

Comparative analysis of alcohol consumption patterns and binge drinking behaviours among working populations: implications for occupational health and workplace safety

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ABSTRACT

Background: Alcohol consumption and binge drinking (BD) are major public health concerns with clear implications for occupational health and workplace safety, particularly in physically demanding or safety-sensitive jobs. However, differences in alcohol-related risk across occupational groups remain insufficiently explored.

Methods: This retrospective observational study analyzed medical records from 1264 workers who underwent routine occupational health surveillance in Palermo, Italy, between 2023 and 2025. Participants were classified as white-collar workers (Work 1; $n = 607$) or blue-collar workers (Work 2; $n = 657$). Alcohol use was assessed with the Alcohol Use Disorders Identification Test Consumption (AUDIT-C) questionnaire, and participants were categorized as abstinent, low-risk, or at-risk drinkers according to sex-specific thresholds. BD was defined as consuming six or more standard drinks on one occasion.

Results: Blue-collar workers showed higher AUDIT-C scores and were more likely to fall into higher alcohol-risk categories than white-collar workers. BD was reported by 43% of participants and was more frequent among blue-collar workers than white-collar workers (47% vs. 38%). Female sex, younger age, blue-collar occupation, and single marital status were independently associated with greater alcohol-related risk.

Conclusions: These findings suggest that occupational and sociodemographic factors jointly shape alcohol-risk patterns, supporting targeted, workplace-based, and gender-sensitive prevention strategies.

Keywords: alcohol consumption; binge drinking; AUDIT-C; occupational health; workplace safety

Introduction

Alcohol consumption is a major global public health concern and a leading contributor to mortality, disability, and loss of healthy life years working age adults.^{1–6} It contributes to a broad range of non-communicable and infectious diseases.^{4,7–14}

Europe has the highest per capita alcohol consumption worldwide, with important consequences for working-age population, productivity and workplace safety.^{15,16} In Italy, approximately 8 million individuals are classified as at-risk

drinkers.¹⁷ Off-meal drinking refers to alcohol consumption outside meals, whereas binge drinking (BD) is defined

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as consuming six or more drinks on a single occasion. Both patterns are particularly prevalent among younger adults.^{17–19}

These consequences are particularly relevant in occupational settings, where alcohol consumption is associated with impaired cognitive and psychomotor performance, reduced productivity, sickness absence, and workplace injuries.^{20–24} The potential impact is greatest in safety-sensitive occupations, including transportation, heavy machinery operation, and complex system maintenance, where even minimal impairment may increase risk.^{25,26}

Alcohol consumption patterns among workers are shaped by sociodemographic and occupational factors.²⁷ The workplace represents a relevant setting for monitoring these behaviors.²⁸ Workload, shift schedules, occupational stress, social support, and workplace culture may influence drinking behaviours, with higher alcohol-related risk reported in construction, hospitality, catering, and entertainment occupations.^{23,29}

Sex and age are also important determinants of alcohol-related risk. Although men generally report higher alcohol consumption, women may experience a shorter interval between the initiation of alcohol use and the onset of alcohol related problems or treatment seeking, a pattern referred to in addiction research as the telescoping effect.^{30,31} Gender differences in problematic alcohol use also appear to be narrowing among younger generations.^{32,33} BD is particularly prevalent during late adolescence and early adulthood and tends to decrease with age.³⁴ However, how these patterns vary across occupational groups and sociodemographic contexts remains insufficiently explored.^{27,35}

Screening tools, such as the Alcohol Use Disorders Identification Test Consumption (AUDIT-C), are widely used to identify risky drinking behaviors and support preventive interventions in clinical and occupational health settings.^{36–39} Nevertheless, evidence remains limited on how occupational, demographic, and lifestyle factors jointly influence alcohol consumption among working adults.

To address this gap, the present study investigates alcohol consumption and BD among workers across different occupational categories. The analysis focuses on differences between occupational groups and their interaction with sociodemographic and anthropometric variables, including gender, age, marital status, and body mass index (BMI). We hypothesized that blue-collar workers would be more likely to engage in risky alcohol consumption than white-collar workers, and that this association may vary according to gender and age.

Materials and methods

Study design and population

This retrospective observational study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.⁴⁰ Medical records were reviewed from workers who underwent occupational health surveillance at a private occupational medicine practice in Palermo, Italy, between January 2023 and December 2025. Occupational health surveillance was routinely provided by the employers to all workers whose occupational risk profile required medical surveillance and did not involve any financial cost to the employees. Attendance at occupational health surveillance was not based on an individual opt-in procedure; however, the anonymized use of clinical data for the present study required valid informed consent.

Eligible participants were workers aged 22 to 65 years with complete clinical records, including anamnestic data obtained during the routine occupational health interview (medical history, current medications, smoking status, and relevant clinical information), anthropometric parameters, AUDIT-C questionnaire data, and valid consent for the use of anonymized data. Records with missing key variables were excluded.

Of 1653 medical records screened, 1264 met the inclusion criteria and were included in the final analysis. Participants were classified as white-collar workers (Work 1; $n = 607$) and blue-collar workers (Work 2; $n = 657$), based on job title and task characteristics as reported in medical records.⁴¹ White-collar workers included individuals engaged in administrative, managerial, or professional roles, while blue-collar workers included manual or technical jobs with higher physical workload or occupational risk exposure. Further details on eligibility criteria, occupational classification, data collection, privacy procedures, and ethical safeguards are provided in the Supplementary Methods.

Assessment of alcohol consumption

Alcohol consumption and related risk were assessed using the AUDIT-C, a validated three-item screening tool widely used to identify risky drinking behaviors and support preventive interventions in clinical and occupational health settings.^{36–38,42,43} The AUDIT-C assesses drinking frequency, quantity, and BD episodes, allowing classification according to sex-specific risk thresholds.^{5,15,39} Each item is scored from 0 to 4, yielding a total score from 0 to 12. According to validated sex-specific thresholds, participants were classified as abstinent, low-risk drinkers, or at-risk drinkers. An AUDIT-C score ≥ 4 in men and ≥ 3 in women was considered indicative

of at-risk alcohol consumption.^{43,44} These thresholds were used for screening purposes and were not intended to define the clinical severity of alcohol use or establish a diagnosis of alcohol use disorder. BD was defined according to the third AUDIT-C item as consuming six or more standard drinks on a single occasion. The available medical records did not contain standardized information on counseling, referral, additional clinical assessment, or follow-up after the identification of at-risk alcohol consumption. Therefore, subsequent interventions and clinical outcomes could not be evaluated in this retrospective study.

Statistical analysis

Continuous variables were summarized as median and interquartile range, and categorical variables as counts and percentages. Baseline comparisons between Work 1 and Work 2 workers were performed using the Wilcoxon rank-sum test for continuous variables and Pearson's chi-square test or Fisher's exact test for categorical variables, as appropriate.

AUDIT-C clinical risk categories were analyzed as an ordinal outcome using proportional odds logistic regression. BD was analyzed as a binary outcome using logistic regression. Both models included sex, occupational group, age group, marital status, and BMI as prespecified covariates. Adjusted associations were reported as odds ratios (ORs) with 95% confidence intervals (95% CIs).

To assess whether the association between sex and AUDIT-C screening category was influenced by the use of sex-specific thresholds, a sensitivity analysis repeated the proportional odds model using a common AUDIT-C cut-off of ≥ 4 for both men and women. Full methodological details and results are reported in the Supplementary Material.

Additional univariable, stratified, post-hoc, effect size, and model diagnostic analyses, and a sensitivity analysis using a common AUDIT-C threshold of ≥ 4 for both sexes are reported in the Supplementary Methods and Supplementary Results. All tests were two-sided, and $P < 0.05$ was considered statistically significant. Analyses were performed in R version ≥ 4.3 .

Results

Sample characteristics of the study population

The final analysis included 1264 workers, of whom 607 were Work 1 workers and 657 Work 2 workers. Baseline characteristics are summarized in Table 1. The sample was balanced by sex, and the two occupational groups were broadly comparable for the main sociodemographic variables. Median age in the overall sample was 45 years (IQR 34–52).

AUDIT-C clinical risk categories by sex and occupational group

The distribution of AUDIT-C clinical risk categories differed significantly between the Work 1 and Work 2 groups in both sexes (Fig. 1A). Overall, the Work 2 group showed a higher prevalence of at-risk alcohol consumption than the Work 1 group, with a more pronounced difference among men.

Among drinkers, AUDIT-C scores were also higher in the Work 2 group than in the Work 1 group, both overall and after sex stratification (Fig. 1B). The median AUDIT-C score was 3 (IQR 2–4) in the Work 1 group and 4 (IQR 2–5) in the Work 2 group ($P < 0.001$). Detailed sex-stratified analyses, effect sizes, and post-hoc residuals are reported in the Supplementary Results.

Age-related patterns of alcohol consumption

Age-stratified analyses showed a consistent decrease in AUDIT-C scores and at-risk alcohol consumption with increasing age, with younger participants showing the highest alcohol-risk profiles (Fig. 2). BD was reported by 43% of the overall sample and was more frequent in the Work 2 group than in the Work 1 group (47% vs. 38%; $P = 0.003$).

Among drinkers, BD was more common among younger and single participants, whereas married participants showed lower BD prevalence (Fig. 2). BMI showed only weak or negligible associations with AUDIT-C scores, indicating no clinically relevant relationship between adiposity and alcohol consumption severity. Detailed age- and sex-stratified comparisons are provided in the Supplementary Results.

Sociodemographic determinants of binge drinking

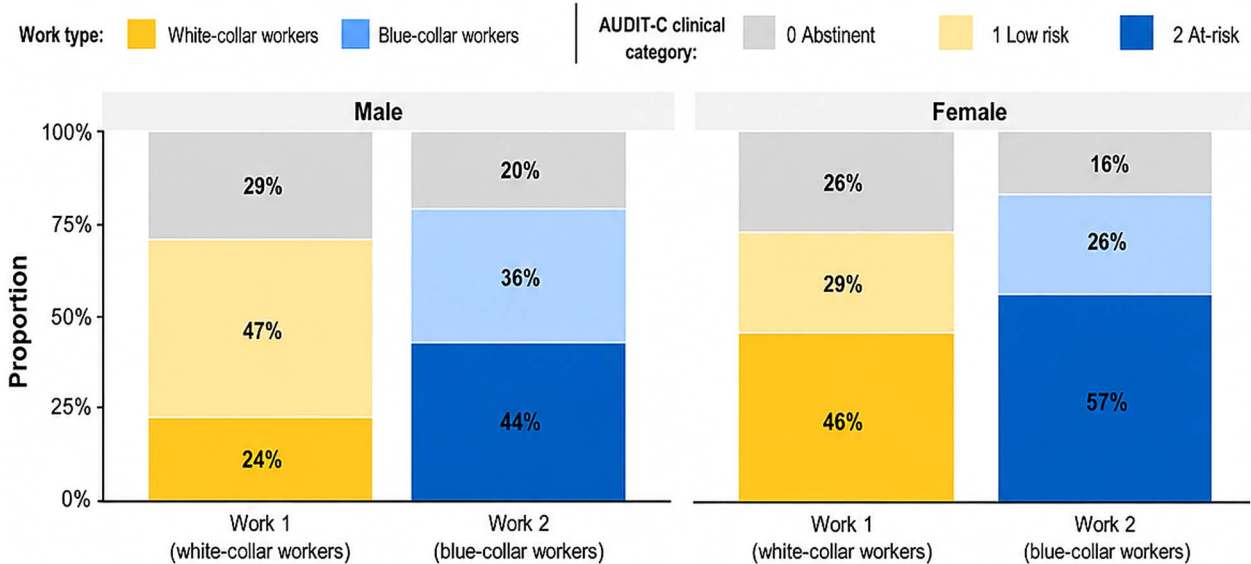
BD was reported by 43% of the overall sample and was more frequent in the Work 2 group than in the Work 1 group (47% vs. 38%; $P = 0.003$). Among drinkers, BD was more common among younger and single participants, whereas married participants showed lower BD prevalence. After sex stratification, work type was not significantly associated with BD among drinkers, suggesting that the overall occupational difference was partly influenced by broader sociodemographic patterns. BMI showed only weak or negligible associations with AUDIT-C scores, indicating no clinically relevant relationship between adiposity and alcohol consumption severity. Detailed age-stratified patterns are shown in Supplementary Fig. S1.

Multivariable models of alcohol-risk severity and BD patterns

In the proportional odds model, membership in the Work 2 group was independently associated with a higher AUDIT-C

A — AUDIT-C clinical category by work type

Full sample: chi-square test on AUDIT-C clinical categories.
Male: $p < 0.001$, $V = 0.211$ | Female: $p = 0.004$, $V = 0.133$



B — AUDIT-C score distribution (drinkers only)

Overall drinkers: Wilcoxon $p < 0.001$ *** | r = rank-biserial effect size

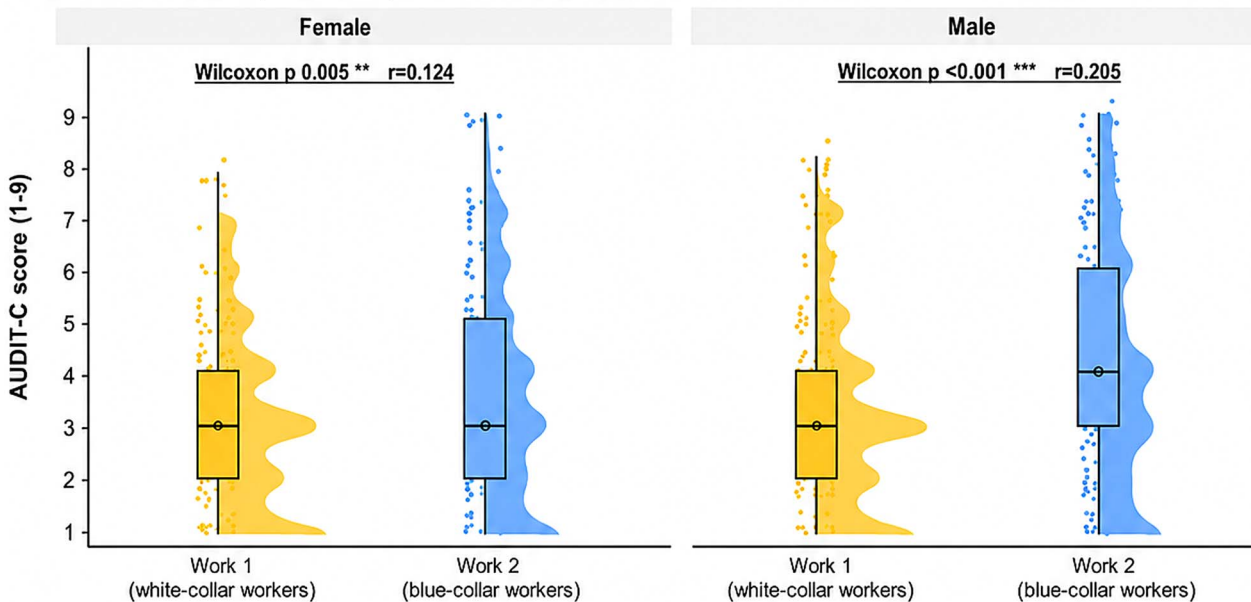


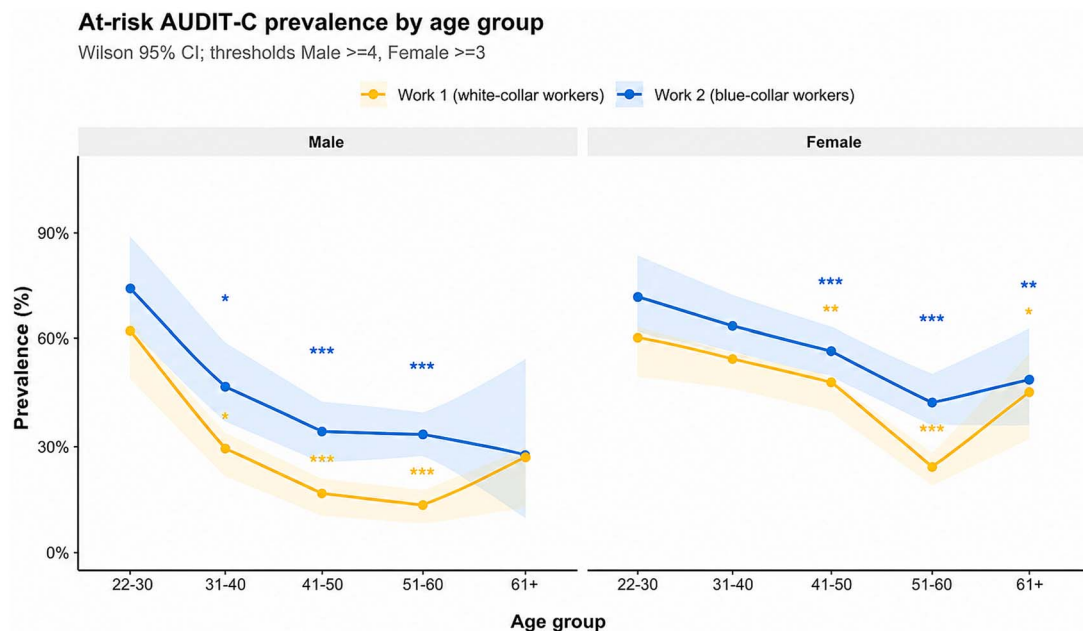
Figure 1 Occupational differences in AUDIT-C clinical risk categories and AUDIT-C scores among workers. (A) Distribution of AUDIT-C clinical risk categories (abstinent, low-risk, and at-risk alcohol consumption) in the full sample according to occupational group and sex. (B) Distribution of AUDIT-C scores among drinkers according to occupational group and sex. statistical comparisons were performed using chi-square tests for categorical variables and Wilcoxon rank-sum tests for continuous variables.

clinical risk category compared with the Work 1 group (OR 1.918, 95% CI 1.549–2.377; $P < 0.001$). Female sex was also associated with a higher alcohol-risk category (OR 1.995, 95% CI 1.595–2.500; $P < 0.001$), whereas older age and

married status were inversely associated with alcohol-risk severity (Fig. 3A). BMI was not significantly associated with the ordinal AUDIT-C outcome. In a sensitivity analysis using a common AUDIT-C threshold of ≥ 4 for both sexes, the

Table 1 Baseline characteristics of 1264 enrolled workers.

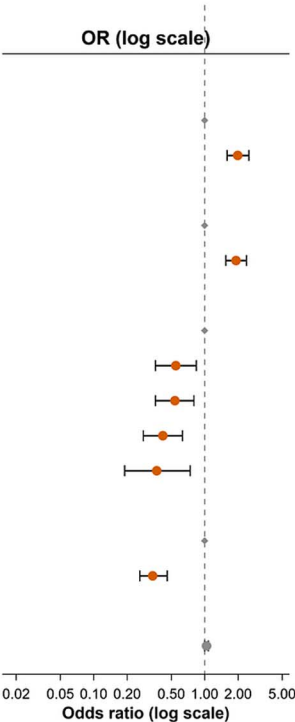
Variable	Overall N = 1,264 ^a	Work 1 N = 607 ^a	Work 2 N = 657 ^a	P-value ^b
Sex				0.2
Male	632 (50%)	316 (52%)	316 (48%)	
Female	632 (50%)	291 (48%)	341 (52%)	
Age	45.0 (34.0, 52.0)	45.0 (34.0, 52.0)	45.0 (34.0, 52.0)	0.5
Age_group				0.9
22–30	183 (14%)	91 (15%)	92 (14%)	
31–40	231 (18%)	115 (19%)	116 (18%)	
41–50	419 (33%)	197 (32%)	222 (34%)	
51–60	391 (31%)	187 (31%)	204 (31%)	
61+	40 (3.2%)	17 (2.8%)	23 (3.5%)	
Marital_status				>0.9
Single	307 (24%)	146 (24%)	161 (25%)	
Married	957 (76%)	461 (76%)	496 (75%)	
BMI	24.0 (22.5, 26.3)	23.9 (22.5, 26.3)	24.0 (22.5, 26.3)	0.9
BMI_cat				>0.9
Underweight	2 (0.2%)	1 (0.2%)	1 (0.2%)	
Normal	725 (57%)	351 (58%)	374 (57%)	
Overweight	498 (39%)	238 (39%)	260 (40%)	
Obese	39 (3.1%)	17 (2.8%)	22 (3.3%)	
Binge	540 (43%)	233 (38%)	307 (47%)	0.003

^a n (%); Median (Q1, Q3)^b Pearson's Chi-squared test; Wilcoxon rank sum test**Figure 2** Age-related patterns of at-risk AUDIT-C prevalence according to sex and occupational group. Points indicate the prevalence of at-risk alcohol consumption by age group, with Wilson 95% confidence intervals. At-risk alcohol consumption was defined using sex-specific AUDIT-C thresholds (≥ 4 in men and ≥ 3 in women). Stars indicate age groups in which AUDIT-C scores among drinkers differed significantly from the 22–30-year reference group after Bonferroni correction.

Forest plots of adjusted odds ratios

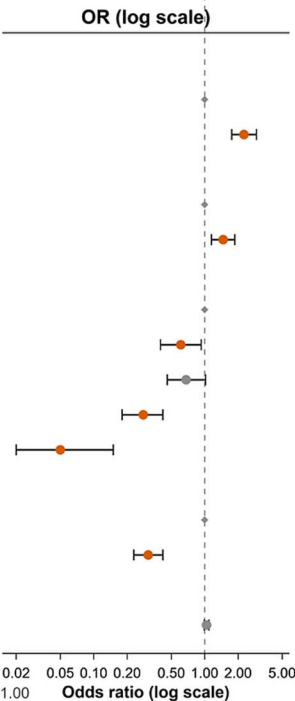
A - POLR model

Variable / Level	OR (95% CI)	p-value
Sex		
Male (ref)	1.00 (ref)	
Female	1.99 (1.59-2.50)	<0.001 ***
Work type		
Work 1 (ref)	1.00 (ref)	
Work 2	1.92 (1.55-2.38)	<0.001 ***
Age group		
22-30 (ref)	1.00 (ref)	
31-40	0.55 (0.36-0.84)	0.005 **
41-50	0.54 (0.36-0.80)	0.002 **
51-60	0.42 (0.28-0.63)	<0.001 ***
61+	0.37 (0.19-0.74)	0.005 **
Marital status		
Single (ref)	1.00 (ref)	
Married	0.34 (0.26-0.46)	<0.001 ***
BMI		
per 1 unit	1.04 (1.00-1.08)	0.052



B - Binge model

Variable / Level	OR (95% CI)	p-value
Sex		
Male (ref)	1.00 (ref)	
Female	2.26 (1.75-2.93)	<0.001 ***
Work type		
Work 1 (ref)	1.00 (ref)	
Work 2	1.47 (1.15-1.87)	0.002 **
Age group		
22-30 (ref)	1.00 (ref)	
31-40	0.61 (0.40-0.93)	0.023 *
41-50	0.68 (0.46-1.02)	0.062
51-60	0.28 (0.18-0.42)	<0.001 ***
61+	0.05 (0.02-0.15)	<0.001 ***
Marital status		
Single (ref)	1.00 (ref)	
Married	0.31 (0.23-0.42)	<0.001 ***
BMI		
per 1 unit	1.04 (0.99-1.09)	0.108



● Significant (p < 0.05, orange) ● Non-significant (grey) ♦ Reference category
CI: 95% confidence interval. POLR: proportional odds logistic regression.

Figure 3 Multivariable models of alcohol-related risk and binge drinking. (A) Proportional odds logistic regression model showing adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for belonging to a higher AUDIT-C clinical risk category. (B) Binary logistic regression model showing adjusted odds ratios and 95% CIs for binge drinking. Models were adjusted for sex, occupational group, age group, marital status, and body mass index (BMI).

association between female sex and a higher AUDIT-C screening category was attenuated and was no longer statistically significant, whereas the association with blue-collar work remained robust (Supplementary Table S1).

In the binary logistic regression model, membership in the Work 2 group was independently associated with BD (OR 1.466, 95% CI 1.149–1.874; $P = 0.002$). Female sex was also associated with BD (OR 2.259, 95% CI 1.749–2.926; $P < 0.001$), while older age and married status were inversely associated with the outcome (Fig. 3B). BMI was not significantly associated with BD.

Full model estimates, age-group-specific odds ratios, performance indices, and diagnostic analyses are reported in the Supplementary Results.

Discussion

Main finding of this study

This study analyzed alcohol consumption patterns and BD behaviors among 1264 working-age adults stratified by occupational classification, revealing significant occupational disparities with important implications for occupational health and workplace safety.

BD, defined according to the AUDIT-C BD item as the consumption of six or more standard drinks on a single occasion, was reported by 43% of the overall sample and was significantly more frequent among Work 2 workers than Work 1 workers (47% vs 38%).^{45,46} This elevated prevalence of episodic heavy drinking is an important occupational health concern, particularly in jobs requiring sustained vigilance, operational precision, and rapid decision-making.

The primary findings indicate that blue-collar workers (Work 2) exhibited significantly higher AUDIT-C scores and a greater prevalence of at-risk alcohol consumption than white-collar workers (Work 1), with distinct patterns emerging across sex and age strata. These occupational differences were particularly pronounced among men, for whom Work 2 workers demonstrated a marked overrepresentation in the at-risk AUDIT-C category.

Importantly, the association between occupational category and alcohol-risk severity persisted after adjustment for sex, age, marital status, and BMI. This suggests that the higher alcohol-related risk among blue-collar workers is not explained solely by demographic or anthropometric differences but may also reflect occupational characteristics such as greater physical demands, occupational hazards, irregular schedules, and elevated work-related stress.

A consistent inverse association between age and alcohol-risk severity emerged across all sex-by-occupational category

strata. Workers aged 22–30 years showed the highest AUDIT-C scores and BD prevalence, with risk decreasing progressively with age.

Sex-related differences were also observed. In the primary analysis, female workers had higher adjusted odds of belonging to a higher AUDIT-C risk category and of reporting BD compared with male workers. However, this association was no longer statistically significant when a common AUDIT-C threshold was applied for both sexes, indicating that the observed sex difference was largely driven using sex-specific screening thresholds. In contrast, the association with blue-collar work remained robust. Moreover, because of the cross-sectional design, the present study cannot distinguish age effects from cohort or period effects. Therefore, the observed age-related differences should be interpreted as within-sample associations in this occupational population rather than as evidence contradicting broader epidemiological trends reported in the general population.

Marital status emerged as a strong protective factor. Married workers showed substantially lower odds of both at-risk alcohol consumption and BD compared with single workers, even after adjustment for occupational and demographic covariates.

Finally, BMI showed only a weak or negligible relationship with alcohol consumption in this population. Spearman correlation analyses revealed minimal associations between BMI and AUDIT-C scores, suggesting that adiposity was not a major determinant of alcohol consumption severity in this occupational sample.

What is already known on this topic

Alcohol-related impairment, even at low levels, may negatively affect cognitive and psychomotor performance, thereby increasing the risk of workplace injuries, reduced productivity, and adverse events involving both workers and the public, especially in safety-sensitive occupations.^{23,47,48}

Previous occupational epidemiology studies have consistently reported higher alcohol-related risk among workers employed in manual, physically demanding, or hazardous occupations, including sectors such as construction, hospital-ity, and catering.^{49,50} However, the workplace's contribution is unlikely to be reflected in the occupational category alone. Work organization factors, including workload, physical and psychosocial stress, irregular schedules, job insecurity, workplace social relations, and harassment, may interact with family circumstances, social support, and individual characteristics in shaping alcohol consumption.^{16,49,51,52} Accordingly, workplace-related drinking should be interpreted as a multilevel process rather than a direct consequence of job type alone.

Age is another well-established determinant of alcohol-related risk. Broader epidemiological surveillance studies show that BD typically peaks during late adolescence and early adulthood and declines progressively with age.^{53,54} This pattern may partially reflect neurobiological maturation of reward and cognitive-control systems, changes in social roles and responsibilities, family formation, and increasing awareness of the health consequences associated with prolonged alcohol misuse.^{46,54,55}

Sex-related differences in alcohol consumption and alcohol-related harm have also been widely described. Although men traditionally report greater absolute alcohol consumption, recent evidence suggests that the gender gap in alcohol-related harms is progressively narrowing.^{56,57} Women may experience a more rapid progression toward alcohol-related consequences, while increasing social and occupational convergence may contribute to more similar drinking behaviors, particularly among younger workers.^{31,58}

Marital and family relationships may also shape alcohol-related behaviors. Previous research has shown that stable marital and family relationships may promote healthier coping mechanisms, emotional regulation, and social support, thereby reducing vulnerability to problematic alcohol use.^{59,60}

Finally, the relationship between BMI and alcohol consumption remains inconsistent. Previous epidemiological studies have reported heterogeneous findings, likely reflecting differences in drinking patterns, dietary behaviors, sex, physical activity levels, and occupational energy expenditure.^{61–63}

What this study adds

The present findings extend previous evidence by showing that occupational differences in alcohol-related risk remain significant even after adjustment for key demographic and anthropometric variables. This suggests that the higher alcohol-risk severity observed among Work 2 workers is not merely explained by demographic composition but may reflect a complex interaction between occupational stress exposure, workplace social norms, and environmental contextual factors.

The study also shows that age-related drinking patterns are evident within occupational settings. Younger workers showed greater alcohol-related risk, suggesting that occupational context may interact with age-related vulnerability, particularly in physical demanding workplace or permissive drinking cultures.

The finding that female workers had higher adjusted odds of alcohol-related risk supports the need for gender-sensitive occupational prevention and screening strategies. At the same

time, the protective association observed for marital status highlights the importance of psychosocial and relational factors in shaping alcohol consumption behaviors within working populations.

From an occupational health perspective, these findings support the integration of routine alcohol-risk screening into occupational health surveillance, particularly in physically demanding or safety-sensitive workplaces. Prevention strategies should be tailored to occupational category, age, sex, and psychosocial profile.

The lack of a clinically meaningful association between BMI and alcohol consumption may partially reflect the influence of occupational physical activity and work-related energy expenditure, particularly among blue-collar workers.^{64,65} More broadly, this finding suggests that alcohol-related risk in occupational populations may be more strongly shaped by psychosocial and work-related than by anthropometric factors.

Future research should use longitudinal designs and more detailed assessments of psychosocial, organizational, and environmental workplace exposures to clarify the mechanisms linking occupational context to alcohol-related behaviors.

Limitations

Several limitations should be considered when interpreting these findings. First, the convenience sample of workers from a single private occupational medicine practice in Palermo, Italy, may have introduced selection bias, potentially limiting generalizability.⁶⁶ Second, the cross-sectional design precludes causal inference, and longitudinal studies are needed to clarify the direction of the observed associations. Third, self-reported AUDIT-C responses may have been affected by recall and social desirability bias. Fourth, the Italian occupational and cultural context may limit generalizability to other countries, healthcare systems, or labor market structures. Fifth, restricting inclusion to workers with complete medical records may have excluded more vulnerable individuals.

Furthermore, the retrospective records lacked standardized information on counseling, referral, and follow-up, precluding evaluation of subsequent interventions and clinical outcomes.

The healthy worker effect may also have influenced the findings, limiting generalizability beyond actively employed populations. In addition, the dichotomous classification of workers as white-collar and blue-collar workers, oversimplifies the heterogeneity, and residual confounding cannot be excluded.

Finally, BD was derived from the AUDIT-C item assessing consumption of six or more drinks on one occasion;

therefore, sex-specific BD thresholds could not be evaluated. Moreover, although the AUDIT-C is an established screening instrument for identifying current at-risk drinking, it does not assess cumulative alcohol-related harms associated with long-term exposure.

Conclusion

This study highlights substantial occupational disparities in alcohol consumption and BD among working-age adults. Blue-collar workers had higher alcohol-risk profiles and were more likely to report BD than white-collar workers, even after adjustment for demographic and anthropometric variables. These differences were particularly relevant among younger workers and were influenced by sex and marital status.

The higher prevalence of risky alcohol consumption among workers exposed to physical demands and occupational hazards has important implications for occupational health surveillance, workplace safety, and prevention. Occupational medicine practitioners should consider occupational context and psychosocial risk profiles when screening alcohol-related behaviors and designing prevention programs. Workplace-based interventions addressing organizational stressors, workplace culture, social support, and health promotion may be particularly beneficial for younger and blue-collar workers.¹⁶

Future longitudinal studies should include detailed assessments of occupational exposures, psychosocial work factors, and organizational characteristics to clarify the mechanisms linking occupational context and alcohol-related behaviors.⁴⁹ Further studies are needed to evaluate workplace-based alcohol prevention and early intervention programs and to translate epidemiological evidence into practical strategies to improve worker wellbeing and workplace safety.

Author contributions

Ginevra Malta (Investigation, Methodology, Writing—review & editing), Daniele Leonardi Vinci (Data curation, Formal analysis), Emanuele Cannizzaro (Project administration, Methodology, Supervision, Resources), Francesca Vaccaro (Validation), Francesca Fiorella (Investigation), Fabiana Plescia (Investigation, Validation), Stella Cascioferro (Data curation, Investigation), Gianluca Lavanco (Conceptualization, Validation, Formal analysis, Writing—review & editing), and Fulvio Plescia (Conceptualization, Project administration, Investigation, Methodology, Supervision, Funding, Writing—original draft, Writing—review & editing).

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Conflict of interest. The authors declare no conflicts of interest.

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Data availability statement

The datasets are not publicly available. Anonymized data may be provided upon request by Fulvio Plescia.

Institutional review board statement

Given the retrospective, observational, and non-interventional nature of the study, and the use of anonymized data collected during routine occupational health surveillance, formal ethics committee approval was not required according to applicable national regulations and international guidance for health research, including World Health Organization guidance on studies based on anonymized retrospective data. All procedures were conducted in accordance with the principles of the Declaration of Helsinki and relevant data protection regulations. (https://extranet.who.int/kobe_centre/sites/default/files/pdf/WHO%20Guidance_Research%20Methods_Health-EDRM_6.4.pdf).

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used Grammarly solely to improve the readability and language. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

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Supplementary Methods

Study design and population

This retrospective observational study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines⁴⁰. The study was carried out in 2026 through the analysis of medical records from individuals who underwent occupational health surveillance at a private occupational medicine practice in Palermo, Italy, between January 2023 and December 2025. Occupational health surveillance was routinely arranged and funded by the employers for all workers whose occupational risk profile required medical surveillance. Employees did not bear any financial cost, and attendance was not based on an individual opt-in procedure. Consent for the anonymized use of medical-record data for research purposes was obtained separately.

The study population consisted of a convenience (opportunistic) sample, defined by the availability of subjects attending the clinic during the study period. For the purposes of the present analysis, only individuals aged 22 to 65 years with complete and adequately documented clinical records were considered eligible.

Inclusion criteria required the availability of a fully completed medical record, including anamnestic data, anthropometric parameters (age, weight, and height). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m²). In addition, inclusion required complete administration of the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C). Records were excluded if incomplete or missing key variables (age, weight, height, or AUDIT-C data), or in the absence of valid informed consent for anonymized data use.

A total of 1,653 medical records were initially screened, of which 1,264 met the inclusion criteria and were included in the final analysis. The study population consisted of men and women, with an age range of 22 to 65 years. Participants were classified into two occupational categories: white-collar (Work 1; n = 607) and blue-collar workers (Work 2; n = 657), based on job title and task characteristics as reported in the medical records⁴¹. White-collar workers included individuals engaged in predominantly administrative, managerial, or professional activities, typically characterized by lower physical demands. Blue-collar workers comprised individuals performing manual or technical tasks, generally involving higher physical workload and greater exposure to occupational risks. This classification allowed the study population to be stratified according to differing profiles of occupational exposure, distinguishing between roles associated with predominantly psychosocial demands and those characterized by greater physical workload and environmental risk.

Data were collected through a retrospective review of medical records, including standardized anamnestic assessments and AUDIT-C questionnaires administered during routine occupational health evaluations.

All participants were informed of the study's purpose, and subjects were asked not to report personal or company identification data in the questionnaires to ensure anonymity and confidentiality. The data processing complied with current Italian legislation on the protection of personal data (Legislative Decree No. 196/2003 and subsequent amendments), and the acquisition and analysis of clinical information and questionnaires on alcohol habits were carried out by a multidisciplinary group of healthcare professionals.

Assessment of alcohol consumption

Alcohol consumption patterns and related risk were assessed using the Alcohol Use Disorders Identification Test-Concise (AUDIT-C). This test represents a shortened version of the 10-item AUDIT questionnaire, originally validated by the World Health Organization, and is widely used to evaluate both the quantity and frequency of alcohol intake as well as patterns of consumption^{42,43}. The use of this screening tool allows for the early identification of individuals with at-risk drinking patterns or increased likelihood of alcohol-related health consequences.

The AUDIT-C consists of three items, each scored from 0 to 4, yielding a total score ranging from 0 to 12. In accordance with established clinical thresholds, a total score ≥ 4 in men and ≥ 3 in women was considered indicative of at-risk alcohol consumption. Higher scores are associated with an increased likelihood of clinically significant alcohol-related disorders.

Based on established sex-specific AUDIT-C screening thresholds, participants were stratified into three ordered categories: abstinent (score = 0), low-risk alcohol consumption (score = 1–3 in men and 1–2 in women), and at-risk alcohol consumption (score ≥ 4 in men and ≥ 3 in women)^{42,44}. These thresholds were used for screening purposes and were not intended to define the clinical severity of alcohol use or establish a diagnosis of alcohol use disorder.

Statistical analysis

Continuous variables were summarized as median and interquartile range (IQR), and categorical variables as counts and percentages. Baseline comparisons between Work 1 and Work 2 workers were performed using the Wilcoxon rank-sum test for continuous variables and Pearson's chi-square test or Fisher's exact test with Monte Carlo simulation, as appropriate when expected cell counts were < 5 , for categorical variables. For chi-square analyses involving contingency tables with more than one degree of freedom, post-hoc inspection of standardized adjusted residuals was performed following significant omnibus results to localise the source of the association; cells with $|z| > 2$ were considered to contribute substantially to the overall chi-square statistic. Preliminary assessment of distributional assumptions was performed using the Shapiro-Wilk test for normality and Levene's test for homogeneity of variances. Given the non-normal and inherently discrete distribution of AUDIT-C scores, non-parametric methods were used for all main univariable analyses.

AUDIT-C scores (range 0–12) were classified into three ordered screening categories using sex-specific thresholds validated in the literature: *Abstinent* (score = 0), *Low-risk* (score 1–3 in men, 1–2 in women), and *at-risk* (score ≥ 4 in men, ≥ 3 in women). This 3-category ordinal outcome served as the primary screening-based endpoint for the multivariable model.

Binge drinking was operationally defined according to the third AUDIT-C item as reporting the consumption of six or more standard drinks on a single occasion at least occasionally. This variable was used as the secondary binary outcome.

Univariable analyses of AUDIT-C score were restricted to drinkers. AUDIT-C scores were compared between occupational groups (Work 1 vs Work 2) using the Wilcoxon rank-sum test, overall and after stratification by sex; effect size was expressed as rank-biserial correlation coefficient (r). Differences across age groups were assessed separately within each sex-by-work subgroup using the Kruskal-Wallis test, followed by pairwise Wilcoxon tests with Bonferroni correction when appropriate.

The distribution of AUDIT-C screening categories across work types was additionally tested using chi-square on the full sample (Abstinent/Low-risk/at-risk), stratified by sex.

Associations between binge drinking and categorical covariates were restricted to drinkers and assessed separately by sex using Pearson's chi-square test or Fisher's exact test with Monte Carlo simulation, as appropriate. Effect size for contingency tables was quantified using Cramér's V . The association between BMI and AUDIT-C score was evaluated using Spearman's rank correlation coefficient.

The primary multivariable analysis used proportional odds logistic regression (POLR), with the 3-level AUDIT-C screening category as the ordinal outcome (abstinent, low risk, at risk). Covariates entered a priori were sex, work type, age group, marital status, and BMI. Adjusted associations were reported as odds ratios (ORs) with 95% confidence intervals (95% CIs). Model performance was summarized using the Akaike information criterion (AIC), Nagelkerke's R^2 , and the concordance statistic (c-index). The proportional odds assumption was assessed by comparing coefficients across cumulative logits.

To evaluate whether the association between sex and AUDIT-C screening category was influenced by the use of sex-specific thresholds, a sensitivity analysis was performed using a common AUDIT-C cut-off of ≥ 4 for both men and women. Participants were reclassified into three ordered screening categories: abstinent (score = 0), low-risk (score = 1–3), and at-risk (score ≥ 4). The proportional odds logistic regression model was then repeated using the same analytical sample, covariates, reference categories, and model specification adopted in the primary analysis.

A secondary binary logistic regression model was fitted using binge drinking as outcome. In the revised binge model, AUDIT-C score was intentionally excluded to avoid overadjustment, given the conceptual overlap between binge drinking and the AUDIT-C construct.

All variables included in the analyses were complete, and no imputation procedures were required. All tests were two-sided, and $p < 0.05$ was considered statistically significant. All analyses were performed in R version ≥ 4.3 .

Supplementary Results

AUDIT-C screening categories by sex and occupational group

In the full sample, the distribution of AUDIT-C screening categories differed significantly between Work 1 and Work 2 in both sexes (Figure 1A in the main manuscript). Among men, the association was stronger ($\chi^2(2) = 28.14$; $p < 0.001$; Cramér's $V = 0.211$): standardized residuals indicated that all three categories contributed significantly, with Work 2 workers showing a marked excess in the at-risk category ($z = +5.29$) and a deficit in both the abstinent ($z = -2.58$) and low-risk ($z = -2.83$) categories, reflecting a uniform rightward shift of the entire distribution. Among women, the overall association was weaker ($\chi^2(2) = 11.43$; $p = 0.004$; Cramér's

$V = 0.133$) and driven exclusively by the two extreme categories: Work 2 workers were overrepresented among at-risk drinkers ($z = +2.95$) and underrepresented among abstainers ($z = -2.89$), whereas the low-risk category was distributed proportionally between the two occupational groups ($z = 0.68$), accounting for the smaller effect size relative to men. Among drinkers, Work 2 workers had higher AUDIT-C scores than Work 1 workers overall and after sex stratification (Figure 1B in the main manuscript). Overall, the median AUDIT-C score was 3 (IQR 2–4) in Work 1 workers and 4 (IQR 2–5) in Work 2 workers ($W = 96,364$; $n_1 = 440$, $n_2 = 537$; $p < 0.001$; $r = 0.161$). In men, the corresponding medians were 3 (IQR 2–4) and 4 (IQR 3–6) ($W = 21,626$; $n_1 = 224$, $n_2 = 252$; $p < 0.001$; $r = 0.205$). Among women, both medians were 3 (IQR 2–4 vs 2–5), but the score distribution was significantly shifted toward higher values in Work 2 workers ($W = 26,376$; $n_1 = 216$, $n_2 = 285$; $p = 0.005$; $r = 0.124$) (Figure 1B in the main manuscript).

Age-related patterns of alcohol consumption

Kruskal–Wallis testing revealed significant differences in AUDIT-C scores across the five age groups in all four Sex-by-work-type strata among drinkers (Figure 2): male Work 1 workers ($H(4) = 38.11$; $p < 0.001$); male Work 2 workers, ($H(4) = 36.23$; $p < 0.001$); female Work 1 workers ($H(4) = 30.04$; $p < 0.001$); female Work 2 workers ($H(4) = 32.04$; $p < 0.001$).

Post-hoc pairwise analyses with Bonferroni correction identified a consistent age gradient, with higher AUDIT-C scores in younger workers. In male Work 1 workers, the 31–40 ($p_{adj} = 0.012$), 41–50 ($p_{adj} < 0.001$), and 51–60 ($p_{adj} < 0.001$) year groups had lower scores than the 22–30 year group. In male Work 2 workers, the same pattern was observed for the 31–40 ($p_{adj} = 0.019$), 41–50 ($p_{adj} < 0.001$), and 51–60 ($p_{adj} < 0.001$) year groups. In female Work 1 workers, the 41–50 ($p_{adj} = 0.003$), 51–60 ($p_{adj} < 0.001$), and 61+ ($p_{adj} = 0.034$) age groups had significantly lower AUDIT-C scores than the 22–30 reference group. The 31–40 group did not differ significantly from the reference ($p_{adj} = 0.075$). In female Work 2 workers, the 41–50 ($p_{adj} < 0.001$), 51–60 ($p_{adj} < 0.001$), and ≥ 61 ($p_{adj} = 0.001$) year groups differed significantly from the 22–30 year reference group. Consistent with these findings, the prevalence of at-risk alcohol consumption decreased with age in both sexes, with Work 2 workers showing higher prevalences than Work 1 workers across most age strata (Figure 2 in the main manuscript).

Sociodemographic determinants of binge drinking

In the full sample, binge drinking was more prevalent among Work 2 than Work 1 workers (47% vs 38%; $p = 0.003$). To characterize binge drinking conditional on alcohol use, subsequent sex-stratified analyses were restricted to drinkers only. Among drinkers, work type was not significantly associated with binge drinking after stratification by sex (men: $\chi^2(1) = 0.003$, $p = 0.957$, Cramér's $V = 0.002$; women: $\chi^2(1) = 2.512$, $p = 0.113$, $V = 0.071$).

Marital status was significantly associated with binge drinking in both men ($\chi^2(1) = 34.22$, $p < 0.001$, $V = 0.268$) and women ($\chi^2(1) = 31.24$, $p < 0.001$, $V = 0.250$), with single workers showing markedly higher binge prevalence than married workers in both sexes.

Age group was significantly associated with binge drinking in both sexes, though the pattern differed qualitatively between men and women. In men, the association (Fisher's exact test with Monte Carlo simulation; $p = 0.0002$; Pearson-derived Cramér's $V = 0.270$) was driven primarily by two age classes: workers aged 22–30 showed a marked excess of binge drinking ($z = +4.93$), while those aged 51–60 showed a corresponding deficit ($z = -4.35$); intermediate age groups did not contribute significantly ($|z| < 2$). In women, a broader gradient was observed ($\chi^2(4) = 98.49$; $p < 0.001$; $V = 0.443$): excess binge drinking extended across the three youngest age groups (22–30: $z = +4.77$; 31–40: $z = +3.17$; 41–50: $z = +2.96$), whereas a sharp and pronounced decline was observed from age 51 onwards (51–60: $z = -7.12$; 61+: $z = -5.39$).

Spearman's rank correlation between BMI and AUDIT-C score among drinkers was weakly negative in men ($\rho = -0.101$; $p = 0.028$) and negligible in women ($\rho = 0.059$; $p = 0.186$), indicating no clinically relevant overall association between adiposity and alcohol consumption severity (Supplementary Figure S1).

Multivariable models of AUDIT-C screening category and binge drinking patterns

In the primary proportional odds model, female sex was independently associated with higher odds of belonging to a higher AUDIT-C screening category (OR 1.995, 95% CI 1.595–2.500; $p < 0.001$), and Work 2

was likewise associated with higher odds of belonging to a higher AUDIT-C screening category compared with Work 1 (OR 1.918, 95% CI 1.549–2.377; $p < 0.001$). (Figure 3A in the main manuscript).

Age was inversely associated with the ordinal AUDIT-C outcome. Compared with workers aged 22–30 years, the adjusted ORs were 0.55 (95% CI 0.365–0.836; $p = 0.005$) for those aged 31–40 years, 0.54 (95% CI 0.364–0.797; $p = 0.002$) for those aged 41–50 years, 0.423 (95% CI 0.284–0.625; $p < 0.001$) for those aged 51–60 years, and 0.371 (95% CI 0.187–0.738; $p = 0.005$) for those aged ≥ 61 years. Married participants had markedly lower odds of belonging to a higher AUDIT-C screening category than single participants (OR 0.344, 95% CI 0.257–0.459; $p < 0.001$). BMI did not reach statistical significance (OR 1.040 per 1-unit increase, 95% CI 1.000–1.081; $p = 0.052$) and was retained in the model as an a priori confounder.

Overall model performance was moderate (AIC = 2531.93; Nagelkerke's $R^2 = 0.154$; c-index = 0.672). The proportional odds assumption was satisfied for work type ($p = 0.197$) and marital status ($p = 0.872$). Potential violations were identified for female sex ($p = 0.005$) and the 41–50 ($p = 0.026$) and 51–60 ($p = 0.001$) age groups, suggesting that the effect of these variables may differ in magnitude across the two cumulative logit cuts; results for work type and marital status, the primary predictors of interest, were not affected.

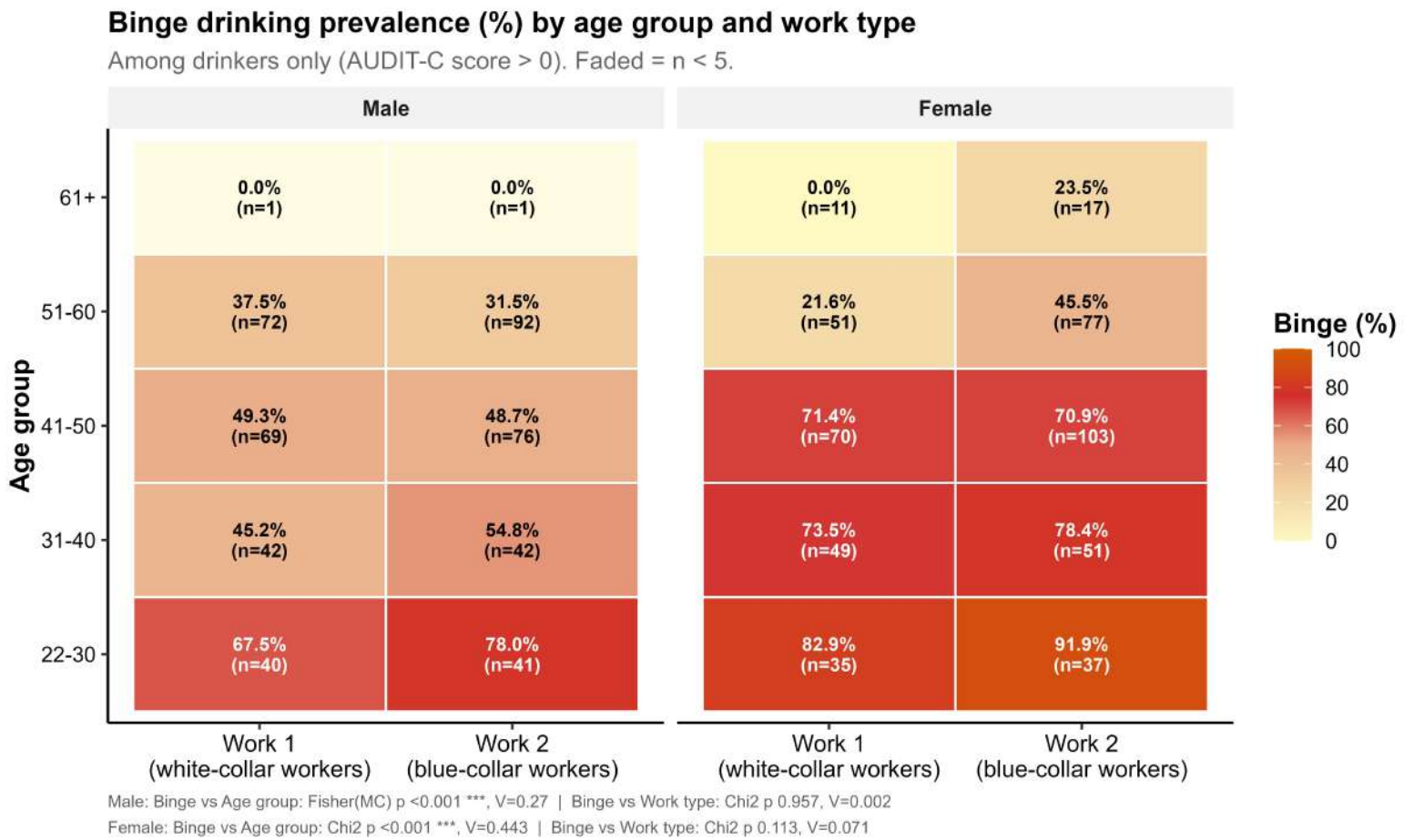
To assess the influence of the sex-specific AUDIT-C thresholds, the proportional odds model was repeated using a common threshold of ≥ 4 for both sexes. Using the original sex-specific AUDIT-C thresholds, 34.0% of men and 52.1% of women were classified in the at-risk category. When the common threshold of ≥ 4 was applied to both sexes, the corresponding proportions were 34.0% and 33.1%, respectively. Consistent with this descriptive change, the association between female sex and a higher AUDIT-C screening category was substantially attenuated and was no longer statistically significant (aOR = 1.22, 95% CI 0.98–1.53; $p = 0.077$). In contrast, the association between Work 2 and a higher AUDIT-C screening category remained statistically significant and of comparable magnitude (aOR = 2.08, 95% CI 1.68–2.58; $p < 0.001$). Age and marital status remained significantly associated with the outcome, whereas BMI remained non-significant. Detailed model estimates are reported in Supplementary Table S1. The association between Work 2 and a higher AUDIT-C screening category remained robust after applying an equivalent threshold to both sexes, whereas the association with female sex was substantially attenuated.

In the secondary binary logistic model for binge drinking, female sex remained strongly associated with binge drinking (OR 2.259, 95% CI 1.749–2.926; $p < 0.001$), and Work 2 also emerged as an independent predictor (OR 1.466, 95% CI 1.149–1.874; $p = 0.002$) (Figure 3B in the main manuscript).

Age showed a graded inverse association with binge drinking. Compared with the 22–30 year group, workers aged 31–40 years had lower odds (OR 0.611; 95% CI 0.398–0.932; $p = 0.023$), those aged 41–50 years showed a non-significant trend (OR 0.684; 95% CI 0.458–1.017; $p = 0.062$), and the association was stronger in older groups: OR 0.276 (95% CI 0.182–0.417; $p < 0.001$) for 51–60 years and OR 0.054 (95% CI 0.015–0.149; $p < 0.001$) for workers aged ≥ 61 years. Married participants had 69% lower odds of binge drinking than single participants (OR 0.310, 95% CI 0.227–0.421; $p < 0.001$). BMI was not significantly associated with the outcome (OR 1.037, 95% CI 0.992–1.085; $p = 0.108$). (Figure 3B in the main manuscript).

Supplementary Figure S1. Binge drinking prevalence among drinkers according to age group, sex, and occupational group. Heatmap cells show the percentage of drinkers reporting binge drinking, with cell counts displayed in parentheses. Faded cells indicate sparse strata with fewer than five observations. Binge drinking was more frequent in younger age groups, whereas work type was not significantly associated with binge drinking after sex stratification.

Supplementary Table S1. Primary model: sex-specific high-risk thresholds (men ≥ 4 ; women ≥ 3). Sensitivity model: equivalent high-risk threshold ≥ 4 for both sexes. Both proportional-odds models included the full sample ($N = 1,264$) and were adjusted for sex, work type, age group, marital status, and BMI. Reference categories were male sex, Work 1, age 22–30 years, and single marital status. β denotes the log-odds coefficient; SE, standard error; aOR, adjusted odds ratio.



Predictor	Primary model				Sensitivity model: equivalent threshold ≥4			
Comparison	Beta	SE	aOR (95% CI)	p	Beta	SE	aOR (95% CI)	p
Female vs Male	0.691	0.115	1.995 (1.595-2.500)	<0.001	0.201	0.114	1.222 (0.978-1.528)	0.077
Work 2 vs Work 1	0.651	0.109	1.918 (1.549-2.377)	<0.001	0.732	0.110	2.079 (1.677-2.582)	<0.001
Age 31-40 vs 22-30	-0.591	0.211	0.554 (0.365-0.836)	0.005	-0.735	0.210	0.479 (0.317-0.721)	<0.001
Age 41-50 vs 22-30	-0.616	0.200	0.540 (0.364-0.797)	0.002	-0.833	0.197	0.435 (0.295-0.639)	<0.001
Age 51-60 vs 22-30	-0.860	0.201	0.423 (0.284-0.625)	<0.001	-0.950	0.199	0.387 (0.261-0.570)	<0.001
Age 61+ vs 22-30	-0.990	0.349	0.371 (0.187-0.738)	0.005	-1.459	0.336	0.232 (0.120-0.448)	<0.001
Married vs Single	-1.067	0.148	0.344 (0.257-0.459)	<0.001	-1.320	0.147	0.267 (0.200-0.356)	<0.001
BMI (per 1 unit)	0.039	0.020	1.040 (1.000-1.081)	0.052	0.025	0.020	1.025 (0.986-1.067)	0.213