

# Changes in alcohol consumption and beverage preference among adolescents after the introduction of the alcopops tax in Germany

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## ABSTRACT

**Aims** The aim of this study is to assess the contribution of the alcopops tax to changes in alcohol consumption and beverage preference among adolescents in Germany. We hypothesize that the decrease of alcohol intake by alcopops is substituted by an increase of alcohol intake by other alcoholic beverages. **Design** Data came from the German 2003 ( $n = 10\,551$ ) and 2007 ( $n = 10\,598$ ) cross-sectional study of the European School Survey Project on Alcohol and other Drugs (ESPAD). **Participants** A propensity score-matched subsample of 9<sup>th</sup> and 10<sup>th</sup> graders ( $n = 4694$ ) was used for the analyses. **Measurement** Alcohol consumption within the last 7 days was assessed by a beverage-specific quantity–frequency index. An individual's beverage preference was assigned for the beverage that had the highest share in total alcohol consumption. Multiple regression analyses were used to assess changes in alcohol consumption; changes in beverage preference were tested using multinomial logistic regression. **Findings** While alcopop consumption declined after the alcopops tax was implemented, consumption of spirits increased. Changes in beverage preference revealed a decrease in alcopop preference and an increase in the preference for beer and spirits. **Conclusions** Results indicate a partial substitution of alcopops by spirits and a switch in preference to beverages associated with riskier drinking patterns. Effective alcohol policies to prevent alcohol-related problems should focus upon the reduction of total alcohol consumption instead of regulating singular beverages.

**Keywords** Adolescents, alcohol, alcopops, beverage preference, epidemiology, policy, price, tax.

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## INTRODUCTION

Alcopops are sweet, ready-mixed soft drinks containing between 5% and 7% alcohol by volume [1]. After the introduction of alcopops in the late 1990s, concerns regarding their seductive power in underage drinkers were raised. It has been argued that the sweet taste of alcopops masked their alcohol content and seduced adolescents, especially girls, to initiate earlier onset of alcohol consumption and to increase volume of drinking [2–4] and frequency of binge drinking [5,6]. To meet these concerns, several countries (e.g. France, Switzerland, Germany and Australia) imposed an extra tax on alcopops. In Germany, the tax was justified by a strong increase of alcopop use in adolescents in the preceding years and was thus intended explicitly to influence

alcohol consumption of under 18-year-olds [7]. After the introduction of the tax in July 2004 [8], retail prices nearly doubled.

There is conclusive evidence for the effectiveness of tax increases as a means for reducing alcohol consumption and alcohol-related negative health effects such as liver cirrhosis (e.g. [9,10]). The reason for the effectiveness of taxes is that alcohol consumption is price-elastic, i.e. consumers change their alcohol consumption according to changes in retail prices. Alcohol consumption is more price-elastic among younger populations than older populations, due probably to limited financial resources [11–13]. Accordingly, after the introduction of the alcopops tax in Germany, the prevalence of alcopop consumption declined from 28.4% in 2004 to 15.6% in 2005 among 12–17-year-olds [14]. Individual data from

Switzerland and sales data from Germany and Australia also suggest a substantial decline in the consumption of alcopops among adolescents after the tax was imposed [15–17]. Whether reducing alcopop consumption will lead ultimately to the intended prevention of harmful drinking patterns is questionable. Studies investigating the association between alcopop consumption and drinking patterns or alcohol-related problems reveal only scarce evidence for an alcopop-specific negative effect among adolescents [1,18]. For example, Wicki *et al.* [1] did not find these associations to be specific to alcopops, but reported a clear link between quantity of alcohol consumption and drinking patterns and problems. Accordingly, in order to gain preventive effects it appears more important to consider total alcohol consumption.

Moreover, the effectiveness of the alcopops tax in reducing total alcohol consumption may be mitigated by beverage substitution. As all alcoholic beverages contain ethanol they might be used as a substitute for each other, leaving total alcohol consumption unchanged. Research on cross-price elasticity, i.e. effects of changes in the price of one beverage upon the demand of other beverages, is not conclusive. Although most studies indicate weak and insignificant substitution effects [19,20], there is also evidence for substantial replacement [21]. Country-specific data from Germany also suggest an existing (although not complete) substitution. Total alcohol consumption decreased slightly, but consumption of beer and mixed beverages on the basis of beer and wine increased [14,17].

While the examination of protective effects is one aspect of the evaluation of the alcopops tax, consideration of negative side effects is another. A tax addressing a specific alcoholic beverage bears the risk that people switch to beverage types associated with riskier drinking patterns and a higher risk for alcohol-related problems. There is evidence that a preference for beer or spirits is associated with higher alcohol intake, higher frequency of binge drinking [22,23], higher delinquency and more alcohol use disorders [24–26]. In contrast, preference for wine seems to be associated with moderate alcohol consumption (e.g. [24]). For alcopops, the few existing studies also indicate a less detrimental drinking pattern [22,27]. In sum, whether beverage substitution will lead to riskier drinking patterns or not depends upon the kind of beverage with which alcopops will be replaced.

The aim of this study is to assess the contribution of the alcopops tax to changes in alcohol consumption and beverage preference among adolescents in Germany using cross-sectional data. We hypothesize (i) a substitution of alcopops by other alcoholic beverages and (ii) a switch to the preference of beverages associated with riskier drinking patterns. Because alcopops are said to

be especially popular in girls, gender effects will also be examined.

## METHODS

### Study design and sample

Data came from the cross-sectional European School Survey Project on Alcohol and other Drugs (ESPAD), which is conducted every fourth year. Germany participated with six of 16 federal states (Bavaria, Berlin, Brandenburg, Hesse, Mecklenburg-Western Pomerania and Thuringia) in 2003 and with seven states (former states plus Saarland) in 2007. The target population consisted of students attending regular schools in grades 9 and 10. The sample was drawn with classes as sampling units proportional to level of education: Hauptschulen (low level of education), Realschulen (intermediate level), Gymnasien (high level) and Gesamtschulen (intermediate and high level). Data collection in each survey year took place in April. Overall class response rates were 86.9% in 2003 and 88.9% in 2007. Within the selected classes, student response rates were 83.0% in 2003 and 80.6% in 2007. Data were weighted to reflect a representative sample of 9th and 10th graders.

All students had been given informed consent to the study and scientific use of the data by their parents and had been informed that participation was voluntary. Within single classes, completed questionnaires were collected in anonymous envelopes that were sealed in front of the class. General information on reliability and validity of the ESPAD core questionnaire has been reported elsewhere [28,29]. The specific measures of alcohol consumption used in this analysis were not part of the international questionnaire.

The original national data sets contained information on 11 122 students in 2003 and 12 568 in 2007. Records with missing values on year of birth, gender and alcohol consumption within the last 7 days as well as records with more than 50% of data missing, selection of the most extreme answers (40 times or more often) for at least seven of the 13 questions on illicit substance use and implausible answers regarding alcohol and drug use were excluded [30]. To assure comparability, only data from six overlapping federal states were considered. Thus, our samples consisted of 10 551 students in 2003 and 10 598 students in 2007. There were significantly ( $\chi^2 = 89.4$ ;  $df = 1$ ;  $P < 0.001$ ) fewer 7-day abstainers in 2007 [ $n = 3935$  (37.2%)] than in 2003 [ $n = 4730$  (43.6%)]. Because we used beverage preference as an outcome, all statistical analyses were restricted to students who had consumed alcohol within the last 7 days and could therefore be assigned a preference, i.e. 5821 (55.2%) in 2003 and 6663 (62.9%) in 2007.

## Measures

### *Alcohol consumption within the last week*

Alcohol consumption within the last week was assessed by a beverage-specific quantity–frequency index for beer, wine, spirits and alcopops. Quantities of all beverages were converted into pure alcohol using beverage-specific standard ethanol contents of 4.8%, 11.0%, 33.0% and 5.5% for beer, wine, spirits and alcopops, respectively (for details see [31,32]). Volume of alcohol consumption within the last week was computed by summing grams of ethanol of all alcoholic beverages.

### *Beverage preference*

Beverage preference for beer, wine, spirits or alcopops was based on the reported alcohol consumption within the last week. An individual's beverage preference was assigned for the beverage that had the highest share in total alcohol consumption.

### *Covariables*

To control for possible confounding influences, age, gender, school type and federal state were used as covariables for all analyses. For the computation of propensity scores, parental education, parental control, perceived family affluence, alcohol expectancies, risk perceptions, age of first alcohol consumption, cigarette/cannabis/ binge drinking prevalence within the last 30 days, truancy, school grade, hobbies, satisfaction with relationship to mother, father and friends, family situation, availability of alcohol and the number of friends using alcohol were also employed.

In order to assess changes in alcohol consumption and beverage preference after the introduction of the alcopops tax, a variable indicating survey year 2003 (coded 0 'before the introduction') and 2007 (coded 1 'after the introduction') was used.

## Potential confounders and propensity score-matching

Large differences may exist in the observed covariables between students exposed to the alcopops tax (survey year 2007; 'exposed') and those not exposed (survey year 2003; 'control'), which may confound the effect of the alcopops tax [33]. In order to balance the covariables in the two groups, propensity scores, defined as the conditional probability of being exposed given the covariables, were used [33–35]. Propensity scores were estimated by using logistic regression with survey year as dependent variable and the covariables as independent variables. For exposed students in 2007, a one–one matched sample of control students from the 2003 data set was selected. The technique used was Mahalanobis metric matching,

including the propensity score within propensity score calipers [36]. The caliper width was 0.2 of a linear propensity score standard deviation, and the variables included in the metric were age, gender, federal state and education.

As a result of matching, 4694 students (38.7%) could be selected for the analyses. Changes in effect size indicate that individuals surveyed in 2007 resembled those surveyed in 2003 with regard to most covariables. Table 1 shows the distribution of the most important variables before and after matching, including individual and social/contextual factors (full table available on request). As indicated by the smaller standardized differences [37], a good balance in terms of the covariables was achieved between the matched samples.

## Statistical analyses

All analyses were conducted using survey procedures of the STATA 10.1 SE [38] to adjust for the complex sampling design. The Pearson  $\chi^2$ -test with Rao/Scott correction was used for comparisons between survey years (gender, school type, beverage preference). Simple regression analyses were performed to determine differences in continuous variables (age, alcohol consumption) between survey years.

### *Changes in alcohol consumption and beverage preference*

Because of a skewed distribution of the outcome measures, generalized linear models (GLMs) [39] with gamma distribution and log-link function were used to examine changes in alcohol consumption. Changes in beverage preference were tested using a multinomial logistic regression model with alcopops preference as the base category. Predicted values for outcome variables were assessed by model predictions for each survey year. In addition to statistical significance, these values are needed to evaluate absolute changes. All models were adjusted for age, gender, education and federal state. Models for beer, wine, spirits and alcopops were adjusted for the consumption of the other types of beverages. To examine gender effects, an interaction term of gender and survey year was included in each model.

### *Sensitivity analysis*

Although the differences between the exposure and control group are minor in the matched sample (Table 1), the stability of the exposure was evaluated across groups of students with different probabilities of being exposed to the alcopops tax. For both outcome variables the original models and models including gender effects were re-run in five strata based on the propensity score [40], resulting

Table 1 Comparison of characteristics between survey years in the unmatched and matched samples among drinkers (7 days).

	Unmatched sample			Matched sample			Standardized differences
	2003 (n = 5690)	2007 (n = 6430)	Standardized differences	2003 (n = 2347)	2007 (n = 2347)	Standardized differences	
Age (years)	15.5	15.8	0.32	15.6	15.7	0.00	
Gender (% male)	46.0	54.0	0.04	50.4	50.3	0.00	
Federal state			0.23			0.05	
Bavaria	19.1	20.2		20.6	20.4		
Berlin	12.3	10.0		12.0	11.6		
Brandenburg	15.7	16.4		13.8	15.8		
Bremen	16.8	17.7		19.6	18.9		
North Rhine-Westphalia	17.1	15.6		15.8	14.7		
Hesse	19.2	20.2		17.2	18.6		
Education			0.58			0.01	
Hauptschule (low)	14.8	11.3		11.9	12.3		
Realschule (intermediate)	34.8	31.6		34.6	33.6		
Gymnasium (high)	33.1	37.2		36.9	36.6		
Gesamtschule (high and intermediate)	17.3	20.0		16.7	17.5		
Alcohol expectancies <sup>a</sup>							
Positive	1.3	1.3	0.00	1.3	1.3	0.03	
Negative	2.8	2.8	0.04	2.8	2.8	0.02	
Age of first alcohol consumption	12.3	12.4	0.09	12.3	12.4	0.04	
Prevalence of tobacco consumption (30 days)	62.4	50.1	1.66	55.4	54.3	0.01	
Prevalence of cannabis consumption (30 days)	18.9	12.2	0.93	16.0	16.7	0.01	
Prevalence of binge drinking (30 days)	78.7	80.5	0.05	79.6	78.8	0.01	
Parental control <sup>b</sup>	3.2	3.2	0.05	3.2	3.2	0.02	
Relationship satisfaction, mother <sup>c</sup>	4.2	4.2	0.02	4.2	4.2	0.01	
Relationship satisfaction, father <sup>c</sup>	4.0	4.0	0.03	4.0	4.0	0.01	
Relationship satisfaction, friends <sup>c</sup>	4.5	4.6	0.04	4.6	4.5	0.03	
Perceived family affluence <sup>d</sup>	4.4	4.4	0.03	4.4	4.4	0.02	
Availability beer <sup>e</sup>	4.8	4.8	0.12	4.8	4.8	0.06	
Availability wine <sup>e</sup>	4.8	4.6	0.32	4.7	4.7	0.05	
Availability spirits <sup>e</sup>	4.4	3.8	0.63	4.2	4.2	0.04	
Number of friends using alcohol			1.27			0.38	
None	0.3	0.2		0.3	0.5		
A few	1.9	2.1		1.7	2.9		
Some	12.2	10.2		10.9	11.4		
Most	59.6	51.6		58.4	51.9		
All	26.0	35.9		28.8	33.8		

<sup>a</sup>1–4, 1 = low, 4 = high; <sup>b</sup>1–4, 1 = low, 4 = high; <sup>c</sup>1–5, 1 = not at all satisfied, 5 = very satisfied; <sup>d</sup>1–7, 1 = very much less well off, 7 = very much better off; <sup>e</sup>1–5, 1 = impossible, 5 = very easy.

in 5 × 5 models for alcohol consumption and 1 × 5 models for beverage preference (with three comparisons within each model).

To address concerns of missing data in the covariables we conducted univariate regression imputation by chained equations. Specifically, the ‘ice’ procedure in STATA using Bayesian methods was applied.

**RESULTS**

**Descriptive results**

Table 2 shows the descriptive statistics with regard to alcohol consumption and beverage preference for both survey years in the unmatched and matched sample. In the analytical sample, no changes between 2003 and 2007 could be observed for total alcohol volume, beer and wine consumption. Volume of spirits increased by 8 g of ethanol, whereas volume of alcopops decreased by 9 g. Beverage preference also changed between 2003 and 2007. The proportion of students preferring alcopops declined, whereas the proportion of students favouring spirits or beer increased. In the same time-period, the proportion of students reporting a preference for wine showed a slight increase.

**Changes in alcohol consumption**

Table 3 summarizes the results of the adjusted models to predict alcohol consumption, controlling for confounding variables. Total amount of alcohol within the last 7 days did not change significantly between 2003 and 2007. Looking at individual beverages, two significant effects emerged. While the volume of alcopop consumption decreased by 11.8 g of ethanol, the amount of spirits increased by 5.3 g. No changes were observed for the consumption of beer and wine. Models including an interaction term for gender and survey year yielded significant results only for wine [exp(b) = 0.67; 95% confidence interval (CI): 0.51–0.89; P < 0.01]. Male average wine consumption increased from 13.9 g of ethanol in 2003 to 17.8 g in 2007, while female wine consumption decreased from 13.1 g in 2003 to 11.3 g in 2007.

**Changes in beverage preference**

Changes in beverage preference after the introduction of the alcopops tax are displayed in Table 4. Results of the multinominal regression analysis indicate that survey year is a highly significant predictor for the observed changes. Comparing dichotomous preferences of alcopops versus beer, alcopops versus wine and alcopops versus spirits yields a higher proportion of adolescents preferring the other beverages over the years. The propor-

**Table 2** Comparisons of alcohol consumption variables between survey years in the unmatched and matched samples among drinkers (7 days).

	Unmatched sample		Matched sample	
	Before (2003) (n = 5821)	After (2007) (n = 6672)	Before (2003) (n = 2347)	After (2007) (n = 2347)
Alcohol consumption (last 7 days in grams of ethanol)				
Total (mean, SD)	90.6 (2.0)	78.2 (2.0)***	88.6 (2.7)	84.5 (2.9)
Beer (mean, SD)	43.4 (1.5)	40.2 (1.4)	42.2 (2.0)	40.2 (2.0)
Wine (mean, SD)	14.1 (0.5)	14.2 (0.7)	13.6 (0.7)	13.1 (0.7)
Spirits (mean, SD)	12.0 (0.6)	17.7 (0.3)***	12.1 (0.8)	20.0 (1.1)***
Alcopops (mean, SD)	21.0 (0.6)	6.2 (0.3)***	20.6 (0.9)	11.3 (0.7)***
Beverage preference <sup>a</sup>				
Beer (n, %)	2570 (45.5)	3528 (54.0)	1028 (44.7)	1096 (48.5)
Wine (n, %)	1295 (20.0)	1471 (21.6)	514 (19.8)	507 (20.4)
Spirits (n, %)	450 (8.7)	1117 (17.6)	186 (9.1)	395 (18.5)
Alcopops (n, %)	1493 (25.8)	554 (6.8)	611 (26.4)	342 (12.5)

\*\*\*P < 0.001. <sup>a</sup>Total n smaller than n indicated above due to loss of people without any beverage preference. Number of observations (n) unweighted, summary statistics weighted. Pearson’s  $\chi^2$  tests (qualitative) and t-test were used (quantitative) for comparisons over survey years. SD: standard deviation.

**Table 3** Predicted alcohol consumption (in grams of ethanol) before and after the introduction of the alcopops tax in Germany among drinkers (7 days).

Introduction of alcopops tax	Alcohol consumption (in grams of ethanol within the last 7 days)				
	Beer	Wine	Spirits	Alcopops	Total
Before (2003)	43.3	13.4	14.1	25.4	88.6
After (2007)	46.7	13.1	19.4	13.6	82.7
Exp(b) (95% CI)	0.95 (0.85–1.07)	0.99 (0.84–1.17)	1.69 (1.45–1.98)***	0.40 (0.34–0.48)***	0.95 (0.88–1.02)

CI: confidence interval. \*\*\* $P < 0.001$ . Generalized linear models (GLM; family: gamma, link function: log) were performed yielding exponentiated coefficients (exp(b)) for survey years. GLMs were adjusted for age, gender, education and federal state; models for beer, wine, spirits and alcopops were also adjusted for other alcoholic beverages.

**Table 4** Predicted beverage preference before and after the introduction of the alcopops tax in Germany among drinkers (7 days).

Introduction of alcopops tax	Beverage preference (%)			
	Beer	Wine	Spirits	Alcopops
Before (2003)	43.7	21.1	8.0	27.3
After (2007)	49.5	22.3	15.8	12.4
Difference	+5.8	+1.2	+7.8	-14.9

Multinomial logistic regression model with alcopops as the reference category; model adjusted for age, gender, education, federal state and total alcohol consumption; relative risk ratios (RRR) (95% confidence interval): beer versus alcopops: 2.6 (2.0–3.3)\*\*\*; wine versus alcopops: 2.3 (1.8–3.0)\*\*\*; spirits versus alcopops: 4.4 (3.3–5.9)\*\*\*; \*\*\* $P < 0.001$ .

tion of students with a preference for alcopops decreased from 27.3% in 2003 to 12.4% in 2007. Thus, alcopops declined from the beverage of second choice to the beverage of last choice. In contrast, the proportion of students with a preference for beer and spirits increased by 5.8% and 7.8% in the same time-period, respectively. Beer remained the beverage of first choice while spirits switched from the least preferred beverage to the beverage of third choice. A smaller increase of 1.2% in the proportion of students with a preference for wine could be observed. A model including an interaction of gender and survey year did not yield significant results.

### Sensitivity analysis

For alcohol consumption, results were identical in all five strata, i.e. alcopop consumption decreased and spirit consumption increased significantly while no changes could be found for beer, wine and total alcohol volume. With regard to beverage preference, 12 of 15 single comparisons could be verified. The higher proportion of students preferring other beverages as compared to alcopops was replicated in all five strata for spirits, in four quintiles for beer and in three strata for wine. All gender effects were constant within the sensitivity analyses (tables available on request).

## DISCUSSION

This analysis used data from the German 2003 and 2007 ESPAD study to examine changes in alcohol consumption and beverage preference among adolescents after the introduction of the alcopops tax. This is the first study to approach an evaluation of the effectiveness of the alcopops tax on adolescents. In general, results indicate a limited effectiveness of the tax in reducing total alcohol consumption and a shift in preference to beverages that are associated with riskier drinking patterns.

### Caveat

Assessing the effect of the alcopops tax using observational data faces the risk of biased intervention effect estimates. First, differences in covariables can confound the tax effect on alcohol consumption. To eliminate the effects of observed covariables we created matched data sets that showed very good balance in terms of a rich set of covariables. Moreover, sensitivity analyses indicated no impact of confounding variables on the effect of the alcopops tax on volume of alcohol consumption and only a minor effect on beverage preference. However, while an effect of observed covariables is unlikely, the influence of unobserved confounders cannot be ruled out. Secondly, and more importantly, cultural and structural changes may have occurred between survey years, e.g. a general trend of declining alcohol consumption or changes in outlet density. As we were not able to control for these factors, observed changes in alcohol consumption might also be influenced by these factors. Thus, the results of this study can be interpreted as indications of the tax effects, keeping in mind the possibility of alternative explanations.

### Alcohol consumption

Our results suggest no effectiveness of the alcopops tax in reducing volume of alcohol consumption. First, as hypothesized, we found evidence for a substitution of alcopops by spirits. However, findings indicate only a

partial substitution because a decrease in alcopop use was not completely balanced out by an increase in spirits intake. These changes did not result in a significant reduction in total alcohol consumption, probably because overall volume was also influenced by a small increase in beer consumption. The interpretation of our results in terms of a substitution is supported by earlier research on cross-price elasticity. While Edwards *et al.* [19] and Österberg [20] found weak substitution effects, Gruenewald *et al.* [21] reported a substantial effect. A partial replacement of alcopops is also corroborated by Australian and German sales data. After the tax was introduced in Australia in 2008, alcopops sales fell by 26% while liquor and beer sales rose by 11% and 2%, respectively [16]. In Germany, sales figures indicate that alcopops were substituted mainly by mixed alcoholic beverages on the basis of beer and wine [17]. These changes may be due to the introduction of fermented alcohol-based mix drinks as a reaction of the alcohol industry to avoid the alcopops tax.

### Beverage preference

Changes in beverage preference indicate an increase in the preference of beer and spirits among adolescents after the introduction of the alcopops tax. Results from the Swiss ESPAD project corroborate these findings. While the share of alcopops declined steeply between 2003 and 2007 the share of spirits increased, although to a lesser extent [15]. Given the indication of a partial replacement of alcopops by spirits, the increase in the preference of spirits may be considered a negative side effect of the alcopops tax. There is evidence that compared to alcopop preference spirits preference is associated with riskier drinking patterns and more alcohol-related problems (e.g. [22,24]). For example, Kuntsche *et al.* [22] could show that adolescents preferring alcopops drank mainly for social purposes, i.e. together with friends at parties or other social gatherings. These young people also tended to drink only moderate amounts of alcohol, whereas others preferring beer or spirits drank more excessively. The motivation to drink for the latter group derived mainly from the intention to have fun, to feel the effects of alcohol, to get drunk or to cope with problems, which in fact can be seen as a much more problematic drinking pattern.

However, changes in beverage preference should be interpreted with caution. Our measure of beverage preference is a relative one, always summing to 100%. Thus, as the proportion of students with a preference for alcopops decreases, the proportion of students with a preference for other alcoholic beverages increases. For example, in the case of cutting down alcopop consumption without changing the consumption of other alcoholic beverages, a shift to the preference for beer is most likely because beer was the most popular beverage in 2003.

Increases in beer preference do not necessarily reflect changes in drinking patterns, but are simply a consequence of the relative measure for beverage preference. In contrast to beer, the consumption of spirits has increased over time, indicating a partial substitution of alcopops. In this case, a shift to the preference for spirits is more likely to reflect 'real' switches to beverages related to riskier drinking patterns. Moreover, it may be that adolescents shifting to beer and spirits do not have the same level of risk as do those who chose these beverages originally. Confounding factors such as personality or other characteristics could influence the association between beverage preference and riskier drinking patterns.

### Gender effects

Interestingly, we found a gender-specific effect only on wine consumption, but not on the consumption of alcopops or on total alcohol consumption. Thus, girls were not protected specifically by the alcopops tax. These results suggest that both genders declined their alcopop consumption equally, but substituted alcopops differentially. While spirits were the beverage of choice to substitute for alcopops in both genders, boys tended more to wine than girls as an alternate beverage for substitution. However, given the small effect size and the low level of wine consumption in boys, the gender tax effect on wine consumption might be of limited practical relevance.

### Limitations

Our study has some limitations. First, our results are based on alcohol consumption within the last 7 days. The advantage of using this relatively short reference period is that it reflects very clearly the current beverage preferences. Moreover, the resulting estimates of alcohol consumption may be considered precise due to the short recall period. However, the 7-day measure bears the risk of overlooking infrequent drinkers [41]. Therefore, caution is warranted when generalizing our results to this group. Comparisons of matched and unmatched students within both survey years show that results do not generalize to the sample of 15- and 16-year-olds. However, for the purpose of this paper, controlling for possible confounding variables was key. Although several statistical procedures were used to take numerous confounders into account, causal inferences are not warranted. The observed changes in alcohol (especially alcopop) consumption may not be due only to the alcopops tax but may also reflect general cultural and structural changes. However, there is some indication from other data [42] that the tax is responsible for a considerable part of the effects. Asked for their reasons for buying fewer or no more alcopops at all in 2005, 63% of adolescents said these beverages had become too expensive.

## CONCLUSION

There is evidence that riskier drinking patterns such as higher frequency of binge drinking and earlier initiation of alcohol use are not caused by alcopop consumption but by alcohol consumption in general [1,18]. Our findings suggest that health benefits of the alcopops tax related to the reduction of total alcohol consumption were mitigated by beverage substitution. Moreover, the tax appears to have entailed negative side effects because a switch to alcoholic beverages that are associated with riskier consumption patterns occurred. Thus, effective alcohol policies to prevent alcohol-related problems among adolescents should focus upon the reduction of total alcohol consumption instead of regulating singular beverages.

## Declarations of interest

None.

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