50.6 % identified as female.

Weighted percentages for baseline characteristics, stratified by

Table 1
Survey-weighted baseline characteristics and bivariate analysis stratified by olfactory function.

Characteristic	Weighted %		Crude odds ratios (95 % CI)
	Normal olfaction (n = 2119)	Olfactory dysfunction (n = 638)	
Age	p-Value ≤ 0.001*		
Years, weighted mean ± SD	66.9 ± 7.2	71.2 ± 7.8	1.08 (1.06–1.09)
Gender	p-Value = 0.001*		
Male	47.2	56.5	Ref
Female	52.8	43.5	0.69 (0.55–0.86)
Race/ethnicity	p-Value ≤ 0.001*		
White	83.0	72.2	Ref
Black	8.0	16.3	2.34 (1.66–3.28)
Hispanic, non-Black	6.8	7.9	1.35 (0.94–1.92)
Other	2.2	3.6	1.85 (0.94–3.66)
Education	p-Value ≤ 0.001*		
Some college or greater	58.6	42.3	Ref
High school or less	41.4	57.7	1.92 (1.56–2.37)
Ever had a stroke	p-Value = 0.001*		
No	92.8	88.0	Ref
Yes	7.2	12.0	1.77 (1.26–2.49)
Dementia, including Alzheimer's	p-Value ≤ 0.001*		
No	99.8	98.0	Ref
Yes	0.2	2.0	8.60 (3.27–22.60)
Parkinson's Disease	p-Value = 0.482		
No	98.5	98.1	Ref
Yes	1.5	1.9	1.33 (0.60–2.95)
Diabetes	p-Value = 0.033*		
No	81.2	77.3	Ref
Yes	18.8	22.7	1.27 (1.02–1.57)
Taking any nasal medications	p-Value = 0.939		
No	98.1	98.0	Ref
Yes	1.9	2.0	1.04 (0.42–2.57)
Self-rated mental health	p-Value ≤ 0.001*		
Good/very good/ excellent	91.4	84.7	Ref
Poor/fair	8.6	15.3	1.91 (1.43–2.55)
Current smoker	p-Value = 0.609		
No	85.0	84.0	Ref
Yes	15.0	16.0	1.08 (0.81–1.42)
Drinks alcohol	**p-Value = 0.206**		
Non-drinker	**56.7**	**61.1**	**Ref**
Light-to-moderate drinker	**35.6**	**31.1**	**0.81 (0.64–1.04)**
Heavy drinker	**7.7**	**7.7**	**0.93 (0.63–1.37)**

SD = standard deviation.
The variable in bold represents the exposure variable of interest in this study. 'Drinks Alcohol' is the main factor being investigated for its potential relationship with olfactory dysfunction.
* P < 0.05.

olfactory function, are listed in Table 1. Bivariate analysis revealed that those with OD were more likely to be older, male, non-White, less educated, have a poorer self-rated mental health status ($p < 0.001$), and were also more likely to have other comorbidities such as prior stroke ($p < 0.001$), dementia ($p < 0.001$), and diabetes ($p = 0.033$). Notably, alcohol consumption was not statistically different between individuals with normal olfaction and those with OD.

The results for the multivariable logistic regression, controlling for covariates that were statistically significant in bivariate analysis, are listed in Table 2. Covariates that were significantly associated with an increased likelihood of OD included age (aOR: 1.08; 95 % CI: 1.06–1.10), Black (aOR: 2.57; 95 % CI: 1.80–3.66) and other race (aOR: 2.17; 95 % CI: 1.04–4.54), high school or less education level (aOR: 1.48; 95 % CI: 1.17–1.88), diagnosed dementia or Alzheimer's disease (aOR: 4.38; 95 % CI: 1.58–10.41), and poor/fair self-rated mental health (aOR: 1.50; 95 % CI: 1.03–2.17). On the other hand, female gender (aOR: 0.60; 95 % CI: 0.48–0.74) was associated with a lower likelihood of OD. Compared to non-drinkers, light-to-moderate drinkers (aOR: 0.99; 95 % CI: 0.76–1.29) and heavy drinkers (aOR: 1.24; 95 % CI: 0.83–1.85) were not associated with OD.

4. Discussion

Our cross-sectional study based on NSHAP data [8] found no significant relationship between alcohol consumption and OD. These findings were consistent across different classifications of alcohol consumption – non-drinkers, light-to-moderate drinkers, and heavy drinkers. We found several covariates to be associated with OD, including age, gender, race, and dementia (including Alzheimer's disease).

Our results are in line with the findings of Park., et al. [7] who also found no clear relationship between alcohol consumption and olfactory function. It is worth noting, however, that Park's study utilized a different methodology of olfactory testing. They used the University of Pennsylvania's smell identification test (UPSIT), which is a 'scratch and sniff' method with 40 distinct odorants. The scoring system categorizes olfactory function into various levels, from total anosmia to normosmia, with higher scores indicating better olfactory ability. While the UPSIT is more extensive than the 5-item Sniffin' Sticks test, which is the test used by NSHAP, the current literature does not establish the superiority of one test over the other. The choice between the two may depend on factors such as sample size, study design, and the feasibility of administering a longer test. It is also worth noting the different population size and demographic makeup of Park's study, which was composed of 117 older individuals (>65 years old) with cognitive impairment in a Korean hospital.

Conversely, other research on the effects of alcohol consumption on olfactory function has provided varying results. Rupp et al. [5] found that alcohol dependence, indicative of excessive alcohol consumption could exacerbate OD, while Liu et al. [6] suggested that light to moderate alcohol consumption might reduce olfactory impairment. The inconsistency in these findings might stem from differing methodologies, sample sizes, and demographic compositions across studies. For example, Liu's study was a cross-sectional study of a nationwide representative sample of the US adult population aged 40 years and older ($n = 3519$), which used the NHANES Pocket Smell Test, where smell impairment is defined as failing to correctly identify 6 of 8 odors. Rupp's study on the other hand looked at olfactory function among a relatively small sample ($n = 32$) of alcohol dependent patients.

In addition to our primary aim of looking at the association between alcohol consumption and OD, our study identified several other factors that were associated with OD. Older age, male gender, Black or other race, and diagnosis of dementia (including Alzheimer's disease), were significantly associated with a higher likelihood of OD. Education level and self-rated mental health were also found to be significant predictors of olfactory function. It is worth noting that NSHAP data has been used in prior research to investigate the association of OD with age, gender, and race, which showed results that are in line with ours [20,21]. However, the associations we identified regarding educational level, self-rated mental health, and dementia are novel contributions in the context of NSHAP data.

This study has some limitations. As it was cross-sectional, we could not establish causal relationships. Also, the alcohol consumption data relied heavily on self-reporting, making it susceptible to recall bias. Additionally, omission of data from individuals who refused to participate in the Sniffin' Sticks tests could have introduced nonresponse bias, as those with OD may be more likely to refuse. The study sample also comprised predominantly older, community-dwelling Americans, limiting the generalizability of the results. Lastly, the use of the abbreviated 5-item Sniffin' Sticks odor identification test instead of the more comprehensive 16-item test may have affected the precision of olfactory function evaluation.

Table 2
Survey-weighted and adjusted associations of drinking status and covariates with olfactory dysfunction.

Covariates	Adjusted odds ratio (95 % confidence interval)
Drinking status	
Non-drinker	**Ref**
Light-to-moderate drinker	**0.99 (0.76–1.29)**
Heavy drinker	**1.24 (0.83–1.85)**
Age (years)	1.08* (1.06–1.10)
Gender, female vs. male	0.60* (0.48–0.74)
Race/ethnicity	
White	Ref
Black	2.57* (1.80–3.66)
Hispanic, non-Black	1.36 (0.97–1.92)
Other	2.17* (1.04–4.54)
Education	
Some college or greater	Ref
High school or less	1.48* (1.17–1.88)
Ever had a stroke	1.21 (0.81–1.81)
Dementia, including Alzheimer's	4.38* (1.73–11.09)
Parkinson's disease	1.07 (0.41–2.78)
Diabetes	1.09 (0.87–1.37)
Self-rated mental health	
Good/very good/excellent	Ref
Poor/fair	1.50* (1.03–2.17)
Current smoker	1.12 (0.82–1.51)

The variable in bold represents the exposure variable of interest in this study. 'Drinking status' is the main factor being investigated for its relationship with olfactory dysfunction.

* $P < 0.05$.

5. Conclusion

In conclusion, our findings suggest that alcohol consumption is not significantly associated with olfactory function, although other demographic and health-related factors are. These results contribute to the growing body of literature exploring the determinants of OD. They also highlight the need for longitudinal studies with more diverse populations and more precise testing methods to further unravel the complex relationship between alcohol consumption and olfactory function. Given the potential role of OD as an early indicator of neurodegenerative diseases, continued research in this area remains crucial.

CRediT authorship contribution statement

Khamis T. Suleiman: Conceptualization, Writing – original draft. **Richard G. Chiu:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft. **Sharmilee M. Nyenhuis:** Conceptualization, Supervision, Writing – review & editing. **Kamal Eldeirawi:** Conceptualization, Methodology, Supervision, Visualization, Writing – review & editing. **Victoria S. Lee:** Supervision, Writing – review & editing, Conceptualization, Investigation, Methodology.

Declaration of competing interest

The Authors declare that there is no conflict of interest.

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