Research Report

# Drink-Driving and its Associations with Sociodemographic Characteristics and Alcohol Consumption in Germany

## A Population Survey

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**Abstract:** *Aims:* To assess the prevalence of drink-driving among adults in Germany and subgroups, and potential associations with sociodemographic or drinking characteristics. *Methodology:* Cross-sectional population survey of 5,153 respondents aged 18+ years in Germany (June–November 2021). We assessed self-reported drink-driving, defined as, in the past month, driving a motorised vehicle within 1 hour of consuming 2 or more alcoholic beverages. Regression models were used to examine sociodemographic and drinking characteristics associations with self-reported drink-driving among adults in Germany who drank alcohol and reported driving a motorised vehicle in the past month. *Results:* The prevalence of self-reported drink-driving was 4.1 % (95 % CI 3.6–4.7) among adults in Germany, and 5.7 % (95 % CI 5.0–6.5) among adults who were alcohol users and reported driving a motorised vehicle in the past month. Lower odds of drink-driving were found for women vs men (adjusted odds ratio ($OR_{adj}$) = 0.63, 95 % CI 0.45–0.88), people with low vs middle income ($OR_{adj}$ = 0.82, 95 % CI 0.72–0.94), people living in rural vs urban areas ($OR_{adj}$ = 0.38, 95 % CI 0.27–0.54), and people consuming low vs medium alcohol levels ($OR_{adj}$ = 0.28, 95 % CI 0.18–0.44). There was no clear association with age or education level. *Conclusions:* Roughly 4 in 100 adults drank and drove in the past month in Germany. This is a public health issue requiring further study and potentially more targeted interventions.

**Keywords:** alcohol consumption, drink driving, Germany, adults, population survey

**Fahren unter Alkoholeinfluss in Deutschland und Assoziationen mit soziodemografischen Merkmalen und Alkoholkonsum: eine Bevölkerungsbefragung**

**Zusammenfassung:** *Zielsetzung:* Exploration der Häufigkeit des alkoholisierten Fahrens, basierend auf Selbstauskunft, bei einer repräsentativen Stichprobe von Erwachsenen in Deutschland sowie in verschiedenen Bevölkerungsgruppen. Zudem sollten mögliche Assoziationen mit soziodemografischen, sozioökonomischen, geografischen Personenmerkmalen sowie Alkoholkonsumlevel ermittelt werden. *Methodik:* Persönlich-mündliche Bevölkerungsbefragung einer Stichprobe von 5153 Befragten ab 18 Jahren in Deutschland (Juni–November 2021) im Querschnittdesign. Selbstberichtetes alkoholisiertes Fahren war definiert als das Lenken eines motorisierten Fahrzeugs im vergangenen Monat innerhalb einer Stunde nach dem Konsum von zwei oder mehr alkoholischen Getränken. Bei Erwachsenen, die Alkohol konsumierten und angaben, im vergangenen Monat ein motorisiertes Fahrzeug gefahren zu haben, wurden Assoziationen zwischen Personenmerkmalen sowie Alkoholkonsumlevel und dem selbstberichteten Fahren unter Alkoholeinfluss mittels Regressionsmodellen exploriert. *Ergebnisse:* Die Prävalenz von Alkohol am Steuer betrug 4.1 % (95 %-KI 3.6–4.7) unter Erwachsenen und 5.7 % (95 %-KI 5.0–6.5) unter Erwachsenen, die Alkohol konsumierten und im vergangenen Monat ein motorisiertes Fahrzeug gefahren haben. Eine geringere Wahrscheinlichkeit, unter Alkoholeinfluss zu fahren, wurde für Frauen im Vergleich zu Männern (angepasstes Odds Ratio [$OR_{adj}$] = 0.63, 95 %–KI 0.45 –0.88), Personen mit niedrigerem gegenüber mittlerem Einkommen



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($OR_{adj}$ = 0.82, 95 %–KI 0.72 –0.94), Menschen, die in ländlichen im Vergleich zu städtischen Gebieten leben ($OR_{adj}$ = 0.38, 95 %–KI 0.27 –0.54) und Menschen mit geringem gegenüber mittlerem Alkoholkonsum ($OR_{adj}$ = 0.28, 95 %–KI 0.18–0.44). Es gab keinen eindeutigen Zusammenhang mit Alter oder Bildungsniveau. *Schlussfolgerungen:* Etwa 4 von 100 Erwachsenen haben im vergangenen Monat in Deutschland Alkohol getrunken und sind Auto gefahren. Dies ist ein Problem für die öffentliche Gesundheit, das weitere Untersuchungen und möglicherweise gezieltere Interventionen erfordert.

**Schlüsselwörter:** Alkoholkonsum, Trunkenheit am Steuer, Deutschland, Erwachsene, Bevölkerungsbefragung

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## Introduction

Alcohol consumption impairs brain functioning and can affect road safety even at low alcohol concentrations (Ogden & Moskowitz, 2004). Drink-driving is defined as driving under the influence of alcohol. Over the past decades, the number of alcohol-related accidents resulting in personal injury has fallen by 73.6 % since 1975, from 51593 to 13628 in 2021, due to strict regulations and the known risks of drink-driving promoted through public education and media campaigns (Destatis, 2022). Nevertheless, accidents involving alcohol-impaired people still occur on a regular basis (Destatis, 2022). There are official statistics from the German Government on incidents in which an alcohol-impaired person was involved in an accident (Destatis, 2022). However, there is no information on the overall prevalence of drink-driving, which will be higher given that not all cases of drink-driving result in an accident. Also, the official statistics are likely to underreport the true number of accidents due to several factors, including that blood alcohol concentration (BAC) is not always measured when an accident occurs, an above-average proportion of people who hit-and-run are under the influence of alcohol or other substances, and accidents in which only the alcohol-impaired person is involved are often not reported (Destatis, 2022). The aim of this study was therefore to provide data on the prevalence of drink-driving in Germany and on specific person characteristics associated with drink-driving.

In Germany, the current law states that a driver with a BAC of 0.05 % or above, or a breath concentration of 0.25 milligrams per litre or above is a misdemeanour (Federal Office of Justice, 2003). For example, a man (weight 80 kilograms, height 1.8 metres) could consume three 0.5-litre beer bottles with an alcohol by volume of 4.5 % within 2 hours to have a BAC of 0.05 % (Widmark, 1932). If a driver shows signs of impairment, legal consequences may already follow from a BAC of 0.03 %. For novice drivers in their probationary period (usually two years from receiving their driver's license) and those under 21 years of age, the German law states a zero-alcohol limit (Federal Office of Justice, 2003).

Despite these regulations, in Germany in 2021, driving under the influence of alcohol was one of the official causes in 5.3 % of all road accidents resulting in injuries, and 6.4 % of all road accidents resulting in deaths (Destatis, 2022). Additionally, the Federal Highway Research Institute estimated the total economic costs of road traffic accidents in Germany at 32.5 billion Euros for 2021 (Bundesanstalt für Straßenwesen, 2022). Even though estimates for drink-driving attributable costs are not available, if one assumed that about 5 % of these were attributable to alcohol-impaired driving, this would result in costs of roughly 1.6 billion Euros.

Regional differences have been observed within Germany, with the three 'city-states' (i.e., Berlin, Hamburg, and Bremen) having the lowest rates of alcohol-related road accidents involving injuries (Destatis, 2022). In 2021, the German police registered 68 % of alcohol-related road accidents involving injuries within built-up areas, 28 % on country roads (i.e., roads outside towns excluding motorways), and 4 % on motorways (Destatis, 2022). Another striking difference between alcohol-related road accidents and all road accidents involving injuries is their timing – about half of alcohol-related accidents happened on weekends, and mostly between 8 pm and 10 pm (Destatis, 2022). Some differences were identified between sociodemographic characteristics, for example, more men, than women, were involved in alcohol-related incidents, and the highest prevalence in the age group 25–34 years and lowest in those aged 65+ years (Destatis, 2022). These statistics refer to incidents where an alcohol-impaired person was involved in an accident, though it could also be a pedestrian involved in the accident rather than the vehicle driver. However, they do not provide information about the overall proportion of people who drove after consuming alcohol.

It is important to understand which population groups are most likely to engage in drink-driving to help detect if any underlying patterns for drink-driving exist and to target interventions/support. Reports on drink-driving in the UK suggest that men are significantly more likely to drink-drive than women (Webster et al., 2020). It was also found that in the UK drink-driving is more pronounced among those from more advantaged socioeconomic groups (Webster et al., 2020), while evidence from New Zealand and Sweden suggests drink-driving is more prevalent amongst those from a less advantaged socioeconomic background (Impinen et al., 2011; Morrison et al., 2002).

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Increasing and higher risk drinking (operationalised as an Alcohol Use Disorder Identification Test – Consumption (AUDIT-C) score of 5 or above for men and 4 or above for women (Rumpf et al., 2002)) and personal alcohol consumption patterns are also critical factors which may influence the likelihood to drink-drive. It was reported that among Australians caught drink-driving, those who drank at increasing and higher risk levels (full AUDIT score ≥ 8) were 4.8 times more likely to report drink-driving in the past six months than those drinking at lower risk levels (Wilson et al., 2010). Other studies in the UK also showed that frequent heavy drinkers are more likely to engage in drink-driving (Webster et al., 2020). Comparable data for Germany have not been reported so far.

This study aimed to examine the prevalence of drink-driving among a sample of the general adult (aged 18 years or older) population in Germany who were alcohol users, as well as among those who also reported driving a motorised vehicle in the past month and among different population groups, and to assess any potential associations with sociodemographic, socioeconomic, geographic, or drinking characteristics, based on data collected between June and November 2021. In particular, this study answered the following research questions:

1a. What is the prevalence of self-reported drink-driving among adults in Germany, and stratified by sociodemographic, socioeconomic, and geographic characteristics, as well as alcohol consumption levels?

1b. What is the prevalence of self-reported drink-driving among adults in Germany who are alcohol users and reported driving a motorised vehicle in the past month?

2. To what extent are different sociodemographic, socioeconomic, and geographic characteristics as well as alcohol consumption levels associated with drink-driving among adults in Germany who are alcohol users and reported driving a motorised vehicle in the past month?

# Methodology

## Study Design and Population

We used data from the German Study on Tobacco Use (DEBRA: "Deutsche Befragung zum Rauchverhalten"), an ongoing population-based household survey on tobacco use in Germany (Kastaun et al., 2017). The DEBRA study collects data every other month from computer-assisted face-to-face household interviews of people aged 14+ years. Respondents are selected using a dual frame design: an approximately 50:50 mix of multiple stratified, multistage random sampling and quota sampling (further information is available on the Open Science Framework: https://osf.io/s2wxc).

All communities within Germany are stratified by federal state, administrative district, and type of community. The geographical area of Germany was divided into 53000 small areas to determine the primary sampling units. For each of these small areas, the sample size was determined in proportion to the total number of households in the area relative to the total number of households in the whole population. The secondary sampling units are represented through private households and are selected by a random walk procedure. The tertiary sampling units are the target persons themselves and are selected using a random process that gives an equal chance of selection to every eligible person within a household. Further details on the methodology, sample selection and weighting technique have been published elsewhere (Kastaun et al., 2017), and further materials are available on the Open Science Framework (sample questionnaire: https://osf.io/ndu6r/ and additional material https://osf.io/e2nqr/).

The study protocol and analysis plan were pre-registered on the Open Science Framework (https://osf.io/rc4jz/). Data on drink-driving were collected across three waves (waves 31–33) of the DEBRA study, between June and November 2021, where each wave included approximately 2,000 respondents. The current analysis aggregated the data across these three waves from respondents who were aged 18+. In the registered protocol, we erroneously stated that the analysis will be conducted with all respondents aged 16+ but data on drink-driving are only available in those aged 18+ years. We focus on adults only as the minimum age for unrestricted driving of standard motor vehicles, such as cars, is 18 in Germany (Bundesamt für Justiz, 2010). Additionally, the sale of beer, wine, wine-like beverages, sparkling wine, or mixtures of these with non-alcoholic beverages is permitted from the age of 16 years in Germany and for all other alcoholic beverages it is 18 years (Bundesamt für Justiz, 2002).

## Measures

The main outcome measure was whether someone drove within one hour of consuming two or more alcoholic beverages ("drink-driving"), based on a question used in the Canadian Addiction Survey (Beirness & Davis, 2007). All variables are listed in Table 1 and are based on self-report.

## Statistical Analyses

Descriptive statistics were calculated to characterise the sample. Data were analysed in SPSS version 28 (IBM Cor-



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**Table 1.** Self-reported study variables derived from DEBRA study between June and November 2021

| Measures | Description |
|---|---|
| Outcome | |
| Drink-driving | Respondents aged 18+ who were alcohol users (scored 1+ on question 1 of the AUDIT-C [Bradley et al., 2007]) on frequency of consumption (all AUDIT-C questions are provided in the supplementary material, ESM 1) were asked: "The following question is about driving after drinking. Could you please state for the past 30 days how often you have driven a motorised vehicle (e.g., a car, motor bike, or scooter) within 1 hour of consuming 2 or more alcoholic beverages?"<br>i. Never<br>ii. Once<br>iii. 2–3 times<br>iv. 4 times or more<br>v. I don't have a driver's license, or I haven't driven in the past 30 days.<br>vi. No response<br>Option (vi) was considered missing.<br>For research question 1a, respondents selecting options (ii), (iii) and (iv) were categorised as drink-driving, all others including those with AUDIT-C score of 0 as not drink-driving. For research questions 1b and 2, respondents selecting option (i) were categorised as not drink-driving, those selecting options (ii), (iii) and (iv) were categorised as drink-driving, and those selecting (v) were excluded. For research questions 1a and 1b, we also reported the outcomes as (ii) once, (iii) 2–3 times, (iv) 4 times or more.<br>Note: When people were asked about their alcohol consumption level (AUDIT-C questions; see supplementary material for the AUDIT-C questions, ESM 1), they were provided with examples for alcoholic beverages ("By an alcoholic beverage we mean a small 0.33-Litre bottle of beer, a small 0.125-Litre glass of wine, a glass of sparkling wine, a double shot or a bottle of alcopops."). The order of the questions was first the AUDIT-C questions, followed by two other alcohol-related questions, and then the question about drink-driving. |
| Co-variables | |
| Age | For research question 1, age was categorised into: 18–24/25–34/35–44/45–54/55–64/65–74/75+; for research question 2, age was modelled using restricted cubic splines with 3 knots placed at the minimum, median, and maximum for age (Bates et al., 2015; Harrell, 2015) to allow for non-linear trends. |
| Sex | Male, female (due to very small numbers, non-binary responses were excluded from the analysis). |
| Highest educational qualification after general school education | Low (junior high school equivalent or no qualification: 'Hauptschul-/Volksschulabschluss' or 'kein allgemeiner Hochschulabschluss'), middle (secondary school equivalent: 'Realschulabschluss/Mittlere Reife/Polytechnische Oberschule 10. Klasse'), high (high school equivalent or advanced technical college equivalent: 'Fachhochschulreife' or 'Abitur/Allgemeine Hochschulreife'). |
| Monthly net household income | Equivalised disposable income according to Organisation for Economic Co-operation and Development (OECD)-modified equivalence scale (Grabka et al., 2016), explained in more detail here: https://osf.io/387fg and the supplementary material, ESM 1). Values can range between 0 and 7; for research question 1a, 3 categories: low (approximately <20$^{th}$ income percentile; values <1 ), middle (approx. 20$^{th}$ to 80$^{th}$ income percentiles; values ≥1 and ≤2), and high (approx. >80$^{th}$ income percentile; values >2), roughly reflecting the distribution of income in the German population (Niehues, 2017; Rakesh, 2017); for research question 2, modelled using restricted cubic splines with 3 knots placed at 0.05, 0.50, and 0.95 quantiles (Bates et al., 2015; Harrell, 2015) to allow for non-linear trends. Exemplary, values at the lower (0.67), median (1.71), and upper quartile (3.33) were selected to show odds ratios for these, using the median as the reference (results in Table 4). |
| Region | 3 categories (explained in more detail here: https://osf.io/zp7c6): rural (<20 000 inhabitants), urban (20 000–500 000 inhabitants), metropolitan (>500 000 inhabitants). |
| Alcohol consumption level | Measured with the AUDIT-C ranging from 0–12 (Bradley et al., 2007) (see supplementary material ESM 1 for exact wording of questions); for research question 1a, 3 categories: low (0–4), medium (5–7), and high (8–12) alcohol consumption level (Office for Health Improvement and Disparities, 2017); for research question 2, continuous variable, range 1 to 12, modelled using restricted cubic splines with 3 knots placed at minimum, median, and maximum for AUDIT-C (Bates et al., 2015; Harrell, 2015) to allow for non-linear trends. Exemplary, four different AUDIT-C scores (1, 3, 5, and 8) were selected to show odds ratios for these, using 3 as the reference (results see Table 4). |

poration, 2021) and RStudio (version 2022.07.2 [RStudio Team, 2022], R version 4.2.1 [R Core Team, 2022]). We reported the percent of missingness for each variable included in the analysis (see the electronic supplementary material [ESM] 2, Table S1). Since less than 5% of data were missing, we conducted a complete-case analysis. For

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alcohol consumption level, respondents who reported drinking monthly or less to the first question of AUDIT-C for wave 31 erroneously were not asked the second and third AUDIT-C questions (n = 433). Therefore, these respondents were excluded from all the analysis. In a sensitivity analysis, we only included data from waves 32 and 33 for research question 2.

For all analyses, data were weighted to match the German population by accounting for personal and household characteristics. In line with the multi-stage sampling procedure, the weighting was conducted in separate stages to differentiate between the design weighting (which corrects unequal selection probabilities due to sample design and is calculated by an analytical approach) and the outcome weighting (which reweights cases who actually participated in the survey compared with known general population parameters and is calculated as rim-weighting within an iterative process). Further details on the weighting technique are described elsewhere (Kastaun et al., 2017). Sensitivity analyses were conducted with unweighted data.

#### Prevalence of Self-Reported Drink-Driving

For research question 1a, all respondents to the survey were included, and we reported the prevalence [and 95% confidence interval (CI)] of self-reported drink-driving (never, once, 2–3 times, or 4 or more times) among adults in Germany. For research question 1a, we also present the prevalence of drink-driving (yes/no) estimates among adults in Germany stratified by the co-variables (age, sex, educational qualifications, monthly net household income, region, and alcohol consumption levels). For research question 1b, we excluded respondents with AUDIT-C score of 0, as they did not consume alcohol, and those who did not drive a vehicle in the past month. We reported the prevalence (and 95% CI) of self-reported drink-driving (never, once, 2–3 times, or 4 or more times) among adults in Germany who consumed alcohol and reported driving a motorised vehicle in the past month.

#### Factors Associated with Self-Reported Drink-Driving

For research question 2, we excluded respondents with AUDIT-C score of 0, as they did not consume alcohol, and those who did not drive a vehicle in the past month. We used logistic regression models to analyse unadjusted and multivariable associations of drink-driving. In the multivariable models, we used the remaining covariates for adjustment (this is a deviation from the pre-registered analysis plan, following peer review). As a sensitivity analysis, we presented the results based on directed acyclic graphs, as specified in the pre-registered protocol, in the supplementary material (ESM 3).

Age, net monthly household income, and alcohol consumption level were included in the models as continuous variables and modelled using restricted cubic splines using the rms package in R (Harrell, 2023; Harrell, 2015). We selected different ages (18, 25, 35, 45, 55, 65, and 75 years), income levels (using the OECD-modified equivalence scale which ranges from 0 to 7: Lower quartile [value: 1.33] – equivalent to a low income, median [value: 1.71] – equivalent to a middle income, upper quartile [value: 2.33] – equivalent to a high income), and AUDIT-C scores (1, 3, 5, 8) to compare the odds for these groups. Additionally, we presented graphs that show the modelled log odds for drink-driving depending on age, income, and AUDIT-C score, respectively (ESM 4).

## Results

A total of 5,227 (weighted n = 5,153) adults in Germany participated in the study between June and November 2021. Among them, 4,053 (weighted n = 4,078) participants reported drinking alcohol, and 3,623 (weighted n = 3,713) reported drinking alcohol and driving in the past month. Weighted and unweighted sample characteristics are reported in Table 2.

### Prevalence of Self-Reported Drink-Driving (Research Questions 1a and 1b)

The prevalence of self-reported drink-driving in the past month among adults in Germany was 4.1% (95% CI 3.6, 4.7). This equates to approximately 2.9 million people in Germany who have driven a motorised vehicle within one hour of consuming two or more alcoholic beverages in the past month during the study period (4.1% x 70 million adults [Destatis, 2023]). Of those who reported drink-driving in the past month, 2.6% (95% CI 2.2, 3.1) reported drink-driving once, 1.1% (95% CI 0.8, 1.4) reported drink-driving 2–3 times, and 0.4% (95% CI 0.2, 0.6) reported drink-driving 4 or more times during the past month. The prevalence of self-reported drink-driving among adults in Germany stratified by the co-variables are presented in Table 3 (unweighted estimates are reported in Table S2 in the ESM 5).

The prevalence of self-reported drink-driving among adults in Germany who were alcohol users and reported driving a motorised vehicle in the past month (n = 3,713) was 5.7% (95% CI 5.0, 6.5). Of those, 3.7% (95% CI 3.1, 4.3) reported drink-driving once, 1.5% (95% CI 1.1, 2.0) reported drink-driving 2–3 times, and 0.5% (95% CI 0.3, 0.8) reported drink-driving 4 or more times (unweighted estimates are reported in Table S2 in the ESM 5).



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**Table 2.** Weighted and unweighted sample characteristics

| Characteristics | N = 5,227 (unweighted) | N = 5,153 (weighted) |
|---|---|---|
| Age in years, % (n) | | |
| 18–24 | 7.4 (385) | 9.2 (476) |
| 25–34 | 13.2 (693) | 14.1 (728) |
| 35–44 | 14.9 (778) | 15.5 (800) |
| 45–54 | 15.1 (792) | 16.6 (857) |
| 55–64 | 20.9 (1,093) | 19.1 (983) |
| 65–74 | 16.9 (881) | 15.1 (766) |
| 75–96 | 11.6 (605) | 10.3 (533) |
| Sex, % female (n) | 51.5 (2,694) | 50.3 (2,590) |
| Educational qualifications, % (n) | | |
| Low | 31.1 (1,624) | 30.1 (1,550) |
| Middle | 36.3 (1,898) | 36.6 (1,887) |
| High | 32.6 (1,705) | 33.3 (1,717) |
| Monthly net household income, % (n) | | |
| Low | 12.6 (658) | 11.2 (575) |
| Middle | 61.8 (3,229) | 63.0 (3,245) |
| High | 25.6 (1,340) | 25.9 (1,334) |
| Region, % (n) | | |
| Rural | 38.1 (1,991) | 40.3 (2,076) |
| Urban | 42.1 (2,198) | 42.3 (2,182) |
| Metropolitan | 19.9 (1,038) | 17.4 (895) |
| Alcohol consumption levels (AUDIT-C score), % (n) | | |
| Low (0–4) | 84.9 (4,438) | 84.4 (4,348) |
| Medium (5–7) | 13.6 (709) | 14.1 (724) |
| High (8–12) | 1.5 (80) | 1.6 (81) |

## Factors Associated with Self-Reported Drink-Driving (Research Question 2)

Women were significantly less likely to report drink-driving than men (Table 4). People with a low income had lower odds of drink-driving than people with median income (as shown in Figure 1; unadjusted log odds in Fig. S1 in ESM 6). People living in rural areas had lower odds of drink-driving than those in urban areas, while those in urban areas did not differ from those in metropolitan areas (Table 4). A strong association was observed between alcohol consumption level and drink-driving; the higher the AUDIT-C score, the higher the odds of drink-driving (as shown in Fig. 1). There was no indication for associations between drink-driving and age or educational qualifications, respectively (Table 4). Results of the sensitivity analyses using unweighted data, including only waves 32 and 33 (i.e., waves in which the error in the data collection regarding AUDIT-C did not occur), and adjusting the models based on pre-specified directed acyclic graphs are presented in the Tables S3–S8 and Figures S2–S6 in the ESM 3, 4, 5. Overall, they are consistent with the main results, considering the wide confidence intervals for some of the variables.

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**Table 3.** Prevalence of self-reported drink-driving among a sample of adults in Germany (n = 5,153), stratified by co-variables

| Characteristics | Prevalence of drink-driving, % (95 % CI) |
|---|---|
| All respondents | 4.1 [3.6, 4.7] |
| Age | |
| 18–24 | 4.0 [2.4, 6.0] |
| 25–34 | 4.7 [3.3, 6.5] |
| 35–44 | 4.1 [2.9, 5.7] |
| 45–54 | 4.2 [3.0, 5.8] |
| 55–64 | 4.6 [3.5, 6.2] |
| 65–74 | 4.1 [2.7, 5.7] |
| 75–96 | 2.4 [1.3, 4.1] |
| Sex | |
| Male | 6.1 [5.2, 7.1] |
| Female | 2.2 [1.6, 2.8] |
| Educational qualifications | |
| Low | 3.4 [2.6, 4.4] |
| Middle | 3.6 [2.8, 4.5] |
| High | 5.3 [2.3, 6.5] |
| Monthly net household income | |
| Low | 1.6 [0.7, 2.9] |
| Middle | 4.1 [3.4, 4.8] |
| High | 5.3 [4.2, 6.7] |
| Region | |
| Rural | 2.4 [1.8, 3.1] |
| Urban | 5.7 [4.8, 6.8] |
| Metropolitan | 4.2 [0.3, 0.6] |
| Alcohol consumption levels (AUDIT-C score) | |
| Low | 2.3 [1.9, 2.8] |
| Medium | 11.8 [9.6, 14.4] |
| High | 33.3 [23.2, 44.7] |

*Abbreviation:* CI: confidence interval. Educational qualifications: Low (junior high school equivalent or no qualification), middle (secondary school equivalent), high (high school equivalent or advanced technical college equivalent); Monthly net household income: Equivalised disposable income according to Organisation for Economic Co-operation and Development (OECD) -modified equivalence scale: low (approximately <20th income percentile), middle (approx. 20th to 80th income percentiles), and high (approx. >80th income percentile), roughly reflecting the distribution of income in the German population. Region: rural (<20 000 inhabitants), urban (20 000–500 000 inhabitants), metropolitan (>500 000 inhabitants).

# Discussion

## Summary of Findings

Among a sample of adults in Germany between June and November 2021, the prevalence of self-reported drink-driving was 4.1 %. Among those who were alcohol users and reported driving a motorised vehicle in the past month, the prevalence of self-reported drink-driving was 5.7 %. In a survey conducted in 2018, among people who drive at least a few days a month, 9 % of respondents from Germany stated that they may have driven when being over the legal limit for drinking and driving in the last 30 days (Goldenbeld et al., 2020). The overall average for Europe was 13 %, with the highest prevalence in Switzerland (22 %) and the lowest in Finland and Hungary (4 %) (Goldenbeld et al., 2020). However, these values are not directly comparable to ours because the study methods differ substantially, for example, the question to measure the outcome was asked differently, the other study was a web-based survey using internet panels and it had a specific focus on road users' attitudes (Goldenbeld et al., 2020).

Prevalence of self-reported drink-driving in this study was higher among men, adults with high educational level, middle or high monthly net income, living in urban areas, and with higher levels of alcohol consumption compared to women, adults with low monthly net income, living in rural areas, and with lower levels of alcohol consumption. Similarly, among those who were alcohol users and reported driving a motorised vehicle in the past month, alcohol consumption level was significantly positively associated with the odds of drink-driving. The relationship was roughly linear, with people drinking at the highest levels being most likely to drive after drinking. This trend has also been reported by other researchers based on data from numerous countries (Webster et al., 2020). Additionally, women had significantly lower odds of drink-driving than men, which is also in line with previous findings (Destatis, 2022; Webster et al., 2020). Further, people living in rural areas were less likely to report drink-driving than those living in urban or metropolitan areas. This is in line with the official statistics about alcohol-related accidents showing that most of them occur in built-up areas in Germany (Destatis, 2022). Interestingly, studies from the UK also found that drink-driving is more common in urban than in rural areas, while research from the US and Australia showed the contrary (Hopkin et al., 2010; Morrison et al., 2002; Webster et al., 2020). Additionally, people with low income had lower odds of drink-driving than people with middle income. Based on the available data, it was unclear whether there was a difference between people with high income compared to those with middle income.



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**Table 4.** Unadjusted and adjusted odds ratios associations between drink driving and different exposures (n = 3,623, weighted)

| Exposure | Unadjusted odds ratio (95 % CI) | Adjusted* odds ratio (95 % CI) |
|---|---|---|
| Age (reference: 18 years) | | |
| 25 years | 0.93 [0.81, 1.07] | 0.95 [0.81, 1.11] |
| 35 years | 0.84 [0.61, 1.16] | 0.89 [0.63, 1.27] |
| 45 years | 0.77 [0.49, 1.20] | 0.86 [0.53, 1.41] |
| 55 years | 0.72 [0.43, 1.18] | 0.86 [0.50, 1.49] |
| 65 years | 0.68 [0.42, 1.11] | 0.90 [0.53, 1.52] |
| 75 years | 0.67 [0.42, 1.06] | 0.97 [0.59, 1.62] |
| Sex (reference: men) | | |
| Women | 0.40 [0.29, 0.54] | 0.63 [0.45, 0.88] |
| Educational qualifications (reference: middle) | | |
| Low | 1.16 [0.80, 1.68] | 1.08 [0.72, 1.63] |
| High | 1.43 [1.03, 1.97] | 1.20 [0.84, 1.71] |
| Monthly net household income (reference: median [value: 1.71] (equivalent to a middle income)) | | |
| Lower quartile [value: 1.33] (equivalent to a low income) | 0.87 [0.77, 0.98] | 0.82 [0.72, 0.94] |
| Upper quartile [value: 2.33] (equivalent to a high income) | 1.12 [1.01, 1.24] | 1.10 [0.98, 1.25] |
| Region (reference: urban) | | |
| Rural | 0.38 [0.27, 0.53] | 0.39 [0.27, 0.56] |
| Metropolitan | 0.87 [0.60, 1.27] | 0.72 [0.48, 1.08] |
| Alcohol consumption levels (reference: AUDIT-C=3) | | |
| AUDIT-C = 1 | 0.21 [0.14, 0.33] | 0.28 [0.18, 0.44] |
| AUDIT-C = 5 | 3.50 [2.85, 4.32] | 3.20 [2.58, 3.96] |
| AUDIT-C = 8 | 14.01 [9.49, 20.70] | 15.53 [10.18, 23.67] |

*Abbreviation:* CI: confidence interval. Educational qualifications: Low (junior high school equivalent or no qualification), middle (secondary school equivalent), high (high school equivalent or advanced technical college equivalent); Monthly net household income: Equivalised disposable income according to Organisation for Economic Co-operation and Development (OECD) -modified equivalence scale: low (approximately <20th income percentile), middle (approx. 20th to 80th income percentiles), and high (approx. >80th income percentile), roughly reflecting the distribution of income in the German population. Region: rural (<20 000 inhabitants), urban (20 000–500 000 inhabitants), metropolitan (>500 000 inhabitants). * Adjustments were made using the most common category or median (unweighted; age: 54 years, sex: men, income: 1.67, education: middle, region: urban, AUDIT-C: 3. All other covariates were used for adjustment).

The odds of drink-driving were particularly uncertain for people on very high incomes because only a small part of the population and respectively only a small number in our sample receive such high incomes.

The results did not show an independent association between age or education and drink-driving. However, potentially, the data were insensitive to detect a true relationship. An indication for the potential insensitivity of the data to detect true relationship between age and drink-driving is that there are small differences between the results of the main and the sensitivity analyses. Overall, if considering the width of the confidence intervals, all results are consistent. However, it is apparent that the graphs showing the relationships between the log odds of drink-driving with age and income levels vary slightly. Other research has shown that while there is a clear association between age and being involved in a drink-driving-related road accident (with young people being more likely to have an accident when drink-driving), it is less clear for age and drink-driving in general (Webster et al., 2020; Wyatt & Novotna, 2021).

The findings from this study may provide some starting points for more in-depth research on the topic which can then lead to the development of targeted interventions to reduce drink-driving rates in Germany. For example, it appears that more people who live in urban areas drive after

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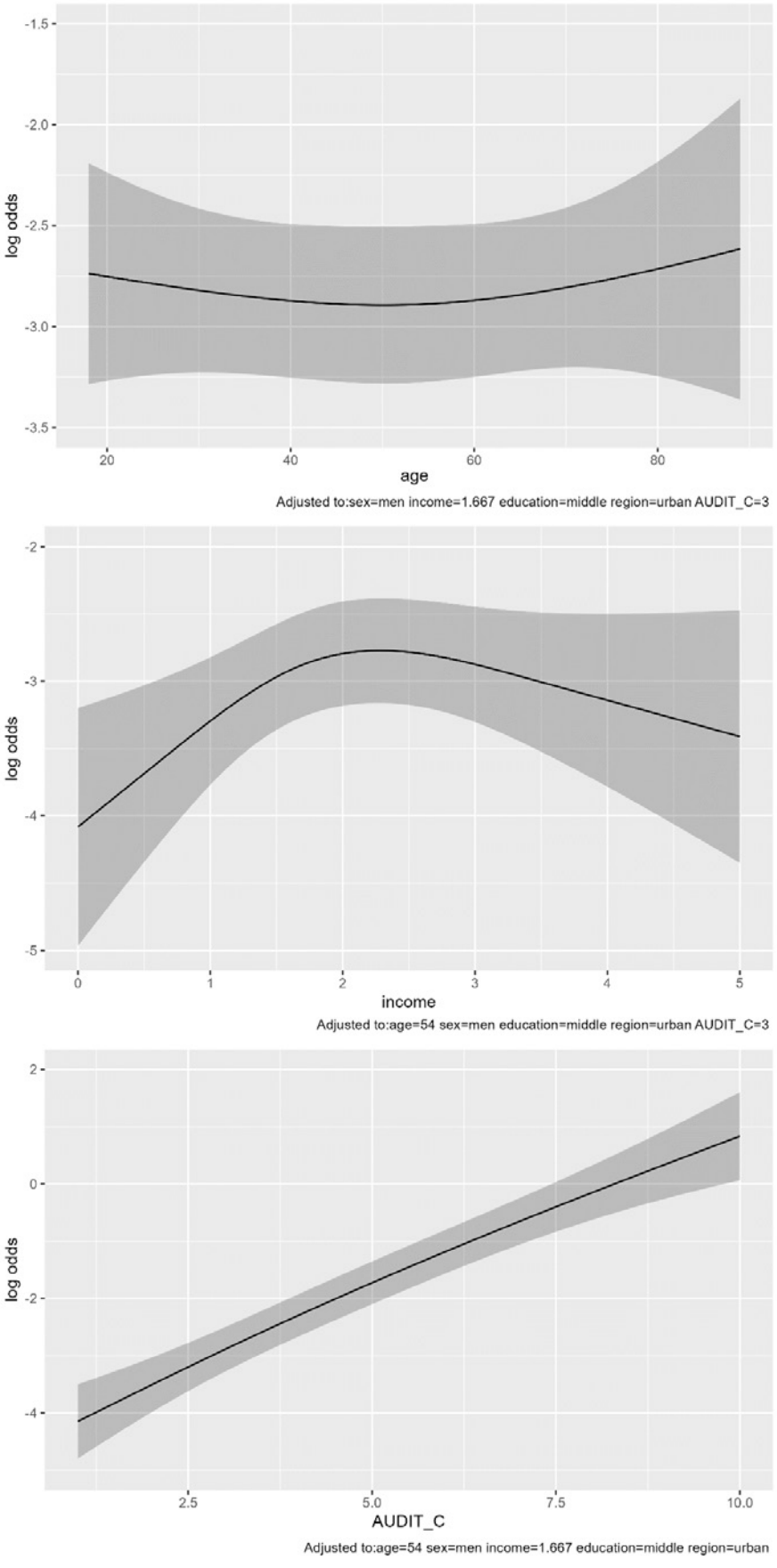


**Figure 1.** Adjusted log odds for drink-driving depending on age (top), income (middle), or AUDIT-C score (bottom), modelled using restricted cubic splines. The shaded areas indicate 95 % Confidence Intervals.



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drinking than those living in rural areas, which is also indirectly reflected in the accident statistics (Destatis, 2022). Qualitative research could explore the reasons for people living in urban areas to drive after drinking, which could help to identify potential intervention starting points. Further studies could also investigate why there might be differences by income. A potential explanation could be that people with high income are less concerned about penalties when getting caught, such as fines and temporary driving bans. If that was the case, the introduction of income-specific penalties could be considered.

### Strengths and Limitations

A key strength of this study is the sampling strategy which aims for a representative sample each month and the presence of a broad range of relevant characteristics that were collected among the general population of adults in Germany. Further, it is the first study of this kind in Germany. However, the study has also a number of limitations. First, missing data are unlikely to be missing at random or completely at random as people might be more likely to not respond to questions of particular salience to them. Second, household surveys asking questions about typical quantities of alcohol consumed can lead to under-estimates (Stockwell et al., 2004), and greater under-reporting of alcohol consumption may be associated with heavy drinking and non-routine drinking patterns (Boniface et al., 2014). Additionally, respondents may be less likely to be honest with reporting of drink-driving given that it is illegal. So, this is likely an under-estimate of the prevalence rates. This is further underpinned by the fact that the study found that higher alcohol levels are associated with high rates of drink-driving and household surveys tend to under-represent those who are from groups who tend to drink more heavily (Rehm et al., 2021).

Third, the methodology of the market research institute conducting the survey, which consists of a hybrid approach of random and quota sampling, does not allow for a calculation of the response rate and therefore we are unable to compare respondents and non-respondents. Fourth, the cross-sectional study design limits our ability to explore causal relationships. Fifth, as the outcome measure was introduced into an existing survey on tobacco and nicotine product use, we were not able to collect other variables of interest, such as use of other (illegal) substances or driving frequency. Sixth, respondents were only asked about drink-driving within the past month, which means the estimates are not directly comparable with 12-month prevalence estimates. The 12-month prevalence may differ from past-month prevalence though the advantage of past-month prevalence may be that it is less prone to recall bias. Generally, the wording of the question could be considered somewhat arbitrary as it asks about the alcohol consumption in a period of one hour prior to driving. For example, if people drank heavily at night, their BAC may still be over the allowed limit for driving the next morning (ADAC Redaktion, 2023). Seventh, during wave 31, an error in the data collection meant that respondents who reported drinking an alcoholic beverage monthly or less (first question of AUDIT-C) were not asked the subsequent two questions, and we therefore excluded them from the analysis. Though, this did not affect the findings of our study as suggested by the sensitivity analysis. Eighth, the sample size might have been too small to detect some true associations between some exposure variables and drink-driving, for example, in relation to age or income.

Ninth, the results could have been impacted by the COVID-19 pandemic, but it is unclear how this effect may have manifested itself. Generally, there were different restrictions put in place by the German Government between March 2020 and 2023, including closing of restaurants, bars, and night clubs (Landeszentrale für politische Bildung Baden-Württemberg, 2023). Such restrictions could mean that people were less likely to drink-drive. However, at the beginning of the data collection in June 2021, the COVID-19 incidence rate was relatively low (Bundesministerium für Gesundheit, 2024), and people got increasingly vaccinated (Bundesministerium für Gesundheit, 2023). Therefore, many restrictions were lifted which may have resulted in people going out more and celebrating. Towards the end of the data collection, some restrictions were put in place again due to rising COVID-19 incidence rates (Bundesministerium für Gesundheit, 2024; Landeszentrale für politische Bildung Baden-Württemberg, 2023). In this context, it is also important to consider that potentially more people chose to drive by car rather than taking public transport or taxis due to risks of infections. Another noteworthy point is that, on a population level, there have been changes in alcohol consumption patterns and increased alcohol-related mortality during the pandemic in Germany (Kilian et al., 2023; Kilian et al., 2022; Kilian et al., 2021). All these points could have had an impact on the study results in one way or another.

## Conclusion

Roughly four in 100 adults in Germany reported drink-driving in the past month, which represents almost three million adults in Germany. This is a public health issue requiring further study and potentially more targeted interventions.

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## Electronic Supplementary Material

The electronic supplementary material (ESM) is available with the online version of the article at https://doi.org/10.1024/0939-5911/a000908.

**ESM 1.** Additional explanations for methods.
**ESM 2.** Missing Values.
**ESM 3.** Sensitivity analysis.
**ESM 4.** Sensitivity analysis: using only data from waves 32 and 33.
**ESM 5.** Sensitivity analysis: unweighted analysis.
**ESM 6.** Graphical display of unadjusted log odds.

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**History**
Manuscript received: March 19, 2024
Manuscript accepted: November 28, 2024

**Declaration of Competing Interests**
Claire Garnett has conducted paid consultancy work for the behaviour change and lifestyle organization, 'One Year No Beer', providing fact checking for blog posts. All other authors declare no conflicts of interest.

**Publication Ethics**
*Study approval statement:* The DEBRA study has received ethical approval the Heinrich-Heine University Düsseldorf (HHU5386R).
*Consent to participate statement:* All participants provided oral informed consent prior to the interview.
*Study registration number:* The DEBRA study is registered on the German Clinical Trials Register (registration numbers DRKS00011322 and DRKS00017157).

**Authorship**
Dimitra Kale and Vera Helen Buss: joint first authors.
Dimitra Kale: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. Vera Helen Buss: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. Claire Garnett: Conceptualization, Writing – review & editing. Sabrina Kastaun: Conceptualization, Writing – review & editing. Daniel Kotz: Conceptualization, Writing – review & editing, Funding acquisition. All authors approved the final manuscript.

**Open Data**
The data that support the findings of this study are available on request from Daniel Kotz.

**Funding**
The DEBRA study was funded from 2016 to 2019 (waves 1–18) by the Ministry of Innovation, Science and Research of the German State of North Rhine-Westphalia (MIWF) in the context of the "NRW Rückkehrprogramm" (the North Rhine-Westphalian postdoc return program). Since 2019 (wave 19 onwards), the study has been funded by the German Federal Ministry of Health. Dimitra Kale receives salary support from Cancer Research UK (PRCRPG-Nov21\100002). Vera Helen Buss receives salary support from the UK Prevention Research Partnership (MR/S037519/1), which is funded by the British Heart Foundation, Cancer Research UK, Chief Scientist Office of the Scottish Government Health and Social Care Directorates, Engineering and Physical Sciences Research Council, Economic and Social Research Council, Health and Social Care Research and Development Division (Welsh Government), Medical Research Council, National Institute for Health Research, Natural Environment Research Council, Public Health Agency (Northern Ireland), The Health Foundation and Wellcome. Claire Garnett has received salary support from Cancer Research UK (PRCRPG-Nov21\100002) and National Institute of Health and Care Research (NIHR127651), and currently receives salary support from NIHR (NIHR302923). Sabrina Kastaun currently receives salary support from German Ministry of Education and Research (BMBF; 01GY2103).
Funders had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript; and decision to submit the manuscript for publication. For the purpose of Open Access, the author has applied a CC BY public copyright licence to any Author Accepted Manuscript version arising from this submission.
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