

## The choice of indicators influences conclusions about the educational gradient of sex-specific alcohol consumption

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Veröffentlichungsversion / Published Version

Arbeitspapier / working paper

### Empfohlene Zitierung / Suggested Citation:

Schulz, F., Wolstein, J., & Engelhardt, H. (2019). *The choice of indicators influences conclusions about the educational gradient of sex-specific alcohol consumption*. (Discussion Papers / Universität Bamberg, Professur für Demografie, 21). Bamberg: Universität Bamberg, Fak. Sozial- und Wirtschaftswissenschaften, Professur für Demografie. <https://nbn-resolving.org/urn:nbn:de:0168-ssoar-63299-2>

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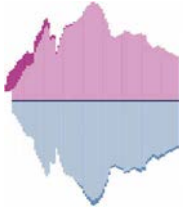
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Professur für Demografie  
Professorship of Demography

University of Bamberg Demographic  
Discussion Papers

No. 21/2019

## **The choice of indicators influences conclusions about the educational gradient of sex-specific alcohol consumption**

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# **THE CHOICE OF INDICATORS INFLUENCES CONCLUSIONS ABOUT THE EDUCATIONAL GRADIENT OF SEX-SPECIFIC ALCOHOL CONSUMPTION**

Florian Schulz, Jörg Wolstein, & Henriette Engelhardt

June 2019

## **ABSTRACT**

There has been considerable public interest in reports on harmful alcohol consumption of higher educated females. This study assesses the robustness of this finding with representative German data using ten different indicators of alcohol consumption. This cross-sectional study used data of the Epidemiological Survey on Substance Abuse from 2012. 4,225 females and 3,239 males represent the German population aged 18–64. It presents ten indicators of alcohol consumption by sex and education and provides group specific means and 95 %-confidence intervals. The main results are: (1) Higher educated males and females are drinking alcohol more frequently than lower educated males and females. (2) When drinking, higher educated males and females tend to drink less alcohol than lower educated males and females. (3) Only when using an indicator for hazardous alcohol consumption with different thresholds for males and females, the results indicate a pattern that significantly exposes hazardous alcohol consumption in the group of higher educated females. Concerning the choice of indicators, this study shows that sex-specific threshold-based indicators of alcohol consumption may lead to different conclusions as the majority of other indicators.

## **KEY WORDS**

Alcohol | sex | education | indicators | hazardous drinking

## INTRODUCTION

There has been considerable public interest (e.g. The Guardian 2015) in the findings of the OECD (2015) report on “Tackling Harmful Alcohol Use” regarding harmful alcohol consumption of higher educated females. According to the report, the effect of education on hazardous alcohol consumption is much more pronounced in females than in males. In the scientific literature, by and large, social gradients of alcohol consumption differ for males and females and by educational levels (e.g. Bloomfield et al., 2006; Droomers, Schrijvers, and Mackenbach, 2004; Huckle, You, and Casswell, 2010; Pabst, Kraus, Gomes de Matos, and Piontek, 2013; van Oers et al., 1999). However, there is mixed evidence regarding the direction of the effects and the effect sizes.

For example, van Oers et al. (1999) and Droomers et al. (1999) reported no significant associations between education and excessive drinking behavior of females but a significantly higher prevalence of this pattern for lower educated males. However, Huckle et al. (2010) reported significant relations between females’ and males’ frequency of drinking and typical occasion quantities, stating that both females and males with higher education drink significantly less alcohol per occasion but also have a significantly higher frequency of drinking alcohol.

The OECD report (2015) defined hazardous alcohol consumption as exceeding a sex-specific threshold of 21 units of alcohol or more for males, or 14 or more for females. However, many studies used other criteria for hazardous alcohol consumption, e.g. using consumption measures without defining thresholds or with thresholds that were not sex-specific. In our study, we therefore use various definitions of the hazardous use of alcohol to assess the sex-specific effect of education on alcohol consumption in a representative German sample of males and females.

We contribute to this debate by estimating the prevalence of alcohol consumption with ten different indicators by sex and education using current representative data for Germany, testing the “robustness” of the results over these different consumption indicators.

## **METHODS**

### *Data and sample*

We used data from the Epidemiological Survey on Substance Abuse (ESA) of 2012, which is a nationally representative German sample on substance consumption, substance-related problems and their consequences (Kraus et al., 2013; Pabst et al., 2013; Steppan, Piontek, & Kraus, 2014). The survey includes 9,081 respondents between 18 and 64 years of age. After dropping cases with missing information for sex, education or with non-German nationality (to reduce cultural heterogeneity), 7,464 respondents remain for the analyses. We applied the probability-weights provided in the data to uphold representativeness of the German population.

### *Measures of alcohol consumption*

In ESA, alcohol consumption is measured with a quantity-frequency-approach (Gmel & Rehm, 2004). The respondents reported the number of drinking days within the last 30 days before the interview and the average units of beer, wine, liquor or other alcoholic beverages on each day they were drinking the respective beverage. Using beverage-specific alcoholic strengths per beverage (Kraus et al., 2014), the total amount of pure ethanol per month per respondent was calculated.

From this frequency and quantity information, we calculated ten indicators of alcohol consumption. frequency indicators (indicators 1-3), quantity and quantity-frequency indicators (indicators 4-7), and indicators that are based on the assumption of physiological differences between females and males (8-10). Table 1 summarizes the operationalization,

indicates which indicators are based on thresholds and sex-specific assumptions, and shows descriptive statistics of each indicator.

--- Table 1 ---

The single indicators of alcohol consumption are: (1) *abstinence* during the last 30 days before the interview, as reported by the respondents in the questionnaire; (2) *number of drinking days* during the last 30 days before the interview, as reported by the respondents; (3) *number of days with five or more glasses of alcohol* (“binge drinking”) within the last 30 days, as reported by the respondents; (4) calculated *average amount of pure ethanol per day* as total amount of pure ethanol during the last 30 days divided by 30 (one respondent with more than 1,000 grams was dropped); (5) calculated *average amount of pure ethanol per drinking day* as total amount of pure ethanol during the last 30 days divided by the number of drinking days; (6) calculated *weight adjusted pure ethanol per day* as the total amount of pure ethanol per day divided by the respondents’ body weight in kilograms; (7) calculated *weight adjusted pure ethanol per drinking day* as the total amount of pure ethanol per month divided by the respondents’ body weight in kilograms and the number of drinking days; (8) calculated *blood alcohol content per drinking day* using Widmark’s formula (1932) with ‘Widmark factors’ of 0.7 for males and 0.6 for females on the basis of the self-reported number of drinking days; *risky drinking behavior*, (9) if males and females consumed more than 24 or 12 grams of pure ethanol on average per day, respectively (guideline for low-risk drinking in Germany; Burger et al., 2004 – for comparison: roughly 0.6 liters of beer or 0.25 liters of wine contain 24g of ethanol), calculated from the total amount of pure ethanol per month, and (10) if males and females consumed more than 16 grams of pure ethanol on average per day (Department of Health, 2016).

### *Stratification variables*

All estimates of alcohol consumption were stratified by respondents' sex, educational level, age and squared age. All are measured as reported by the respondents in the questionnaire. Highest attained educational level is based on the updated CASMIN classification (Brauns, Scherer, & Steinmann, 2003), which has proven to capture the educational gradient in different domains of everyday life, discerning three categories: tertiary qualification (labeled "high"), intermediate or maturity qualification (labeled "medium"), and qualification below the intermediate level (labeled "low"). Table 2 shows case numbers and descriptives of the stratification variables, separately for males and females.

--- Table 2 ---

### *Analyses*

We calculated the predicted prevalence of each of the ten drinking patterns by sex and education, as it is common in alcohol research (van Oers et al., 1999; Blomfield et al., 2006). In Figures 1-3, we presented group specific means and 95%-confidence intervals for each combination of sex and education.

The predicted probabilities, frequencies, or quantities were derived as margins at the means (Williams, 2012) from the appropriate regression models in Tables A1, A2. The predictions were adjusted by setting all independent variables to the sample means. We estimated separate models for females and males. We used binary logistic regression models to predict the probabilities of abstinence (indicator 1), and the two versions of risky daily consumption (indicators 8, 9). We used negative binomial regression models to predict the frequencies of drinking days (indicator 2) and binge drinking days (indicator 3). We used linear regression models to predict the quantities of alcohol consumption (indicators 4, 5, 6, 7, 10). For all analyses of drinking frequency or quantity, we excluded abstainers. This is

common in the literature on drinking patterns, as the explanation of being abstinent has been found to be different from the explanation of different levels of drinking (Kuntsche et al., 2012).

We ran several sensitivity analyses to ensure the robustness of our results using different modeling approaches, control variables and samples restrictions. Most notably, we included abstainers in the models of drinking frequency and quantity. None of the sensitivity analyses showed substantially different results.

## **RESULTS**

Figure 1 shows higher abstinence rates for females than for males in all three educational groups as well as higher abstinence rates for lower than for medium than for higher educated females and males. Males' average number of drinking days within the last 30 days before the survey are significantly higher than females' in all educational groups. For both females and males, lower and medium educational levels are not significantly different from each other. For males, the number of drinking days is significantly higher for the higher educated than for the medium educated; higher educated females have a significantly higher drinking frequency than both medium and lower educated females. Lower and medium educated males have, on average, the highest number of days on which they drink five or more glasses of alcoholic beverages. Within all three groups of education, males' average is significantly higher than females'. For both males and females, there is a significant difference only between medium and higher education.

--- Figure 1 ---

Figure 2 shows that the total calculated amount of pure ethanol per day and per drinking day is higher for male than for female respondents. There are no significant differences between



educational groups for females and males regarding ethanol consumption per day. Highly educated females, however, record the least calculated ethanol per drinking day compared to lower or medium educated females; the same association with education is found within the group of males. In all three educational groups, males record significantly higher amounts of pure ethanol per kilogram of body weight than females. For males, there are significant differences between the medium and the higher educated groups, for females between the lower and higher educated groups for ethanol in grams per kilogram body weight per day. The differences between males' and females' levels of weight-adjusted ethanol disappear if analyzed for drinking days. Again, the associations within the two sex-groups are identical as higher educated significantly differ from lower and medium educated males as well as females.

--- Figure 2 ---

Figure 3 shows the average calculated blood alcohol content of females and males per drinking event: higher educated females have a significantly higher average than higher educated males. Again, the differences regarding education are the same within all males and females: higher educated have significantly lower averages of blood alcohol content than both lower and medium educated.

--- Figure 3 ---

Risky alcohol consumption – applying version (a) with thresholds of 24 g for males and 12 g for females – is more prevalent for higher educated females than for higher educated males as well as for all other combinations of sex and education. This is the only striking exception from the previous indicators as females show a clearly different pattern than males. Changing the thresholds of risky drinking behavior to version (b)'s 16 g for both males and females changes the picture completely as, first, the prevalence for higher educated females

clearly decreases and, second, the prevalence of higher educated females is no longer significantly differs from lower educated females but still slightly differs from females with medium education.

## **DISCUSSION**

Using a nationally representative sample of 7,464 German females and males, we presented a comparison of ten different indicators to measure alcohol consumption depending on sex and education. Nine out of ten indicators showed rather robust results regarding the education gradient of alcohol consumption for males and females. On the whole, we showed that higher educated males and females are drinking alcohol more frequently than lower educated males and females. When drinking, higher educated males and females tend to drink less alcohol or at least do not consume significantly different amounts of alcohol than lower educated males and females. . Only when using an indicator for hazardous alcohol consumption with different thresholds for males and females, our results indicated a pattern that significantly exposed hazardous alcohol consumption in the group of higher educated females, as did the OECD (2015) report.

The definition of thresholds for low-risk drinking is part of a long tradition in drinking guidelines. These guidelines have been established as a prevention tool in many countries (overview in House of Commons Science and Technology Committee, 2012) but the definition of limits varies largely (Harding & Stockley, 2007, Furtwaengler & de Visser, 2013) and often lacks clear scientific evidence (Rehm & Patra, 2012). Moreover, there is no consent, whether different limits of alcohol consumption should be recommended for males and females. Traditionally, lower limits of alcohol consumption were recommended for females than for males (e.g. 12 g/day for females and 24 g/day for males in Germany; Burger et al. 2004, Gomes de Matos et al., 2016), and this still shows in many national guidelines (House of Commons Science and Technology Committee, 2012). However, a rising number

of guidelines now recommend the same limits for both females and males (Department of Health 2016, Room & Rehm, 2012). Although they are meant as an educational prevention measure, the impact of such guidelines on drinking behavior is unclear (WHO 2007). Moreover, drinking guidelines were perceived as having little relevance and were generally disregarded by lay people (Lovatt et al., 2015). However, they have been used to define thresholds of hazardous drinking and thus identify persons at risk in epidemiological studies. In these cases, one may assume that results may vary remarkably, especially if sex-effects are at question, depending on which guideline is used.

In our study we showed that by using a different threshold for the definition of hazardous alcohol use (12 g/day for females, 24 g/day for males, Burger et al. 2004, Gomes de Matos et al., 2016), highly educated females not only showed higher risks attributable to alcohol as compared to males, but also as compared to females with medium or low education. In contrast, when defining the threshold equally at 16 grams per day for males and females, as was done in the current guidelines of the UK Department of Health (2016), females showed generally less problematic alcohol use than males, and there was no significant difference between low and medium as well as low and high educated females.

Two possible limitations of the empirical design have to be considered: first, all estimates are based on self-reported measures of alcohol consumption which may be prone to measurement bias (Devaux & Sassi 2015). Second, our analyses are based on one single but nationally representative survey of German females and males aged 18–64 years. As for all studies of this kind, replications with other surveys have to contest our results.

We conclude from our study, first, that the education gradient of sex-specific alcohol consumption is not as large as shown in OECD (2015). Second, only when using the sex-specific threshold-indicator to flag risky drinking behavior, we were able to replicate the finding in OECD (2015) that high educated women are a high-risk group. Third, if there are differences between varying educational levels, these differences are rather related to

consumption patterns, i.e. the higher educated are drinking more frequently but consume lower quantities.

Concerning measurement and the choice of indicators, we conclude that it is not advisable to apply sex-specific threshold-based indicators as sole indicators of alcohol consumption. If sex-specific threshold-based indicators are of particular importance for whatever reason, we recommend embedding them in several other indicators as the majority of other indicators tell a different or much less pronounced story.

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**Table 1.** Summary of the 10 indicators, and descriptives by respondents' sex

Indicator	Operationalization	Threshold?	Sex-specific?	Females	Males	
<i>Frequency indicators</i>						
1	Abstinence	Reported no alcohol consumption within last 30 days	No	No	.28	.18
2	Drinking days	Reported number of drinking days within the last 30 days	No	No	6.56 (6.51)	9.67 (8.17)
3	Binge drinking days	Reported number of days with 5 or more glasses of alcohol within the last 30 days	No	No	0.72 (2.12)	2.12 (4.20)
<i>Quantity-frequency indicators</i>						
4	Ethanol per day	$\frac{\text{Consumed ethanol in grams during last 30 days}}{30}$	No	No	8.76 (15.17)	16.88 (29.51)
5	Ethanol per drinking day	$\frac{\text{Consumed ethanol in grams during last 30 days}}{\text{Number of drinking days within last 30 days}}$	No	No	41.27 (39.64)	56.07 (108.00)
6	Ethanol per body weight per day	$\frac{\text{Consumed ethanol in grams during last 30 days}}{30 * \text{body weight in kg}}$	No	No	0.13 (0.23)	0.21 (0.37)
7	Ethanol per body weight per drinking day	$\frac{\text{Consumed ethanol in grams during last 30 days}}{\text{Number of drinking days within last 30 days} * \text{body weight in kg}}$	No	No	0.63 (0.61)	0.69 (1.48)
<i>Indicators based on physiological differences</i>						
8	Blood alcohol content per drinking day	Males: $\frac{\text{Consumed ethanol in grams per drinking day}}{\text{Body weight in kg} * 0.7}$ Females: $\frac{\text{Consumed ethanol in grams per drinking day}}{\text{Body weight in kg} * 0.6}$	No	Yes	0.10 (0.10)	0.10 (0.21)
9	Risky daily consumption ("24/12")	Males: given if average ethanol consumption exceeds 24 grams of ethanol per day Females: given if average consumption exceeds 12 grams of ethanol per day	Yes	Yes	.21	.20
10	Risky daily consumption ("16/16")	Given if average consumption exceeds 16 grams of ethanol per day	Yes	No	.14	.32

*Note:* Own compilation. Means/percentages and standard deviations (in parentheses). Epidemiological Survey on Substance Abuse 2012.

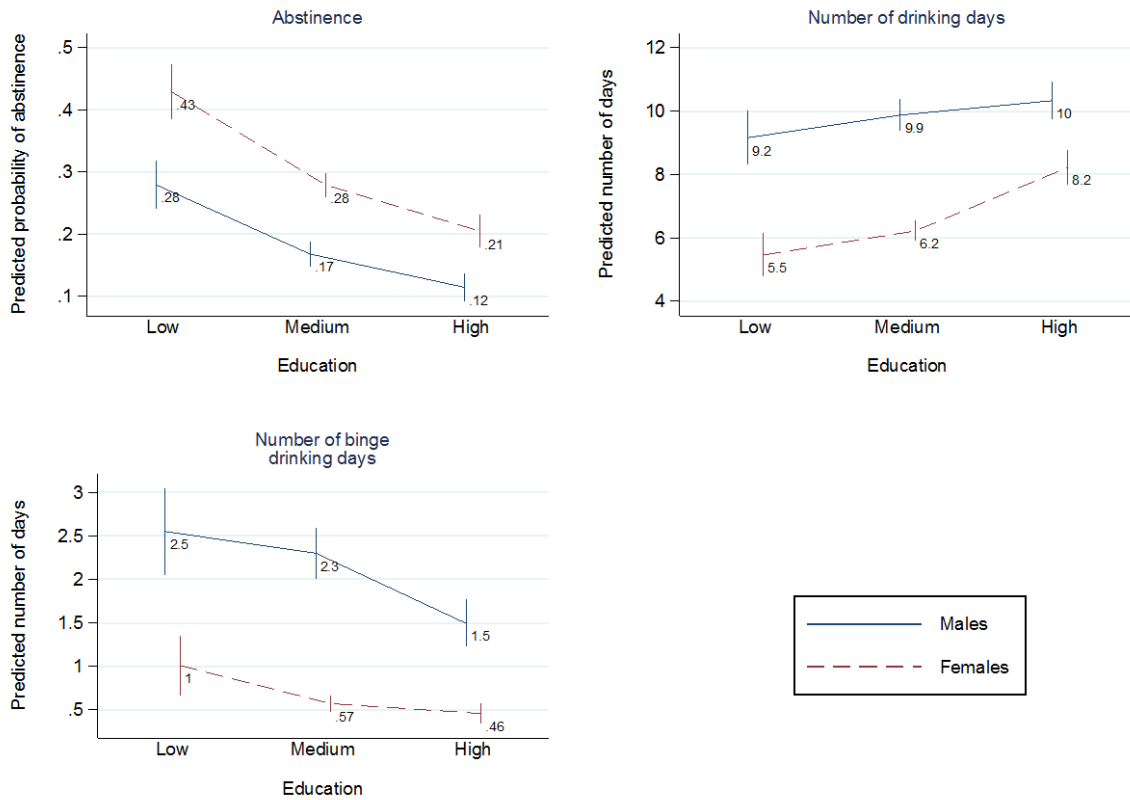


**Table 2.** Sample descriptives by respondents' sex

	Females	Males	Total
Education			
Low	.14	.20	.17
Medium	.63	.55	.59
High	.23	.25	.24
Age	40.1 (14.3)	40.3 (15.0)	40.2 (14.6)
Age squared / 100	18.1 (11.7)	18.5 (12.2)	18.3 (11.9)
Number of observations	4,225	3,239	7,464

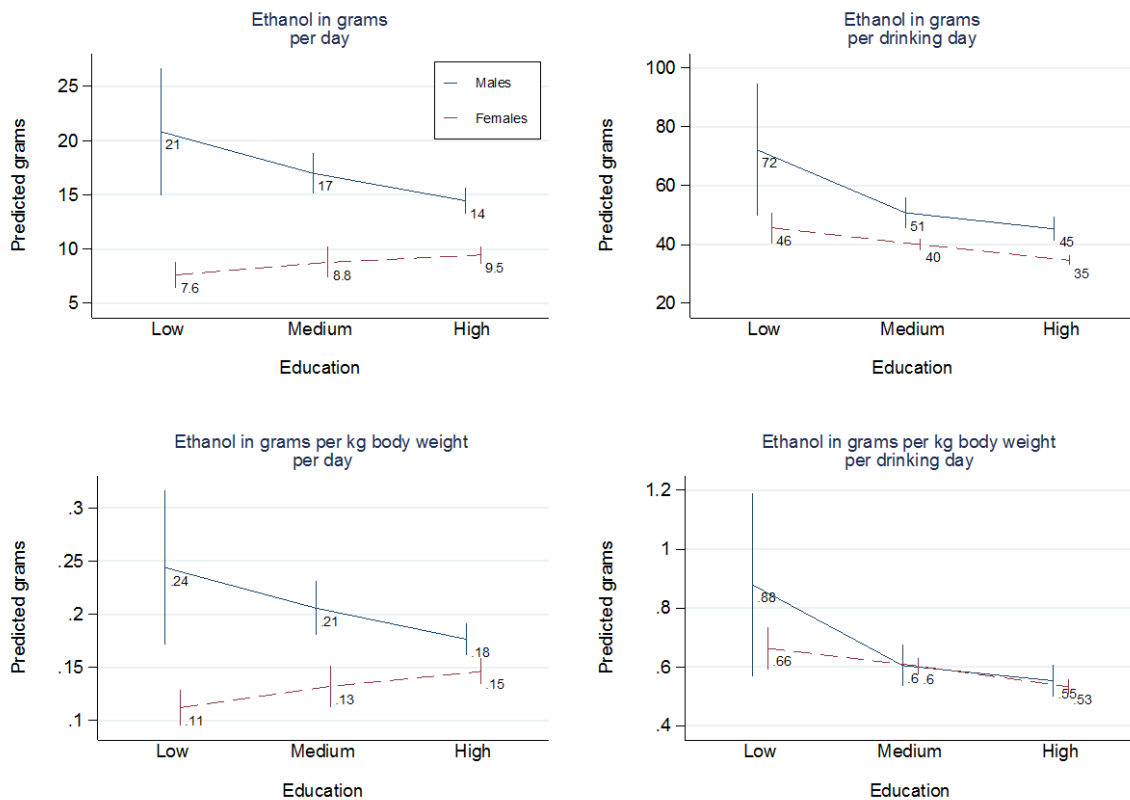
*Note:* Case numbers, percent (education), means (age, age squared), standard deviations in parentheses. Epidemiological Survey on Substance Abuse 2012; not weighted.

**Figure 1.** Frequency indicators of alcohol consumption: predicted prevalence of abstinence, number of drinking days and number of binge drinking days by sex and education, 95% CI



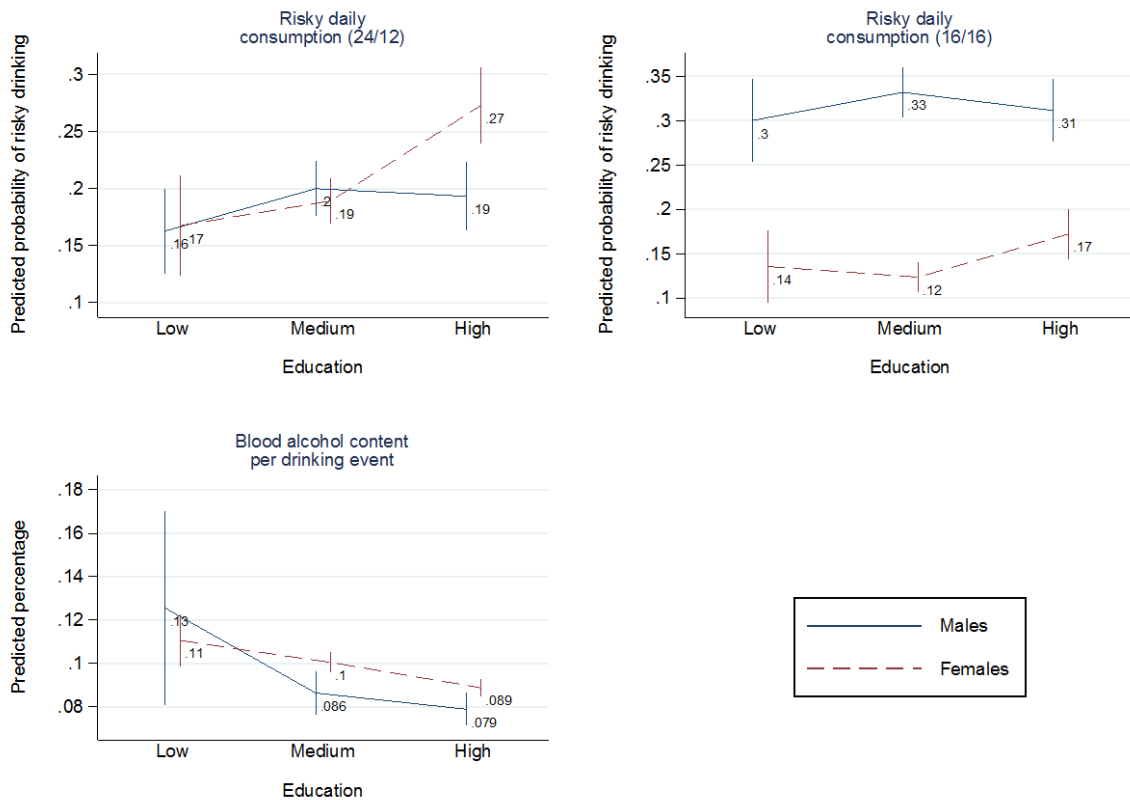
*Note:* Different scales to better illustrate the differences. All estimates are based on respondents' self-reported alcohol consumption during the last 30 days before the interview. Binge drinking days: 5+ glasses of alcohol. Predictions are based on the regression models in Table A1 (females) and A2 (males). *Source:* Epidemiological Survey on Substance Abuse 2012; weighted results.

**Figure 2.** Quantity and quantity-frequency indicators of alcohol consumption: predicted prevalence of (weight-adjusted) alcohol consumption sex and education, 95% CI



*Note:* Different scales to better illustrate the differences. All estimates are based on respondents' self-reported alcohol consumption during the last 30 days before the interview. Predictions are based on the regression models in Table A1 (females) and A2 (males). *Source:* Epidemiological Survey on Substance Abuse 2012; weighted results.

**Figure 3.** Indicators of alcohol consumption that are based on the assumption of physiological differences between females and males: predicted prevalence of blood alcohol content and risky drinking behavior by sex and education, 95% CI



*Note:* Different scales to better illustrate the differences. All estimates are based on respondents' self-reported alcohol consumption during the last 30 days before the interview. Predictions are based on the regression models in Table A1 (females) and A2 (males). *Source:* Epidemiological Survey on Substance Abuse 2012; weighted results.

## Appendix

**Table A1.** Regression models for each indicator of alcohol consumption for females

	(1) Abstinence	(2) Drinking days	(3) Binge days	(4) Ethanol per day	(5) Ethanol per drinking day	(6) Ethanol per day (weight adjusted)	(7) Ethanol per drinking day (weight adjusted)	(8) Risky consumption (24/12)	(9) Risky consumption (16/16)	(10) Blood alcohol content
	logit	nbreg	nbreg	ols	ols	ols	ols	logit	logit	ols
Education										
Medium	-0.66*** (0.11)	0.13+ (0.07)	-0.57** (0.20)	1.16 (0.98)	-5.74+ (2.98)	0.02 (0.01)	-0.06 (0.04)	0.15 (0.17)	-0.11 (0.20)	-0.01 (0.01)
High	-1.07*** (0.13)	0.41*** (0.07)	-0.79*** (0.22)	1.84* (0.74)	-11.06*** (2.81)	0.03** (0.01)	-0.13*** (0.04)	0.62*** (0.19)	0.28 (0.21)	-0.02*** (0.01)
Age	0.01 (0.02)	0.01 (0.01)	-0.14*** (0.04)	-0.20 (0.19)	-2.15*** (0.42)	-0.00+ (0.00)	-0.04*** (0.01)	-0.05+ (0.03)	-0.06+ (0.03)	-0.01*** (0.00)
Age <sup>2</sup> / 100	-0.02 (0.03)	0.00 (0.01)	0.14** (0.05)	0.24 (0.21)	2.04*** (0.50)	0.01+ (0.00)	0.04*** (0.01)	0.06+ (0.03)	0.07+ (0.04)	0.01*** (0.00)
Intercept	-0.43 (0.37)	1.20*** (0.21)	3.18*** (0.61)	11.27** (3.92)	97.01*** (9.21)	0.21*** (0.05)	1.63*** (0.13)	-0.76 (0.48)	-0.76 (0.57)	0.27*** (0.02)
Pseudo R <sup>2</sup>	0.023	0.010	0.013					0.009	0.005	
R <sup>2</sup>				0.002	0.039	0.003	0.051			0.051
N	4213	3016	3020	2995	2976	2954	2935	3041	3041	2935

*Notes:* Regression models: logit = binary logistic regression; nbreg = negative binomial regression; ols = ordinary least squares regression.

Unstandardized regression coefficients, standard errors in parentheses. Reference category for education: low education. Predictions in Figures 1, 2, and 3 are based on these 10 models. Significance levels: + .1, \* .05, \*\* .01, \*\*\* .001. *Source:* Epidemiological Survey on Substance Abuse 2012; weighted results.

**Table A2.** Regression models for each indicator of alcohol consumption for males

	(1) Abstinence	(2) Drinking days	(3) Binge days	(4) Ethanol per day	(5) Ethanol per drinking day	(6) Ethanol per day (weight adjusted)	(7) Ethanol per drinking day (weight adjusted)	(8) Risky consumption (24/12)	(9) Risky consumption (16/16)	(10) Blood alcohol content
	logit	nbreg	nbreg	ols	ols	ols	ols	logit	logit	ols
Education										
Medium	-0.65*** (0.13)	0.08 (0.06)	-0.10 (0.12)	-3.83 (3.40)	-21.44 (13.56)	-0.04 (0.04)	-0.27 (0.19)	0.25 (0.16)	0.15 (0.13)	-0.04 (0.03)
High	-1.09*** (0.15)	0.12* (0.05)	-0.53*** (0.14)	-6.35* (2.93)	-26.94** (10.37)	-0.07+ (0.04)	-0.33* (0.14)	0.21 (0.17)	0.05 (0.14)	-0.05* (0.02)
Age	0.01 (0.03)	0.03** (0.01)	-0.01 (0.02)	-0.16 (0.42)	-3.79+ (1.94)	-0.00 (0.01)	-0.06* (0.03)	-0.04 (0.03)	-0.02 (0.02)	-0.01* (0.00)
Age <sup>2</sup> / 100	-0.01 (0.03)	-0.02 (0.01)	0.01 (0.03)	0.14 (0.43)	3.17+ (1.84)	0.00 (0.01)	0.05* (0.03)	0.06+ (0.04)	0.03 (0.03)	0.01* (0.00)
Intercept	-1.17* (0.53)	1.36*** (0.21)	1.17** (0.42)	24.87* (11.16)	170.47** (57.01)	0.35* (0.14)	2.41** (0.80)	-1.12* (0.55)	-0.69 (0.46)	0.34** (0.11)
Pseudo R <sup>2</sup>	0.028	0.007	0.003					0.005	0.002	
R <sup>2</sup>				0.004	0.017	0.004	0.018			0.018
N	3236	2632	2642	2630	2612	2595	2577	2659	2659	2577

*Notes:* Regression models: logit = binary logistic regression; nbreg = negative binomial regression; ols = ordinary least squares regression.

Unstandardized regression coefficients, standard errors in parentheses. Reference category for education: low education. Predictions in Figures 1, 2, and 3 are based on these 10 models. Significance levels: + .1, \* .05, \*\* .01, \*\*\* .001. *Source:* Epidemiological Survey on Substance Abuse 2012; weighted results.