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Alcohol policy changes and 22-year trends in individual alcohol consumption in a Swiss adult population: a 1993–2014 cross-sectional population-based study

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ABSTRACT

Objective: Evidence on the impact of legislative changes on individual alcohol consumption is limited. Using an observational study design, we assessed trends in individual alcohol consumption of a Swiss adult population following the public policy changes that took place between 1993 and 2014, while considering individual characteristics and secular trends.

Design: Cross-sectional study.

Setting: Swiss general adult population.

Participants: Data from 18 963 participants were collected between 1993 and 2014 (aged 18–75 years).

Outcome measures: We used data from the 'Bus Santé' study, an annual health survey conducted in random samples of the adult population in the State of Geneva, Switzerland. Individual alcohol intake was assessed using a validated food frequency questionnaire. Individual characteristics including education were self-reported. 7 policy changes (6 about alcohol and 1 about tobacco) that occurred between 1993 and 2014 defined 6 different periods. We predicted alcohol intake using quantile regression with multivariate analysis for each period adjusting for participants' characteristics and tested significance periods. Sensitivity analysis was performed including drinkers only, the 10th centile of highest drinkers and smoker's status.

Results: Between 1993 and 2014, participants' individual alcohol intake decreased from 7.1 to 5.4 g/day (24% reduction, p<0.001). Men decreased their alcohol intake by 34% compared with 22% for women (p<0.001). The decrease in alcohol intake remained significant when considering drinkers only (28% decrease, p<0.001) and the 10th centile highest drinkers (24% decrease, p<0.001). Consumption of all alcoholic beverages decreased between 1993 and 2014 except for the moderate consumption of beer, which increased. After adjustment for participants' characteristics and secular trends, no independent association between alcohol legislative changes and individual alcohol intake was found.

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Strengths and limitations of this study

- The main strengths of the study are the very large sample of data used, the long study period, the use of the same validated food frequency questionnaire (FFQ), and a strict and repeated methodology with interviews to assess and complete individual self-reported alcohol consumption.
- While the FFQ used in this study is the best possible option to assess dietary intake in the Swiss French-speaking population, data derived from FFQ suffers from limitations.
- Individual alcohol consumption could have been underestimated because of social desirability bias.
- We cannot exclude some residual confounding.
- The present study does not include economic conditions affecting alcohol outcomes; including participants' income; intraperiod alcohol prices; and measures of outlet density and type.

Conclusions: Between 1993 and 2014, alcohol consumption decreased in the Swiss adult population independently of policy changes.

INTRODUCTION

Alcohol misuse is an important determinant of health and a major contributor to the burden of disease worldwide.[1] The WHO, the European Commission in 2006 and recently the Global Strategy in 2010 have tried to raise awareness on alcohol-related harm and lead countries to adopt strategies to reduce them.[2]

In Switzerland, in 2014, according to data from the Federal Office of Public Health (OFSP), almost one-quarter (23.2%) of the

population aged over 15 years has had a hazardous alcohol consumption in the past 12 months.[3] Hazardous alcohol consumption was defined as either chronic excessive (more than 20 g per day for women and more than 40 g per day for men) or binge drinking (more than four standard drinks for women and five for men in a short time[4]).

With regard to alcohol use regulations, Switzerland has a long history of efforts to regulate alcohol production, sale and use, at the cantonal and federal levels.[5] In July 1999, a Swiss reform on taxation on spirits came into effect, in accordance to the World Trade Organization agreement on the elimination of discriminating duties on foreign spirits. A uniform tax rate was established, leading to a reduction of 30–50% of the price of imported spirits in Switzerland and an increase in alcohol consumption.[6] One year later, on 9 June 2000, a cantonal law limiting alcohol and tobacco advertisement was established in the State of Geneva.[7] On 1 February 2004, the Federal Council abolished the uniform tax rate and implemented a 300% tax on alcopops (mix of distilled alcohol, malt beverage and wine cooler) which are very attractive beverages for the younger population, due to their taste and appearance. The aim was to limit their availability and protect the younger generation.[8] On the 1 January 2005, a federal policy lowered the legal alcohol blood limit to drive to <0.5 g/1000 mL.[9] Immediately following this law, a 14.0% decrease in alcohol-related traffic accidents was observed.[10] Also, 1-month later, in Geneva, a new policy restricted the sale of alcohol (limited from 7:00 to 19:00 and only in certain retail outlets[11]).

Worldwide, several studies reviewed the evidence for the effectiveness of policies to reduce the harm caused by alcohol.[12 13] Other reports examined how changes in legislation affect *individual* alcohol consumption including in Switzerland. For example, Nelson and McNall,[14] in addition to illustrating the general decline in alcohol consumption after 2000 in Switzerland, identified five studies[6 15–18] that explored policy effects on alcohol consumption in Switzerland. The overall effects of policy changes were estimated to be unclear and to depend on context and culture.[14 18] Also, the number of different legislative changes either across countries or within a given country using comparable individual data is limited.

Moreover, individual characteristics such as gender, marital status, education, smoking and secular trends are often not considered. A Finnish study showed that the reduction in alcohol prices (after tax cuts in 2004) and the subsequent increase in consumption increased alcohol-related mortality in different age and socio-economic groups, but especially in men aged 55–59 years. In the 30–59 years' age group, mortality increased mostly among the unemployed, early-age pensioners and those with low income, of low social class and low education.[19] While not covering policy changes

per se, Abel *et al*[20] reported interesting social and regional variations in health status and health behaviour among young Swiss adults. They found that risk drinking (more than two units per day for young men and more than one unit per day for young women) was more widespread among males in the French rather than in the German-speaking region. In Geneva, one of the longest studies ever conducted in Europe showed a decrease in alcohol intake in both genders between 1993 and 2012.[21] In 1993–1999, higher and lower educated men presented no difference in their alcohol consumption; conversely, higher educated women had a higher alcohol intake compared with women with a lower education but this difference was no longer significant in 2006–2012. In this study, trends in alcohol intake were reported but not related to the different changes in alcohol legislation.

The aim of our study was to evaluate trends in alcohol consumption in the adult population of Geneva following the public policy changes that took place between 1993 and 2014. We considered participants' characteristics (age, gender, marital and smoking status, education, energy intake, country of birth), environmental factors (alcohol legislation) and time trends that influenced individual drinking behaviour. Smoking ban may affect alcohol consumption.[22] Of note, another important step forward in terms of promotion of health in Geneva was the implementation of a legislative smoking ban in public places in October 2009.[23]

METHODS
Study design
We used data from the 'Bus Santé' study, a cross-sectional ongoing population-based study that collects information on chronic disease and lifestyle risk factors in Geneva, a State of 490 000 inhabitants, in Switzerland. The 'Bus Santé' is described elsewhere.[24] Briefly, the study started in 1993 and ever since, each year, a representative sample of non-institutionalised men and women aged 34–75 years was recruited from 1993 to 2009, and aged 18–85 from 2010 to 2014. Eligible participants were identified with a standardised procedure using a residential list annually established by the local government. Random sampling in age-specific and sex-specific strata was made in order to be proportional to the corresponding frequencies in the population. A person who was not reached after three mailings and seven phone calls was replaced using the same selection protocol previously discussed, but individuals who were reached and refused to participate were not replaced. Included participants were not eligible for future recruitment and surveys. Participation rate ranged between 55% and 75%.[21]

Participants were asked to fill questionnaires at home and to participate to a physical examination in either a mobile unit (Bus Santé) or in two different stationary clinics.

Data collection

Between 1993 and 2014, approximately a thousand participants were randomly selected each year and contacted to answer a self-reported food frequency questionnaire (FFQ) developed and validated in the target population.[25] Participants also completed a standardised questionnaire covering family status, self-reported education level, reproductive history, cardiovascular risk factors, age and physical activity. Smoking status was subdivided into never and former (more than 100 cigarettes smoked in the past), and current body weight and height were measured using standard procedures and body mass index (BMI; kg/m^2) was calculated.[26]

Alcohol intake was assessed using the FFQ. For each alcoholic beverage (beer, wine, champagne, aperitif like martini or anisette and spirits like whisky, brandy or liqueur), consumption frequencies ranged from 'less than once during the last 4 weeks to two or more times per day'. Participants were also asked to indicate the average serving size (smaller, equal or bigger) compared with the standard alcohol serving size, equal to 10 g of pure alcohol.[24] We excluded participants who did not answer all the questions about alcohol and also those who gave incoherent answers. Data derived from this FFQ have been used by several large worldwide consortium (eg, Nutricode[27]) and published in high-impact journals.[28] Of note, the same FFQ was used for the entire period of analysis (1993–2014).

Exclusion criteria

Participants with missing data, with extreme energy (<850 or >4000 kcal/day) or alcohol (>99th centile, >79.72 g/day) intake were excluded from the analysis as previously suggested.[29]
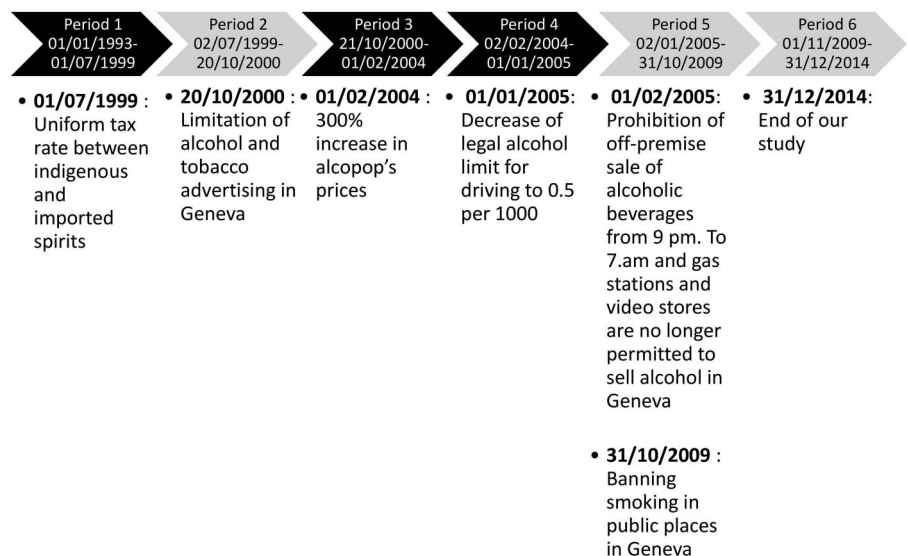
Ethics statement

The Bus Santé Geneva study complied with the Declaration of Helsinki. All participants had given written informed consent.

Statistical analysis

Statistical analyses were performed with the Stata V.13.1 for windows (Stata Corp, College Station, Texas, USA). The study period included six new legislations. However, given the very short time (1 month) between the implementation of the alcohol driving limit and the new schedule of off-premise sale, period 5 thus include two different laws (figure 1).

We summarised baseline participants' characteristics including age, gender, BMI, marital status, education, smoking status, country of birth and energy intake. All participants' alcohol consumption expressed in g/day was computed in median and IQR and stratified by their characteristics in each period's sample. The frequency of alcohol intake was classified similarly as in the FFQ (1–4 times a week and 1–2 times a day) and stratified into different types of alcoholic beverages (beer, wine and champagne, aperitifs and spirits) and expressed in percentage. To account for the survey year-specific age and gender structure, estimates and associations were weighted using the 2014 Geneva Census population. Weights were used to account for complex survey design and non-participating bias. Estimates and variances were calculated using design-based method procedures.[30] To account for the potential secular trends of diseases that would be independent of the legislation periods, we included a linear time trend in the models. Using quantile regression (for which no survey procedures are implementable), we predicted alcohol intake with multivariate analysis for each period adjusting for participants' characteristics and tested statistical significance between periods. We further tested differences across periods adjusting for secular trends. Then, we reported the adjusted associations between policy modifications and median alcohol (g/day) intake of the participants using three different models: (1) adjusted for previous policy modification(s), if any; and (2) adjusted for age, gender, BMI, marital status, education, smoking status and country of birth, with a further adjustment for previous

Figure 1 Study period divided in six periods according to policy changes between 1993 and 2014.

Period 1 01/01/1993-01/07/1999	Period 2 02/07/1999-20/10/2000	Period 3 21/10/2000-01/02/2004	Period 4 02/02/2004-01/01/2005	Period 5 02/01/2005-31/10/2009	Period 6 01/11/2009-31/12/2014
• **01/07/1999**: Uniform tax rate between indigenous and imported spirits	• **20/10/2000**: Limitation of alcohol and tobacco advertising in Geneva	• **01/02/2004**: 300% increase in alcopop's prices	• **01/01/2005**: Decrease of legal alcohol limit for driving to 0.5 per 1000	• **01/02/2005**: Prohibition of off-premise sale of alcoholic beverages from 9 pm. To 7.am and gas stations and video stores are no longer permitted to sell alcohol in Geneva • **31/10/2009**: Banning smoking in public places in Geneva	• **31/12/2014**: End of our study

policy modification(s), if any; and (3) adjusted for secular trends with a further adjustment for age, gender, BMI, marital status, education, smoking status, country of birth and policy modification(s), if any. Furthermore, we stratified this analysis by smoking status as smoking was thought to possibly modify the associations, if any.

We conducted sensitivity analysis including drinkers only (to avoid an underestimation due to the proportion of abstinent participants) and the highest decile drinkers' alcohol consumption expressed in g/day. The latter analysis was motivated by results from previous reports[6 15] suggesting different effects of Swiss alcohol policies on alcohol consumption among heavy drinkers. We reported adjusted association between policy modifications and median alcohol (g/day) intake of drinkers only using the three previous models as mentioned. Statistical significance was considered for a two-sided test with a p value <0.05.

RESULTS
Descriptive data
Of the initial sample, 1666 participants (8.8%) were excluded; thus, data from 18 963 participants with a mean age 48.5 (SD 12.0) years (range 18–85 years) were analysed. Characteristics of all included participants over the five periods are presented in table 1.

Trends in alcohol intake
Among all participants, 90.7% of women consumed alcohol <20 g/day and 89.6% of men consumed <40 g/day (ie, 'high-risk' use in women and men, respectively). When drinkers only were considered, 88.3% of women had an alcohol consumption <20 g/day and 88.5% of men <40 g/day. Trends in alcohol consumption between 1993 and 2014 according to gender, marital status, education, smoking status and country of birth are reported in table 2. Throughout all periods, participants' alcohol intake ranged from 7.1 to 5.4 g/day (24% reduction, p<0.001; figure 2). Men drank more than three times as much as women did, but decreased their alcohol intake by 34% compared with 22% for women. Married and cohabiting adults consumed more than divorced and single participants; the consumption of widowed participants showed no differences across periods. Participants with high education had a higher alcohol intake than participants with low education. Ex-smokers and current smokers drank more than twice as much as never-smokers, and ex-smokers had higher alcohol consumption than smokers. Participants born in Switzerland had higher alcohol consumption than those born abroad.

We observed similar results among drinkers only (see online supplementary table S1) and heaviest drinkers (see online supplementary table S2) with a decrease of, respectively, 28% and 24% (p<0.001; figure 2). Considering drinkers only, men decreased their alcohol intake by 30% and women by 23%. However, conversely to the previous results, an inverse relationship was found regarding education if drinkers only were considered. Participants with low education had a higher alcohol intake than participants highly educated.

Table 1 Characteristics of the participants of the 'Bus Santé' study, Geneva, Switzerland, according to study period*

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	p Value
Sample size	6403	1550	4094	920	1928	4068	
Women (%)	3416 (50.0)	841 (51.0)	2178 (49.6)	465 (47.0)	1003 (49.0)	2087 (48.6)	0.492
Age (years) mean, SD	48.6, 11.9	49.2, 12.1	48.9, 12.1	47.4, 11.6	48.8, 12.2	48.1, 13.5	0.006
BMI (kg/m^2) mean, SD	24.3, 3.8	24.4, 3.9	25.6, 18.4	27.9, 34.2	25.4, 10.6	25.2, 7.7	<0.001
Marital status (%)							<0.001
Single	593 (11.0)	150 (10.6)	439 (12.5)	90 (11.1)	213 (12.2)	481 (15.7)	
Married/cohabiting	4789 (74.7)	1140 (74.3)	2961 (72.8)	668 (72.4)	1393 (73.5)	2911 (70.0)	
Divorced	765 (10.8)	201 (11.7)	522 (11.0)	133 (13.8)	276 (12.2)	568 (11.9)	
Widowed	256 (3.5)	59 (3.4)	172 (3.7)	29 (2.7)	46 (2.1)	108 (2.4)	
Education (%)							<0.001
University	1954 (32.3)	503 (34.2)	1433 (37.2)	358 (42.1)	792 (42.2)	1852 (47.7)	
Lower than university	4449 (67.7)	1047 (65.8)	2661 (62.8)	562 (57.9)	1136 (57.8)	2216 (52.3)	
Smoking status (%)							<0.001
Never smoked	2849 (43.4)	697 (44.2)	1840 (45.6)	428 (47.0)	869 (45.4)	2011 (50.5)	
Ex-smoker	1510 (25.8)	376 (27.0)	939 (24.2)	212 (24.5)	441 (23.7)	992 (24.4)	
Current smoker	2044 (30.8)	477 (28.8)	1315 (30.2)	280 (28.5)	618 (30.9)	1065 (25.1)	
Country of birth (%)							<0.001
Switzerland	4647 (72.1)	1167 (74.8)	2917 (69.6)	628 (66.0)	1378 (68.6)	2788 (66.1)	
Other	1756 (27.9)	383 (25.2)	1177 (30.4)	292 (34.0)	550 (31.4)	1280 (33.9)	
Total energy intake (kcal/day) mean, SD	2002.4, 640.7	2022.0, 637.7	1994.8, 632.6	1960.6, 608.6	1918.6, 647.2	1896.9, 639.8	<0.001

*Figure 1 provides details on the dates of each period. Results are expressed as number of participants (percentage) or mean±SD. Proportions and means (SD) are weighted.
BMI, body mass index.

Table 2 Alcohol (g/day) intake of the participants of the 'Bus Santé' study, Geneva, Switzerland, according to study period,* stratified by participants' characteristics

	Period 1		Period 2		Period 3		Period 4		Period 5		Period 6		
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	p Value
Sample size (N)	6403		1550		4094		920		1928		4068		
All participants	7.1	1.8–19.2	6.6	1.8–17.56	6.6	1.2–18.2	5.9	1.2–15.7	5.7	1.3–14.7	5.4	1.2–13.4	<0.001
Men	13.2	4.2–26.6	12.0	4.2–24.2	11.5	3.8–25.0	9.2	2.9–22.3	9.8	3.0–20.5	8.7	3.0–17.8	<0.001
Women	3.6	0.7–11.5	3.5	0.7–11.8	3.1	0.5–10.7	3.0	0.2–9.5	3.2	0.6–8.6	2.8	0.5–7.6	0.005
Marital status													
Single	6.6	1.7–15.4	6.6	1.4–16.5	6.6	1.9–16.5	6.5	2.4–13.1	6.5	1.7–13.3	4.8	1.2–11.8	0.173
Married/cohabitating	7.3	1.8–19.8	6.8	1.9–17.6	6.6	1.3–19.2	6.1	1.2–16.7	6.1	1.4–15.0	5.4	1.2–13.8	<0.001
Divorced	7.1	1.7–19.8	7.2	1.8–19.7	6.6	1.2–15.4	4.7	1.0–14.7	4.2	1.2–14.8	4.2	0.5–13.2	0.007
Widowed	4.8	1.2–14.8	4.7	1.2–13.7	3.3	0.5–16.2	2–8	1.2–13.2	4.9	0–17.8	2.8	0.1–13.2	0.519
Education													
University	7.1	2.4–17.8	6.8	1.9–16.0	6.6	1.7–17.5	6.7	1.7–14.5	5.7	1.7–14.3	5.6	1.7–13.2	0.018
Lower than university	7.1	1.7–19.8	6.6	1.8–18.0	6.6	1.2–19.3	5.0	1.2–17.1	5.7	1.2–15.5	4.8	1.0–13.5	<0.001
Smoking status													
Never smoked	4.7	1.2–13.5	4.2	1.2–13.2	3.6	0.5–13.2	4.1	0.5–13.0	4.1	1.0–12.7	4.0	0.6–10.5	0.163
Former smoker	10.3	2.8–23.8	10.1	2.8–19.8	9.9	2.9–23.3	7.3	2.0–19.8	7.1	2.8–17.1	7.2	2.4–17.3	<0.001
Current smoker	9.8	2.8–21.2	9.9	2.8–20.5	8.9	2.8–21.0	9.1	2.8–20.0	7.1	2.8–17.2	6.6	1.8–15.5	<0.001
Country of birth													
Switzerland	6.8	1.8–17.6	6.6	1.8–16.1	6.6	1.7–17.6	5.4	1.4–14.4	6.5	1.8–14.5	5.7	1.7–13.4	0.004
Other	8.2	1.7–21.1	7.4	1.9–19.8	6.6	1.2–19.8	6.7	1.0–18.2	4.3	0.7–15.4	4.2	0.5–13.2	<0.001

*Figure 1 provides details on the dates of each period. Results are expressed as weighted median and IQR.
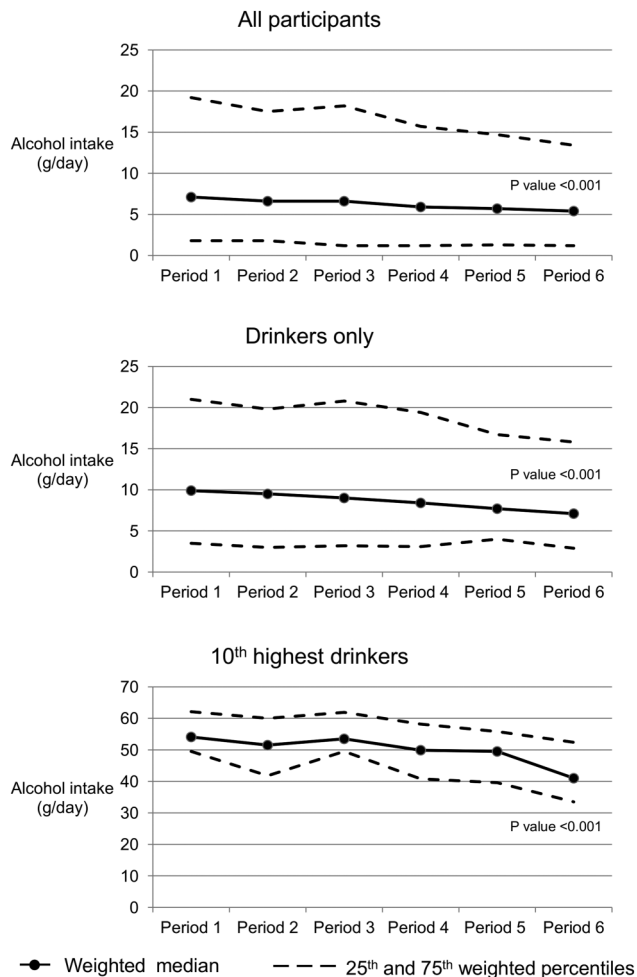
Figure 2 Trends in alcohol consumption among all participants, drinkers only and 10th highest drinkers between 1993 and 2014.

Table 3 shows the pattern of consumption of each type of alcoholic beverage. Wine appeared to be the beverage of choice among Geneva participants. Beer consumption from 1×/month to 1–2×/week was significantly higher in period 6 compared with period 1 and the proportion of beer abstainers decreased by 11.0% (p<0.001). There was a general decrease in wine consumption and an increase in abstinence throughout the periods except a slight increase in adults who drank wine 2–3 times a month. Regarding wine and champagne consumption, only 17–21% were totally abstinent compared with other alcohol beverages like beer, aperitifs and spirits for which about 50–70% were totally abstinent (p<0.001). Every type of aperitif consumption decreased between 1993 and 2014. Participants drinking spirits generally decreased from period 1 to 6, except two temporary increases in periods 3 and 6.

In table 4, multivariable-adjusted alcohol intake of participants shows that consumption of every category (except for widowed participants due to a small sample) decreased in comparison to the first period. However, when we adjusted these results for secular trends, none

was significant. Adjusted association between policy modifications and median alcohol (g/day), according to the period, shows only one significant result: a decrease (β coefficient -1.1, 95% CI (-1.9 to -0.3)) after the fifth policy modification (p<0.007). Models including individual characteristics and secular trends showed no significant associations (table 5). Similar findings were obtained when drinkers only were considered (see online supplementary table S3) and among heaviest drinkers also (data not shown).

Among non-smokers, there was a significant decrease (β coefficient -1.0, 95% CI (-2.0 to -0.01)) after the second policy modification, for period 3 compared with period 1 (table 6). Online supplementary tables S4–S6 present quantile regression analyses for different models including models adjusted for secular trends only, models adjusted for covariates only, and models adjusted for both secular trends and covariates.

Of note, results were robust to statistical changes, including the use of sample weights.

DISCUSSION

This repeated cross-sectional study investigated trends in alcohol consumption from 1993 to 2014 in the State of Geneva, Switzerland, after the implementation of seven different policies. While studies explored change in alcohol use, drinking patterns and alcohol-related harms following legislative changes, few studies considered individual data and participants' characteristics. To the best of our knowledge, this is the first study ever conducted in Switzerland assessing trends in individual alcohol intake following legislative changes in a very large representative population-based sample. Our results suggest that alcohol consumption decreased throughout the years and evolved in general very similarly in all groups. This decrease seems not to be a consequence of the changes in alcohol-related legislation but rather a phenomenon due to secular trends.

Trends in alcohol intake

In general, adults from the State of Geneva seemed to drink less than what the OFSP considered, at the time of the study, in its recommendations as a 'high-risk chronic use' (<20 g/day for women and <40 g/day for men) although acknowledging that we missed details on binge drinking.[31]

In Geneva, men drank overall more than women, a finding in agreement with the literature that is explained, at least partly, by cultural, neurological and neuroendocrine mechanisms.[32 33] Married and cohabitating individuals decreased their alcohol consumption since 1993, but they still drank about 1 g more per day than adults living alone; this is consistent with the social aspect of alcohol.[20] Participants with high education drank more than those with low education. Marques-Vidal et al[21] previously showed higher alcohol consumption among highly educated women in Geneva.

Table 3 Weighted frequency of alcohol intake of the participants of the 'Bus Santé' study, Geneva, Switzerland, according to study period,* stratified by type of alcoholic beverage

Beer	Period 1 N	Period 1 Per cent	Period 2 N	Period 2 Per cent	Period 3 N	Period 3 Per cent	Period 4 N	Period 4 Per cent	Period 5 N	Period 5 Per cent	Period 6 N	Period 6 Per cent	p Value
Never	3574	53.3	853	54.0	2296	53.0	511	53.2	1021	50.6	2026	47.3	<0.001
1×/month	482	7.6	117	7.1	314	7.4	61	7.4	155	7.9	363	9.3	
2–3×/month	738	12.3	190	13.0	518	13.5	122	13.3	280	15.6	623	15.4	
1–2×/week	752	12.8	185	112.51.9	481	13.1	107	13.0	249	13.7	569	15.3	
3–4×/week	443	7.1	107	7.2	243	6.6	57	6.7	108	6.0	272	7.1	
1×/day	267	4.4	61	3.7	163	4.5	39	4.1	79	4.2	141	3.4	
2× or more/day	147	2.4	37	2.5	79	1.9	23	2.3	36	1.9	74	2.1	
Wine, champagne													
Never	1071	17.0	245	16.8	801	19.7	188	21.5	385	20.9	837	21.1	<0.001
1×/month	362	6.0	82	5.8	227	5.9	44	5.6	112	6.4	327	8.6	
2–3×/month	829	14.5	213	14.3	561	15.4	132	14.8	273	15.4	680	17.8	
1–2×/week	1280	20.4	331	22.4	792	20.2	198	22.6	429	22.6	888	22.5	
3–4×/week	933	14.7	220	14.0	542	13.0	129	14.0	300	15.2	561	13.4	
1×/day	1350	19.4	343	19.4	833	18.6	168	16.1	317	14.6	606	13.2	
2× or more/day	578	7.9	116	7.2	338	7.2	61	5.4	112	5.0	169	3.4	
Aperitifs													
Never	4426	68.5	1076	69.7	2988	71.2	683	73.6	1447	73.9	3157	77.4	<0.001
1×/month	614	9.9	154	10.2	325	8.4	81	8.8	181	10.0	351	8.6	
2–3×/month	737	12.4	190	12.8	423	11.4	85	9.9	175	9.6	349	9.2	
1–2×/week	461	6.8	100	5.7	237	6.1	46	5.1	83	4.6	165	3.7	
3–4×/week	101	1.4	17	0.9	85	2.1	16	1.6	23	1.2	26	0.7	
1×/day	58	0.9	13	0.7	36	0.8	8	0.9	17	0.6	19	0.3	
2× or more/day	6	0.1	0	0	0	0	1	0.1	2	0.1	1	0.0	
Spirits													
Never	4276	66.4	1094	69.4	2771	66.7	647	69.4	1398	71.6	2860	67.2	0.004
1×/month	729	11.9	152	11.0	442	10.9	112	11.8	217	11.8	496	13.6	
2–3×/month	740	11.9	160	10.6	474	12.4	86	10.8	186	9.8	419	11.5	
1–2×/week	454	6.7	102	6.4	275	7.1	50	5.1	92	4.8	207	5.7	
3–4×/week	128	2.0	24	1.4	81	1.9	16	1.8	22	1.1	56	1.4	
1×/day	73	1.0	17	1.0	49	1.1	8	0.8	12	0.6	28	0.5	
2× or more/day	3	0.01	1	0.04	2	0.05	1	0.1	1	0.01	2	0.01	

*Figure 1 provides details on the dates of each period. Results are expressed as number and weighted percentage.

Income is thought to be positively associated with heavy drinking rates among women.[33] Ex-smokers and current smokers had higher alcohol consumption compared with the other groups. Picone et al,[22] using the data of the six waves of the Health and Retirement Study longitudinal survey in Michigan, observed a positive reinforcement effect of past cigarette consumption on current alcohol consumption.

Changes in alcohol distribution

Profile consumption of each type of alcohol between 1993 and 2014 were similar to the Swiss Alcohol Board 2014 report of alcohol sales between 2009 and 2012.[34] Whereas the use of other types of alcohol decrease, beer consumption increased before and after period 4 corresponding to the time after the raise in alcopops taxes and the decrease in alcohol blood level limit for driving. This change in alcohol distribution can be an overall trend or a result of public policies. The increase in beer intake might be expected because of the increase in the price of alcopops (the beverages are economic substitutes), but the beneficial effect of the alcohol blood level law is harder to explain as discussed elsewhere.[14] While acknowledging differences in the alcohol environment between Russia and Switzerland, it is interesting to note that Neufeld and Rehm[35] outlined a similar phenomenon in Russia in years 2001–2010 after alcohol policies when beer consumption was reported more often than that of vodka or any other alcoholic beverage. No clear pattern in the use of spirits was found. Heavy consumption of spirits (2× or more per/day) remained unchanged throughout time suggesting that adults with this type of consumption might be already too dependent to be affected by prevention measures.

Impact of legislative changes on alcohol consumption

In general, the decrease in individual alcohol intake observed throughout the study period was not independently associated with policy changes after considering secular trends, which is in line with the international

Table 4 Multivariable-adjusted alcohol (g/da y) intake of the participants o f the 'Bus Santé' study, Geneva, Switzerland, according to study period*

	Period 1		Period 2		Period 3		Period 4		Period 5		Period 6		p Value	p Value*
	Median	95% CI	Median	95% CI	Median	95% CI	Median	95% CI	Median	95% CI	Median	95% CI		
All participants	8.6	(8.3 to 8.9)	8.3	(8.0 to 8.5)	7.9	(7.7 to 8.1)	7.5	(7.3 to 7.8)	7.2	(6.9 to 7.4)	6.8	(6.5 to 7.2)	<0.001	0.084
Men	14.0	(13.4 to 14.6)	13.2	(12.8 to 13.7)	12.5	(12.1 to 12.9)	11.7	(11.3 to 12.2)	11.0	(10.4 to 11.5)	10.2	(9.5 to 10.9)	<0.001	0.730
Women	4.2	(4.0 to 4.5)	4.0	(3.8 to 4.2)	3.8	(3.7 to 4.0)	3.6	(3.4 to 3.8)	3.4	(3.2 to 3.6)	3.2	(2.9 to 3.5)	<0.001	0.059
Marital status														
Single	7.4	(6.5 to 8.3)	7.0	(6.4 to 7.7)	6.7	(6.1 to 7.3)	6.3	(5.7 to 6.9)	6.0	(5.2 to 6.7)	5.6	(4.7 to 6.6)	0.015	0.210
Married/cohabitating	9.0	(8.7 to 9.4)	8.6	(8.4 to 8.9)	8.3	(8.0 to 8.5)	7.9	(7.7 to 8.2)	7.6	(7.2 to 7.9)	7.2	(6.8 to 7.6)	<0.001	0.246
Divorced	8.2	(7.5 to 8.9)	7.8	(7.2 to 8.3)	7.4	(6.9 to 7.8)	6.9	(6.4 to 7.4)	6.5	(5.9 to 7.2)	6.1	(5.3 to 6.9)	0.001	0.284
Widowed	6.5	(5.2 to 7.8)	6.1	(5 to 1.7.1)	5.8	(4.9 to 6.7)	5.4	(4.3 to 6.5)	5.1	(3.7 to 6.5)	4.7	(2.9 to 6.6)	0.175	0.866
Education														
University	8.7	(8.2 to 9.1)	8.3	(7.9 to 8.6)	7.9	(7.6 to 8.2)	7.5	(7.2 to 7.8)	7.1	(6.7 to 7.5)	6.7	(6.2 to 7.2)	<0.001	0.100
Lower than university	8.6	(8.3 to 9.0)	8.3	(8.0 to 8.6)	7.9	(7.7 to 8.2)	7.6	(7.3 to 7.9)	7.3	(6.9 to 7.6)	6.9	(6.4 to 7.4)	<0.001	0.462
Smoking status														
Never smoked	5.8	(5.5 to 6.2)	5.6	(5.3 to 5.8)	5.3	(5.1 to 5.5)	5.0	(4.8 to 5.3)	4.8	(4.5 to 5,1)	4.5	(4.1 to 4.9)	<0.001	0.178
Former smoker	12.5	(11.7 to 13.3)	11.6	(11.0 to 12.2)	10.8	(10.3 to 11.3)	10.0	(9.4 to 10.5)	9.1	(8.4 to 9.9)	8.3	(7.4 to 9.2)	<0.001	0.100
Current smoker	10.8	(10.2 to 11.5)	10.4	(9.9 to 10.9)	10.0	(9.6 to 10.4)	9.6	(9.1 to 10.1)	9.2	(8.5 to 9.8)	8.7	(7.9 to 9.6)	<0.001	0.699
Country of birth														
Switzerland	9.3	(8.6 to 9.9)	8.9	(8.4 to 9.3)	8.5	(8.0 to 8.9)	8.1	(7.6 to 8.5)	7.7	(7.1 to 8.2)	7.3	(6.5 to 8.0)	<0.001	0.465
Other	8.4	(8.1 to 8.7)	8.1	(7.8 to 8.3)	7.7	(7.5 to 7.9)	7.4	(7.1 to 7.6)	7.0	(6.7 to 7.3)	6.7	(6.3 to 7.1)	<0.001	0.118

*Figure 1 provides details on the dates of each period. Predicted alcohol (g/day) intake adjusted for age, gender, body mass index, marital status, education, smoking status and country of birth;
*p value for model further adjusted for secular trends.

Table 5 Multivariable-adjusted association between policy modifications and median alcohol (g/day) intake of the participants of the 'Bus Santé' study, Geneva, Switzerland

Number of participants	First policy modification period 1–2 7953		Second policy modification period 1–3 12 047		Third policy modification, period 1–4 12 967		Fourth policy modification period 1–5 14 895		Fifth policy modification period 1–6 18 963	
	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value
Model 1	−0.2 (−1.1 to 0.7)	0.637	−0.4 (− 1.3 to 0.4)	0.318	−0.1 (−1.1 to 1.0)	0.876	−0.1 (−1.2 to 1.1)	0.898	−1.1 (−1.9 to −0.3)	0.007
Model 2	−0.5 (−1.3 to 0.4)	0.290	−0.3 (−1.2 to 0.6)	0.512	−0.3 (−1.5 to 0.8)	0.561	−0.2 (−1.4 to 1.0)	0.720	−0.6 (−1.4 to 0.1)	0.098
Model 3	−0.6 (−1.7 to 0.5)	0.300	−0.2 (−1.2 to 0.8)	0.734	−0.2 (−1.4 to 1.0)	0.765	−0 0.05 (−1.4 to 1.3)	0.938	−0.6 (−1.6 to 0.3)	0.161

Results are expressed as β coefficient (g/day) and (95% CI) obtained from quantile regression. Model 1: adjusted for previous policy modification(s) (when appropriate); model 2: adjusted for previous policy modification(s) (when appropriate), age, gender, body mass index, marital status, education, smoking status and country of birth; model 3: adjusted for previous policy modification(s) (when appropriate), age, gender, body mass index, marital status, education, smoking status, country of birth and secular trends.

Table 6 Multivariable-adjusted association between policy modifications and median alcohol (g/day) intake of the participants of the 'Bus Santé' study, Geneva, Switzerland, by smoking status

	First policy modification period 1–2		Second policy modification period 1–3		Third policy modification period 1–4		Fourth policy modification period 1–5		Fifth policy modification period 1–6	
	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value	β (95% CI)	p Value
Number of non-smokers	3546		5386		5814		6683		8694	
Non-smokers	−0.01 (−1.0 to 1.0)	0.967	−1.0 (−2.0 to −0.01)	0.046	−0.05 (−1.2 to 1.1)	0.934	0.2 (−1.2 to 1.6)	0.790	−0.6 (−1.6 to 0.5)	0.312
Number of smokers	1886		2825		3037		3478		4470	
Smokers	−1.9 (−4.4 to 0.5)	0.121	0.7 (−1.7 to 3.0)	0.564	−1.6 (−4.4 to 1.2)	0.271	−1.9 (−5.3 to 1.4)	0.253	−1.8 (−4.4 to 0.8)	0.187

Results are expressed as β coefficient (g/day) and (95% CI) obtained from quantile regression. Adjusted for previous policy modification(s) (when appropriate), age, gender, body mass index, marital status, education, country of birth and secular trends.

literature.[36] Allamani et al[18] reported that aggregate Swiss alcohol consumption was largely affected by secular trends and unaffected by Swiss policy changes. Moreover, Nelson and McNall[14] reviewed the results from empirical studies of alcohol policy interventions in Denmark, Finland, Hong Kong, Sweden and Switzerland and found a lack of consistent results that could provide an evidence base for development of alcohol tax policies. In sensitivity analyses, we found different associations between policy changes and alcohol consumption among smokers and non-smokers. Indeed, non-smokers decreased their alcohol consumption in period 3 in comparison with periods 1 and 2 after the policy of alcohol and tobacco advertising limitation in Geneva in October 2000. But the association was only borderline significant. Some authors underlined the potential association between alcohol advertising and its consumption[37] and others pointed out that greater public health benefits may be realised if legislative restrictions are applied to alcohol marketing instead of alcohol marketing self-regulation which is routinely not enforced.[38] It is however worth noting that our results do not clearly support these views and that the general level of evidence on the beneficial effect of alcohol marketing is low.[39] In Switzerland, Allamani et al[18] explored this issue within the AMPHORA Project and found that the effect of alcohol advertising policy was uncertain. Conversely, we did not find yet an effect of the antismoking ban in Geneva in October 2009 on alcohol intake of ex-smokers and current smokers. The impact of smoking legislation on alcohol use is not clear and a slight correlation between alcohol and tobacco is described in the literature. Kasza and colleagues tried to demonstrate a link between alcohol and tobacco consumption by assessing the impact of smoke-free bar policies on the drinking behaviour of hazardous drinkers and heavy smokers. Smoking bans in public places did not appear to be associated with sizeable reductions in smokers' alcohol consumption in general, but might be associated with small consumption reductions among hazardous drinkers and heavy smokers.[40]

Strengths and limitations

This study presents several limitations. First, data are derived from FFQ, which suffers from limitations that we acknowledged elsewhere.[21] Yet, this FFQ has been validated in the Geneva population and data derived from this FFQ have recently contributed to worldwide analyses from consortiums involving experts in nutrition.[27] To the best of our knowledge, there is no validated FFQ assessing annual dietary intake in Switzerland, and it has been shown that FFQs assessing dietary intake for shorter periods than 1 year have the same validity as FFQs assessing annual dietary intake.[37] Thus, the FFQ used in this study is the best possible option to assess dietary intake in the Swiss French-speaking population. We acknowledge that individual alcohol consumption could have been underestimated because of social

desirability bias. Still, as the same FFQ was used throughout the study period, the magnitude of the bias might have remained constant, so trend would not be affected. Second, data on young adults (18–33 years) were only included in 2010. Moreover, our study only included adults between 18 and 85 years and it would be relevant to extend it to adolescents (15–18 years) who constitute a vulnerable group regarding alcohol use disorders especially with the risky single-occasion drinking during weekends (binge drinking[41]). Third, although we observed that trends in alcohol use are secular and seem independent of legislative measures, we cannot entirely exclude some residual confounding. Finally, the present study does not include economic conditions affecting alcohol outcomes, including participants' income; intra-period alcohol prices; and measures of outlet density and type. The main strengths of the study are the very large sample of data used, the long study period, the use of the same validated FFQ, and a strict and repeated methodology with interviews to assess and complete individual self-reported alcohol consumption.

CONCLUSION

Between 1993 and 2014, overall alcohol consumption, including that of heavy drinkers, decreased in our sample of the Swiss adult population. Risk factors for higher alcohol consumption were identified. However, although numerous policies have been established, this decrease does not seem to be associated with policies but rather with secular trends. Since alcohol misuse is still a major health problem, supplementary public health measures should be considered. In the future, long-term data sets such as 'Bus Santé' are valuable tools for monitoring alcohol use trends and evaluating legislative policies based on large representative samples.

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Notes