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Original Article

Impact of minimum unit pricing on youth alcohol consumption: insights from Lebanon

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Abstract

This paper analyses the impact of introducing an alcohol minimum unit pricing policy on youth's off-premise alcohol consumption. We rely on price elasticities derived using stated preference alcohol purchase data from a survey of 1024 university students in Lebanon. Selectively targeting drinks with high ethanol concentration by applying a minimum unit pricing (MUP) corresponding to the maximum price that respondents are willing to pay per beverage achieves a reduction in ethanol intake close to 0.23 l/month (~28% of pre-MUP ethanol intake). Imposing a flat MUP corresponding to the average price respondents are willing to pay for all alcoholic beverages decreases ethanol intake by nearly half the reduction from the previous targeted MUP. This work provides evidence in favour of MUP in conjunction with taxation capable of substantially reducing alcohol consumption. We also document a positive welfare benefit of MUP.

Keywords: Almost-ideal demand system, volumetric choice experiment, alcohol, youth, minimum unit pricing, elasticity

Key messages

- MUP targeting high-ethanol-content beverages reduces consumption more than flat MUP
- MUP is an effective alternative to taxation for reducing youth alcohol consumption
- Imposing MUP on alcoholic beverages has positive welfare benefits

Introduction

Youth alcohol consumption remains a global concern as it remains highly prevalent despite the declining trends in some countries. Key highlights from a survey conducted among 11 800 students in the USA show that alcohol use among the 8th-, 10th- and 12th-grade students has levelled off after a gradual decline over the past 5 years (National Institute on Drug Abuse, 2020). A European survey from 35 different countries further confirms the declining trend in smoking and drinking among 15–16-year-old school students (ESPAD Group, 2020).

There exists strong causal evidence linking harmful alcohol consumption to increased healthcare costs, decreased productivity and increased property damage costs resulting from traffic accidents and increased criminal justice and law enforcement costs (Collins and Lapsley, 1996; Devlin *et al.*, 1997; Fenoglio *et al.*, 2003; Jarl *et al.*, 2008). Alcohol-attributable chronic diseases and conditions are substantial and result from both the overall volume of alcohol consumption and patterns of drinking (Rehm *et al.*, 2003; Shield *et al.*, 2014).

Response measures including alcohol pricing policies and taxation methods aim at stimulating economic, health and social benefits via generating tax revenues, reducing harmful alcohol consumption and impeding drinking initiation among abstainers especially in low- and middle-income countries (WHO, 2018). Taxation and pricing policies that increase the cost of alcoholic products relative to other products are empirically documented and modelled to be among the most effective policies aimed to reduce heavy and harmful consumption of alcohol (Wagenaar *et al.*, 2010; Zhao *et al.*, 2013). Wagenaar and colleagues showed a strong link between tax/price and alcohol consumption based on aggregate sales (i.e. alcohol sales within the population) with weighted price elasticities of −0.17 for beer, −0.30 for wine, −0.29 for spirits and −0.44 for total alcohol consumption (Wagenaar *et al.*, 2009). Beer is thus documented to be the least receptive type of alcoholic beverage to positive price shocks (Burton *et al.*, 2017).

One of the most popular methods for taxing alcohol is specific taxation that depends on the volume of ethanol per beverage. It is documented to be most effective in high-income countries with an advanced prevalence of current drinkers (Alcohol and Public Policy Group, 2010). Another effective method is *ad valorem* taxation that depends on the price of

the alcoholic beverage (Cnossen, 2005; Delipalla and Keen 1992).

Besides taxation, alcohol minimum unit pricing (MUP) is another key pricing policy measure that governments rely on to ban the sale of a particular alcoholic beverage below a designated price (Hirshleifer *et al.*, 2005). Unlike taxation tools that indirectly impact prices, MUP directly affects prices of alcoholic beverages by increasing prices that are below the policy threshold up to exactly the threshold level (Brennan *et al.*, 2014).

Alcohol-related policies such as MUP have been effective at increasing the economic cost and decreasing the affordability of alcohol for the purpose of reducing its demand (Purshouse *et al.*, 2009; 2010). Other alcohol-related policies nudge the supply side of alcohol and aim to regulate the sale of alcohol to minors and restrict its physical availability (time and place), thus increasing the effort to obtain it (Anderson *et al.*, 2009; Alcohol and Public Policy Group, 2010; Martineau *et al.*, 2013; WHO, 2014). Regulating alcohol marketing and adopting effective drink-driving countermeasures also contribute to the reduction of harmful alcohol consumption (Anderson *et al.*, 2009; Alcohol and Public Policy Group, 2010; Martineau *et al.*, 2013; WHO, 2014).

The vast majority of research on alcohol harm reduction, including taxes and MUP, has generally excluded countries of the Arab region mainly due to data limitations (Ghandour *et al.*, 2016) and the fact that most Arab countries fail to recognize alcohol drinking among youth as a key national health priority (Mandil, 2009; WHO, 2014; Ghandour *et al.*, 2016). To tackle this evidence gap in the region, Chalak *et al.* (2020) model Lebanon's youth's off-premise alcohol demand and price elasticities using an Almost Ideal Demand System (AIDS), to investigate the impact of introducing broad-based vs targeted taxation using a survey of 1024 university students in Lebanon.[1]

In countries with weak and almost absent real market alcohol data, such as the case of most Arab countries, survey-based analysis using stated preferences (SPs) provides one of the useful tools for conducting research related to alcohol and alcohol policy recommendations and interventions. Stated responses provided by survey respondents would help describe consumers' purchasing patterns when facing hypothetical situations that closely simulate market choices options. This type of analysis is also important in forecasting the potential effect of introducing a new policy such as alcohol MUP. SP exercises can produce credible estimates of respondents' willingness to pay among other key features. Previous studies used SP analysis to investigate the impact of promotions on alcohol retails (Lu *et al.*, 2017) and explore preferences for alcohol policy packages (Pechey *et al.*, 2014).

The present paper contributes to the literature on youth's off-premise alcohol consumption patterns in the Arab region and relies on findings from Chalak *et al.* (2020) to evaluate the effect of MUP policy, rather than alcohol taxation policies, while forecasting the welfare impacts of implementing such a policy. The purpose of this paper is thus to contribute to the literature on alcohol in the Arab region, by examining the impact of introducing alcohol MUP policies on alcohol demand and, ultimately, aggregate ethanol intake using survey data collected from a SP survey of 512 university students in Lebanon. We focus on off-premise alcohol demand among university students in Greater Beirut and rely on price elasticities derived from SP alcohol purchase data. This is particularly interesting given the high records of yearly per capita (15+) alcohol consumption in Lebanon, which are high (1.5 l of pure alcohol) in comparison to WHO Eastern Mediterranean Region (0.6 l).

The paper then carries out a welfare analysis and forecasts the welfare costs and benefits of implementing such a policy. We account for both the direct and indirect economic costs of alcohol-related car fatalities and injuries. We focus uniquely on hospital care costs as a measure of direct economic costs and on losses in future earnings due to premature deaths or work-related injuries to capture the indirect economic costs.

The rest of the paper is structured as follows. In the Methods section, we provide a brief background of the survey sampling, design and questionnaire development in Chalak *et al.* (2020) on Lebanon's youth's off-premise alcohol demand and price elasticities modelled using AIDS. We then present the methodology used in this paper to examine the impact of alcohol MUP introduction. In the Results section, we present our findings and carry out the welfare analysis. The Discussion section provides a thorough discussion of our results and reviews the limitations of this study and lastly the Conclusion section concludes.

Methods

Most research studies on alcohol minimum pricing policies have used the Sheffield Alcohol Policy Model (SAPM). The SAPM is a causal, deterministic, epidemiological model that analyses the impact of the alcohol pricing policies on prices for different types of alcohol; the effect of price changes on the level of alcohol consumed and the impact of the changes in consumption levels on consumers' expenditures and retailers' revenues (Holmes *et al.*, 2014). Finally, the SAPM provides evidence on the impact of changes in alcohol consumption on hospital admissions due to alcohol consumption as well as morbidity and mortality levels (Angus *et al.*, 2016; Brennan *et al.*, 2008; 2014; Hill McManus *et al.*, 2012; Holmes *et al.*, 2014; Meier *et al.*, 2010; Meng *et al.*, 2012; Purshouse *et al.*, 2010). Other studies implement an alternative modelling strategy using counterfactual analysis techniques (Sharma *et al.*, 2016) or apply policy-to-price and price-to-consumption effects analysis using panel data (Vandenberg and Sharma 2016).

In this paper, we rely on price elasticities derived using SP alcohol purchase data from a survey of 512 university students in Lebanon. Investigating price and tax elasticities is the convention for analysing the effectiveness of taxation and pricing policies in economics. Price elasticity of demand for alcohol is determined by the percentage change in the quantity of alcohol consumed as a result of a 1% increase in the price of alcohol, which translates into the impact of alcohol pricing on drinking. A systematic review of studies investigating the association between alcohol taxes and price levels policies has shown an inverse relationship between alcohol prices and taxes and alcohol drinking in general (Wagenaar *et al.*, 2009).

Survey design, sampling and questionnaire development

Our study builds upon a study by Chalak *et al.* (2020), which implements a volumetric choice experiment (VCE) survey to investigate off-premise alcohol purchasing patterns among

youths in Lebanon. VCEs are a novel variant that extends the standard discrete choice experiments (DCEs) to allow for the assessment of count data in order to mirror real-world decisions that involve the purchase of multiple units of the same product (Chalak *et al.*, 2020; Louviere *et al.*, 2016).[2] Survey data were collected during December 2015 among a sample of 512 university students (aged 18–25 years) from Lebanon who identified themselves mainly as 'off-premise drinkers', i.e. respondents that report off-premise drinking at least once per week in the past year, by purchasing alcoholic products from different points of sales and consuming them at home or in private places. Data collection was undertaken by Information International, a leading Beirut-based market research company.

Sixty-four students were recruited from each of eight different private and public universities in the Greater Beirut area and adjacent Jounieh to ensure diversity. These included the following: (1) American University of Beirut, (2) Lebanese American University, (3) Lebanese University, (4) Lebanese International University, (5) Beirut Arab University, (6) St. Joseph University, (7) Notre Dame University and (8) Holy Spirit University of Kaslik. Students who were in the vicinity of the eight universities were recruited and interviewed by trained fieldworkers. An inclusion criterion for the study is that the student identifies him/herself as a 'drinker'. If the student identified as a drinker, he/she was then given a form that further describes the study and its procedures, before he/she orally consented to participate in the study. Once the student agreed to participate, the trained fieldworker then provided him/her with a questionnaire to complete. The fieldworker clearly informed the student that the participation in the study was entirely voluntary, and responses were to be used strictly for research purposes and kept in locked files and did not require any information that reveals the identity of the recruited student.

As mentioned above, the study included 512 'off-premise drinkers', in contrast to 512 'on-premise drinkers' who reported consuming alcoholic beverages in restaurants, bars, etc., and who were tackled in a separate VCE and analysis. The questionnaire thus consisted of two parts. The first part captured youth alcohol purchasing habits including their weekly expenditure on alcohol consumption, the frequency of purchasing, the type and brands of alcohol purchased and where the consumption occurs. The second part consisted of two consecutive SP exercises. The first SP exercise was a DCE that examined the factors that shaped youths' alcohol shopping visits (type of outlet, day and time of purchase, distance and convenience). The second SP exercise—the VCE of interest to this paper—looked at the demand of youths for various alcoholic beverage types.

The alcohol beverage types, their respective price ranges and discounts/offers that may apply to some of them were identified using three focus group discussions (FGDs) among youths completed between October and November 2014. These FGDs were facilitated by the various investigators involved in this project. The broad types of beverages were determined to be beer, wine, spirits, vodka mixes and alcopops, and arak—a traditional aniseed-flavoured spirit distilled from grapes. As for hypothetical beverage prices, these were drawn from a beverage-specific vector of five levels that spanned the typical range of prices advertised on the websites of major Greater Beirut supermarkets and offers/discounts and were chosen out of four possible options for any of the drinks: 'buy 1 get 1 free', 'free gift', '50% discount' or none.

Price elasticities for the different alcoholic products were derived based on the econometric analysis of respondents' purchasing choices (number of units of each beverage respondents report willing to purchase at a given price) when confronted with repeated choice tasks that altered the prices of alcoholic units (can or bottle depending on the beverage) and promotions (discount/offer) for each beverage.

Elasticity estimates

In this paper, we relied on own and cross-price Marshallian (uncompensated) elasticities for beverage i with respect to any beverage j (ε_{ij}), with i and j being the same for own-price elasticities, and different for cross-price elasticities, derived using AIDS strategy. As mentioned earlier, this study uses data from VCE survey to investigate the impact of a MUP. The own and cross-price uncompensated elasticities estimated in Chalak *et al.* (2020) are crucial for the purpose of this research. This is because they allow us to predict the impact of price changes, due to the introduction of hypothetical MUP policies, on the quantity demanded of each alcoholic product using respondents' purchasing intentions at different prices.

Among the previous year (PY) off-premise drinkers, 84% reported purchasing beer in the past month, 74% reported purchasing spirits, 63% purchased vodka mix/alcopops, 53% purchased wine and lastly 45% reported purchasing arak in the past month. The average unit prices (can or bottle) that respondents reported typically paying for each alcoholic beverage on their next trip to buy alcohol were as follows: LBP2201 (USD1.47) for beer; LBP30 994 (USD20.66) for wine, LBP23 LBP875 (USD15.82) for spirits, LBP4220 (USD2.81) for vodka mix/alcopops and lastly LBP22 820 (USD15.21) for arak.

Table 1 recalls the uncompensated expenditure and price elasticities derived by Chalak *et al.* (2020) using a censored AIDS model. A 'negative expenditure elasticity' for a given alcoholic beverage indicates that an increase in the overall budget allocated to alcohol consumption would be associated with a decrease in that product's consumption. This is the case for beer and vodka mix/alcopops where the AIDS model yields negative and statistically significant expenditure elasticities vs statistically significant positive expenditure elasticities for the remaining relatively more expensive alcoholic products (wine, spirits and arak). This suggests that the latter alcoholic products would be considered normal goods (an increase in their demand in response to an increase in the budget). This can be interpreted as a shift in students' preferences from relatively affordable products to more expensive ones with the increase in budget. Moreover, the positive and statistically significant 'own-price elasticities' associated with relatively cheaper alcoholic products (beer and vodka mix/alcopops) provide further evidence that cash-strapped students facing the same budget constraint would continue to consume these cheaper options despite their price increase.

Finally, the vast majority of cross-price elasticities are negative and statistically significant, which offers supporting suggestive evidence that students are more likely to cut their consumption levels of alcoholic products in general when facing an increase in prices. We similarly report in Table 2 compensated (Hicksian) own- and cross-price elasticities,

Table 1. Expenditure (μ_i) and uncompensated own- and cross-price (ε_{ij}) elasticity estimates

	Beer	Wine	Spirit	Vodka mix/ alcopop	Arak
μ_i					
Expenditure	−2.496***	1.513***	1.151***	−0.316***	1.813***
ε_{ij}					
Beer	3.538***	−0.733***	0.307*	1.234***	−1.850***
Wine	−0.757***	−0.738***	0.091***	−0.530***	0.421***
Spirit	−0.116***	0.028***	−1.133***	−0.089***	0.159***
Vodka mix/ alcopop	0.747***	−0.342***	0.031	0.692***	−0.811***
Arak	−0.744***	0.101**	0.181***	−0.526***	−0.826***

Note: *** $P < 0.01$,
** $P < 0.05$,
* $P < 0.10$.

Table 2. Compensated (Hicksian) own- and cross-price (ε^*_{ij}) elasticity estimates

	Beer	Wine	Spirit	Vodka mix/ alcopop	Arak
ε^*_{ij}					
Beer	3.242***	−1.131***	−0.732*	0.838***	−2.217***
Wine	−0.578***	−0.497***	0.721***	−0.290***	0.643***
Spirit	0.020	0.212***	−0.654***	0.094***	0.328***
Vodka mix/ alcopop	0.709***	−0.392***	−0.101	0.642***	−0.857***
Arak	−0.529***	0.390***	0.936***	−0.238***	−0.559***

Note: *** $P < 0.01$,
** $P < 0.05$,
* $P < 0.10$.

ε^*_{ij} derived from the same censored AIDS model. We rely on those elasticities to carry out the welfare analysis of the impact of MUP application on alcohol. This said, we note the positive uncompensated and compensated price elasticities for beer and vodka mixes/alcopops.

This suggests that among Lebanese youths, these beverages take on the characteristics of Giffen goods (Varian, 2003). One explanation could be that cash-strapped university students purchase beers and vodka mixes primarily because they are cheaper; increases in the prices of these beverages would further reduce their already limited purchasing power. This would in turn force them to redirect whatever little money they would spend on the more expensive substitutes to consuming more of them.

Simulating MUP scenarios

The first step in examining the impact of introducing MUP on alcohol consumption is to use the derived Marshallian (uncompensated) price and expenditure elasticities from the AIDS model (Table 1), which relies on the stated quantities purchased from each alcoholic beverage for a given price level given by the VCE data.

We introduce a beverage-specific MUP that selectively targets alcoholic beverages with high ethanol concentration, in a similar spirit to Chalak *et al.* (2020) who find that taxes targeting such beverages are more effective in reducing overall ethanol intake among youth. For high-ethanol-content beverages (spirits and arak), the MUP imposed corresponds to the 'maximum' price that respondents are willing to pay for that specific beverage. In contrast, the MUP is set to the 'average' price that respondents are willing to pay for beer, wine and vodka mix/alcopops.[3]

Table 3. Typical bottle/can volumes and ethanol concentrations for the various alcoholic beverage categories

Alcoholic beverage category (i)	Typical bottle/can volume (v_i)	Typical ethanol concentration (c_i)
Beer	33 cl	4.5%
Wine	75 cl	12%
Spirit	75 cl	40%
Vodka mix/alcopop	33 cl	10.5%
Arak	75 cl	50%

Next, we predict the impact of MUP on alcohol demand and ethanol intake. To this end, we use the basic expression of a price elasticity:

$$\varepsilon_{ij} = \frac{d\ln Q_i}{d\ln P_j} = \frac{\Delta \ln Q_i}{\Delta \ln P_j} \tag{1}$$

where ε_{ij} represents the constant Marshallian, or uncompensated, elasticity for any beverage i with respect to any beverage j (ε_{ij}), where i and j are any two alcoholic beverages from the set of products S available in the market. When i and j are identical, ε_{ij} becomes an own-price elasticity, when different, a cross-price elasticity. Q_i (see Chalak *et al.*, 2020 for details on how purchasing quantities were derived) and P_j are the quantity demanded and price of i and j, respectively. When price changes are considered across all beverages j in S, the change in the quantity consumed of beverage i is calculated as follows:

$$\Delta \ln Q_i = \sum_j \varepsilon_{ij} \Delta \ln P_j \tag{2}$$

With some manipulation, this leads to the following expression that predicts the proportion change in the demand for any beverage i in response to proportion increases in prices resulting from the imposition of MUP on the range of alcoholic beverages j in C:

$$\frac{\Delta Q_i}{Q_i} = \prod_j \left(\frac{\Delta P_j}{P_j} + 1\right)^{\varepsilon_i} - 1 \tag{3}$$

Finally, the proportion change in ethanol intake E can be derived as follows by summing up the relative ethanol intake changes affected by each beverage i in S:

$$\frac{\Delta E}{E} = \sum_i \frac{\Delta Q_i}{Q_i} \cdot c_i \cdot v_i = \sum_i \left(\prod_j \left(\frac{\Delta P_j}{P_j} + 1\right)^{\varepsilon_{ij}} - 1\right) \cdot c_i \cdot v_i \tag{4}$$

where c_i and v_i are the ethanol concentration and volume of the alcoholic unit (bottle/can) of beverage i typically encountered in the Lebanese market. Table 3 reports the types of alcoholic beverages considered in this study along with their unit (can or bottle) volume and ethanol content.

Results

Sample characteristics

Table 4 provides an overview of sample characteristics. The average age of respondents is around 21.5 years, with almost

Table 4. Sample characteristics

Label		Mean	SD
Age (years)		21.5	1.8
Gender			
Female		0.31	0.46
Education (% of participants)			
Freshmen	4.1%		
Sophomores	19.5%		
Juniors	24.6%		
Senior students	30.4%		
(5th year/beyond)	16%		
Graduates	5.2%		

69% being male and 31% female 'off-premise' PY drinkers. The majority of students were sophomore, junior and senior students (19.5%, 24.6% and 30.4%, respectively), with another 16% of undergraduates in their 5th year or more. The remaining respondents are either freshman (4.1%) or graduate (5.2%) students. In terms of drinking patterns, 65% of the 'off-premise' PY drinkers were classified as binge drinkers (i.e. consumed five or more drinks at least once in the preceding month). In terms of drinking preferences, around 27% of respondents were classified as 'high-ethanol' drinkers (i.e. reported consuming mostly or exclusively high-ethanol-content drinks such as arak and/or spirits), as opposed to 'low-ethanol' drinkers (73%) who more often drank beer, wine and/or vodka mix and alcopops in the preceding month.

Impact of MUP on alcohol demand and ethanol intake

By means of Equation (4), we investigate the impact of MUP introduction on alcohol demand, and, ultimately, aggregate ethanol intake, via the $\Delta P_j / -P_j$terms. ΔP_jin this case is equal to the difference between the newly introduced beverage-specific MUP and the price that individual respondents report paying for this beverage if the former is higher than the latter and 0 otherwise. MUP thus becomes analogous to a tax that selectively targets individuals who report paying a lower price (lower than the MUP) for a given beverage. Conversely, MUPs would have a null effect on individuals who report paying a price higher than the MUP ($\Delta P_j = 0$). In Table 5, we report our results for the changes in prices as a result of MUP introduction (i.e. terms). These results indicate that the most pronounced changes in prices are associated with spirits and arak beverages, whereas prices for beer, for instance, increased by only 18% as a result of MUP.

In Table 5, we also report the average proportion change of quantity of units of beverage *i* that respondents would consume as a result of MUP introduction. The positive signs indicate an increase in the demand for beer and wine that were targeted with a lower MUP in comparison to high-ethanol-concentrated beverages (spirits and arak). The change is close to zero for vodka mix/alcopop, whereas demand for spirits and arak (i.e. beverages targeted with a more pronounced MUP) decreases. These results provide evidence that cash-strapped students would shift their demand towards low-ethanol-concentration (and relatively cheaper) alcoholic beverages (beer and wine) as a result of the introduction of a selective MUP targeting high-ethanol-content beverages.

Table 5. The effects of targeted MUP on the demand for alcoholic beverages

	Percentage change in prices ($\Delta P_j / -P_j$)	
Alcoholic beverage category	**Mean**	**SD**
Beer	0.18	0.35
Wine	0.29	0.65
Spirit	5.09	4.47
Vodka mix/alcopop	0.50	0.81
Arak	1.82	2.27
	Average proportion change in quantity consumed ($\Delta Q_i / Q_i$)	
Alcoholic beverage category	Mean	SD
Beer	3.70	17.36
Wine	0.16	0.57
Spirit	−0.61	0.41
Vodka mix/alcopop	−0.01	0.71
Arak	−0.31	0.43

Table 6. The effects of targeted MUP on ethanol intake

	Ethanol intake change (ml/month)	
Alcoholic beverage category	**Mean**	**MUP (USD/can or bottle)**
Beer	54.89	$1.47
Wine	14.7	$20.66
Spirit	−182.9	$100
Vodka mix/alcopop	−0.4	$2.81
Arak	−115.0	$50
Total ethanol intake reduction (ml/month)	−228.8	
Pre-MUP ethanol intake (ml/month)	824.0	
% Ethanol intake reduction	−27.76%	

Results reported in Table 6 display the average change in ethanol intake for each beverage as a result of the MUP introduction. We find that selectively targeting high-ethanol-content beverages with a relatively higher MUP than for low-ethanol-content beverages achieves a considerable reduction in ethanol intake close to 0.23 l/month (∼28% of pre-MUP ethanol intake). Of note, introducing a flat MUP achieves a decrease in ethanol intake that is close to only 0.10 l/month, i.e. about half the size of the decrease with targeted MUP.

The reduction in ethanol intake as a result of the decrease in spirits, vodka mix/ alcopops and arak consumption is diluted by ethanol intake resulting from the increased consumption of beer and wine (i.e. shifting to low-ethanol-content and relatively cheaper alcoholic beverages). However, the overall reduction in ethanol intake (about 0.23 l/month or 28% of pre-MUP ethanol intake) remains larger than what is achieved using either a blanket taxation policy or a targeted one (were the tax is levied only on the high-alcohol-content beverages, namely spirits and arak). Chalak and colleagues report an overall decrease in ethanol intake of about 0.044 and 0.129 l/month (5% and 16% of pre-tax ethanol intake) when imposing a 20% blanket tax on all five alcoholic beverages and a 20% tax targeting only high-alcohol-content beverages, respectively (Chalak *et al.*, 2020). While the direction of our present results is in line with prior findings using

taxation (Chalak *et al.*, 2020), our estimates show more pronounced reductions in ethanol intake than alcohol taxes. This supports the need to introduce MUP alcohol policies to reduce youth alcohol consumption.

Welfare cost of MUP

In this section, we seek to evaluate the consumers' welfare cost induced by the introduction of selective alcohol MUP policy. To do so, we rely on estimating compensating variation (CV) that allows us to examine the effect of alcohol price increase affected by MUP on consumers' welfare. To this end, we follow Friedman and Levinsohn (2002) and account for both direct and indirect effects of price changes effected by the MUP introduction to the various alcoholic beverage types, not least substitution between various product types.

Let C be a minimum expenditure function, the compensating variation (CV) following the application of MUP across alcoholic beverages making up the set S can be derived as follows:

$$\Delta \ln C = \sum_i w_i \Delta \ln P_i + \frac{1}{2} \sum_i \sum_j w_i \varepsilon_{ij}^* \Delta \ln P_i \Delta \ln P_j \quad (5)$$

$$CV = \left(e^{\Delta \ln C} - 1 \right) C \quad (6)$$

where w_i is the share of expenditure out of total alcohol expenditure C allocated to beverage i prior to MUP introduction; $\Delta \ln C$ and $\Delta \ln P$ refer to proportional changes in alcohol expenditure and price of alcoholic beverages, respectively, due to the introduction of MUP. Finally, ε_{ij}^* is a compensated (Hicksian) own/cross-price elasticity derived from the AIDS model presented in Chalak *et al.* (2020).

Using Equations (5) and (6), we find that the average per month CV for alcohol-drinking youth in Greater Beirut is equal to LBP24 500 (USD16.3 in 2015). This means that selectively targeting alcoholic products with high ethanol concentration (spirits and arak) with MUP reduces youths' welfare by an average of USD16.3 per person per month. Therefore, for alcohol-drinking youth to maintain their initial welfare level (i.e. pre-MUP introduction), they need on average a compensation of USD16.3 per person per month. This is ~2% of the average monthly disposable income (USD205) that respondents reported.

Welfare benefits of MUP

To estimate the welfare benefits for alcohol-drinking youth from introducing selective MUP, we adopt a 'cost-of-illness' approach that focuses solely on alcohol-related car fatalities and injuries among youths due to their driving under the influence (DUI). We ignore all other alcohol-attributable diseases due to data limitations (Thavorncharoensap *et al.*, 2010). The scope of this study includes both the direct and indirect economic costs of these fatalities and injuries. We focus uniquely on hospital care costs as a measure of direct economic costs and on losses in future earnings due to premature deaths or work-related injuries to capture the indirect economic costs.

The first step is to estimate the Population Attributable Risk (PAR) for alcohol-related car fatalities and injuries among youths. The PAR is calculated as follows:

$$PAR = \frac{[P(RR-1)]}{[1+P(RR-1)]} \quad (7)$$

where P is the proportion of youth in Greater Beirut who drink alcohol and RR is the relative risk of alcohol on car fatalities and injuries among youths (i.e. ratio of incidence rates of deaths/injuries in two groups of youths, those who drink and those not exposed to drinking). It thus captures whether exposure to alcohol among youths affects the rate of car fatalities/injuries due to drunk driving.

We rely on 2011 estimates from Choueiri *et al.* (2015) who report that during that year, 35% of traffic fatalities (178 out of a total 508) and 45% of road traffic injuries (2718 out of a total of 6040) resulted from 4447 accidents that involved persons aged between 15 and 29 years (see Table 7). We further rely on Youth Association for Social Awareness (YASA) statistics reporting an average of nearly 33% of car accidents among youth leading to deaths being due to DUI of alcohol (Maloy, 2017). We assume this figure is the same for road injuries. Based on this figure, the total number of road traffic fatalities among youths due to DUI is 59 (33% of 178) and road traffic injuries among youths due to drunk driving is 897 (33% of 2718). In total, the number of traffic fatalities and injuries among youths due to DUI is 956, and the corresponding number for non-DUI traffic fatalities and injuries is 1940.

The relative risk is thus estimated at $RR = \frac{59}{956} / -\frac{119}{1940} = 1.006$, where the numerator and denominator denote the risk of accident fatality that is due to DUI and non-DUI, respectively. The Population Attributable Risk (PAR) for alcohol-related car fatalities and injuries among youths is therefore ~0.4%, assuming that 63% of youth in Greater Beirut drink alcohol, based on the survey data conducted by Chalak *et al.* (2020). Of note, the statistics on road fatalities and injuries are probably an under-estimation of the reality due to the absence of unified figures across different sources. For instance, Internal Security Forces exclude from their figures, car-crash victims who spent less than 6 days in the hospital as well as injured and dead military personnel (Khatib, 2002).

Next, we multiply the PAR with the direct and indirect economic costs of fatalities and injuries due to car accidents. The direct average medical cost of injuries is close to USD1056 per person, based on an average stay of road injured of 1.76 days in the hospital and an average cost of USD600 per day (Choueiri *et al.*, 2010). Correcting for ~50% inflation in 5 years (to adjust to 2015 prices, the time the survey was conducted), these costs are about USD1584 per person. Due to

Table 7. Authors' compilation of 2011 fatalities and injuries due to car crashes among Lebanese youth

Alcohol drinking	Fatalities	Injuries	Total
Yes	59[a]	897[a]	956
No	119	1821	1940
Total	178[b]	2718[b]	

[a] YASA reports 33% of youths' car accidents resulting in deaths are due to drunk driving (Maloy, 2017). We assume this figure is the same for road injuries.
[b] 35% of the total 508 fatalities in 2011 and 45% of the total 6040 injuries in 2011 (Choueiri *et al.*, 2015).

data limitations, we assume that these costs are the same for car fatalities.

The indirect average cost of fatalities is estimated at about USD23 000, calculated by computing the net present value of lost future earnings due to premature deaths.[4] The total cost of fatalities is thus obtained by summing up the direct and indirect average medical costs of fatalities, and these are about USD24 000 on average per person. With regard to the indirect average costs of injuries, they are estimated at USD250 per person, obtained by assuming that the person takes 5 days off from work due to injury and then by multiplying this by the average daily wage, assuming a USD1000/month average wage in 2015 and a 35% probability of work for youth. The total cost of injuries is about USD1800 on average per person.

As shown earlier, the consumers' welfare cost induced by the introduction of selective alcohol MUP policy (or the CV) amounts to USD16.3 per person per month. The welfare benefit for alcohol-drinking youth from introducing selective MUP is about USD19 per person per month. This is obtained by applying the PAR to the total (direct and indirect) costs of road traffics resulting in fatalities and injuries.

This means that introducing a targeted alcohol MUP policy that selectively focuses on high-ethanol-concentrated beverages yields a positive welfare benefit of about USD2.7 per person per month among youths. Since the sample of 'off-premise' PY drinkers is recruited from the Greater Beirut area, we refrain from extrapolating our findings to Lebanon. Future research must aim to collect data on youth from across Lebanon to enable drawing inferences from different contexts and carrying out cross-areas analysis.

Discussion

Alcohol MUP is a novel public health policy introduced in several countries in the last decade including Belarus, Kyrgyzstan, the Republic of Moldova, the Russian Federation and Ukraine (WHO, 2014). Scotland was the first country to implement alcohol MUP in 2018 by setting a floor price for a unit of alcohol (currently 50 pence per unit) at the national level (Scottish Government, 2019). Ireland, Australia and New Zealand are currently reviewing alcohol MUP policies (Department of Health Ireland, 2015; Australian National Preventive Health Agency, 2012; New Zealand Ministry of Justice, 2020). Empirical evaluations of MUP policies are best documented and limited to some provinces in Canada (Stockwell *et al.*, 2012; Zhao *et al.*, 2013). MUP has led to a substantial decrease in alcohol consumption in different Canadian provinces including British Columbia and Saskatchewan (Stockwell *et al.*, 2012). Significant health benefits (reduction in the prevalence of deaths and hospital admissions due to alcohol) were also recorded in British Columbia following an increase in minimum alcohol prices (Zhao *et al.*, 2013).

Comparing our findings to other studies is challenging for a number of reasons. For example, our analysis is mainly based on a comparative examination of various MUP scenarios that provides a deep contrast between targeted vs flat MUP. Our analysis additionally allows for a comparison between MUP and taxation, in terms of alcohol consumption changes and ethanol intake. The most relevant study is perhaps Chalak *et al.* (2020), which offers insights on the impact of various taxation schemes on alcohol consumption and ethanol intake among youths in Lebanon. We find that ethanol intake reductions following the introduction of a targeted MUP exceed that of what is achieved with flat or targeted taxation policies. The reduction in ethanol intake is ~28% of pre-MUP ethanol intake levels with targeted MUP in comparison to 5% and 16%, respectively, with flat and targeted taxation policies (Chalak *et al.*, 2020).

Given that the introduction of MUP policies is relatively recent, substantive research on its impact is still missing from the literature. Evaluation of the impact of MUP introduction in Scotland for instance is still ongoing, with the final report to be published in 2023. Lastly, our analysis relies on a SP approach, while other studies use real alcohol market data. This makes any comparison challenging and subject to scepticism because SP-based demand forecasts do not enjoy the same face validity as their real market data counterparts.

Our results however converge towards that of other studies in terms of direction, by documenting a decrease in alcohol consumption and ethanol intake. While already existing research documents a decrease in the prevalence of deaths and hospital admissions due to alcohol following MUP introduction (Zhao *et al.*, 2013), a comprehensive welfare analysis has not been carried out yet, to the best of our knowledge.

One concern is a possible substitution between expensive alcoholic beverages, as a result of these policies, and cheaper alcoholic products (WHO, 2018). Our results show evidence in support of substitution towards cheaper alcoholic products. We showed an increase in the demand for beer and wine (cheaper beverages), which were targeted with a lower MUP, in comparison to high-ethanol-concentrated beverages (spirits and arak). Consequently, the ethanol intake reduction is attenuated by the higher consumption demand for cheaper alcoholic beverages. Substitution, therefore, may strongly attenuate the impact of these policies whether through a cross-beverage shift among alcohol consumers, or a substitution within beverages across brands, or via a shift from taxed beverages to non-taxed or unrecorded beverages (Chalak *et al.*, 2020).

Other options would be for consumers to switch to off-premise consumption of alcohol, which is typically cheaper than on-premise purchase of alcoholic products (Jiang *et al.*, 2016). The effectiveness of alcohol taxation and pricing policies has been documented in the literature to be less pronounced as a result of unrecorded alcohol consumption (Anderson *et al.*, 2009). In our analysis, we focus on off-premise drinkers and examine the impact of introducing alcohol MUP targeting off-premise alcohol prices. This means that a plausible limitation to this study is the fact that consumers may switch to on-premise purchase of alcoholic products as a result of MUP introduction. While this is true, we believe that for our sample of university students, consumers are more likely to be largely off-premise drinkers, particularly given that it is a cheaper option for them.

In this realm, it becomes crucial that fiscal policies target simultaneously all alcohol beverages (regardless of their ethanol levels) and both on-premise and off-premise prices for them to contribute collectively significantly to lowering ethanol intake without reverting to substitution.

Another concern is whether these policies can successfully target heavy drinkers rather than targeting social drinkers (The Partnerships for SDGs Online Platform, 2017). Concerns with increasing MUP for alcoholic beverages have centred around the potential effect on responsible drinkers and individuals with low income. Modelling studies designed to estimate the effects of MUP if it were to be implemented in

the UK showed that MUP would impose the greater burden on heavy rather than moderate drinkers and that regressive effects, if they existed, would be small, concluding that alcohol consumption reductions would translate into significant health benefits (Griffith *et al.*, 2013; Holmes *et al.*, 2014; Ludbrook *et al.*, 2012; Purshouse *et al.*, 2010). In Appendix Table 1, we push our analysis further and repeat our estimations by subpopulation groups. Particularly, we examine alcohol consumption and ethanol intake reductions for female and male respondents separately. We also carry out this analysis by the intensity of drinking as well as alcohol preference. To do so, we rely on price elasticities modelled using AIDS for the subgroup in question. Our results reveal that, while targeted MUP results in an overall reduction of alcohol consumption and ethanol intake that exceeds that of a flat MUP or broad/targeted taxation policies, introducing such a policy yields more pronounced ethanol intake reductions for young women than for young men. Our results also provide suggestive evidence that targeted MUP is weak at targeting heavy and regular drinkers. This is because the latter group of consumers shift substantially towards low-ethanol-content beverages. MUP policies that set a low minimum price for high-image alcoholic products with low ethanol content might induce initiation of alcohol consumption since initiation often occurs via low-alcohol-content beverages (Sornpaisarn *et al.*, 2012; Jernigan, 2001). One study highlights a potential disadvantage of using MUP, in terms of increased profit benefitting alcohol producers due to increases in selling prices, which might be counter-beneficial for public health (Sornpaisarn *et al.*, 2012). The absence of tax revenues might weigh some welfare implications. These concerns combined again stress the need for fiscal policies, such as MUP (and taxation), to not only be evidence-informed but also contextualized to avoid any unintended and undesirable consequences. Further research should investigate simultaneously the impact of MUP if implemented alongside reformed alcohol taxes.

Despite its strengths, our study is unable to deal with any concern regarding the impact of MUP on alcohol initiation among previous abstainers due to the type of data collected as well as the sample considered. An additional caveat is that our study relies on a SP approach using hypothetical scenarios due to weak and almost absent real market alcohol data. It remains thus crucial to ensure a better quality of data and for future research to carry a revealed preference estimation.

Conclusion

Our findings suggest that selectively targeting drinks with high ethanol concentration by applying a MUP corresponding to the maximum price that respondents are willing to pay per beverage achieves a reduction in ethanol intake close to 0.23 l/month (~28% of pre-MUP ethanol intake). This decrease in ethanol intake exceeds that achieved by flat or targeted alcohol taxation policies. Our welfare analysis reveals a positive welfare of about USD2.7 per person per month.

Alcohol control policies in Lebanon, including sales to minors and DUI, are weakly enforced, if at all. Consequently, alcohol-related harms, including alcohol-related car fatalities and injuries, remain a major public health concern in the country. This research study helps quantify the health benefits, through an economic cost–benefit analysis, from introducing an alcohol MUP policy, particularly, by reducing both the direct and indirect economic costs of fatalities and injuries. While we are unable to quantify the implications on alcohol-attributable diseases due to data limitations, we do think that our 'cost-of-illness' approach, which focuses solely on DUI-related car fatalities and injuries among youths, is fundamental. Introducing alcohol MUP policy in Lebanon should further be accompanied by a strong and formal enforcement framework, as well as a more 'serious' implementation of the already in place Lebanese traffic law. This would reduce the likelihood of hospitalization and losses in future earnings due to premature deaths or work-related injuries, in addition to benefits in terms of lower alcohol–attributable disease prevalence.

Our findings have interesting policy implications. First, we provide evidence on the benefit of introducing MUP as an effective pricing policy, besides alcohol taxation, that reduces ethanol intake and yields welfare benefits (reduction in both monetary and health costs induced by alcohol-related car crashes). A future potential study should aim at investigating the impact of complementing alcohol taxation and MUP on ethanol intake, welfare benefits and the induced welfare costs.

Data availability

The data underlying this article cannot be shared publicly due to in order to safeguard the anonymity of the individuals that participated in the study.

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Author contributions

- Conception or design of the work: J.C., J.H., L.G. and A.C.
- Data collection: J.H.
- Data analysis and interpretation: J.H. and A.C.
- Drafting the article: J.H.
- Critical revision of the article: J.C., J.H., L.G. and A.C.
- Final approval of the version to be submitted: J.C., J.H., L.G. and A.C.

Ethical approval. Ethical approval to conduct survey-based data collection was received from the Institutional Review Board at the American University of Beirut.

Conflict of interest statement. None declared.

Notes

1. Chalak *et al.* (2020) forecast the impact of two tax scenarios on the overall ethanol intake among university students in Lebanon. The first is a broad-based tax scenario that imposes 20% tax on all types of alcoholic beverages, and the second scenario imposes a

targeted 20% tax only on the high-ethanol-content beverages, while exempting the lower-ethanol-content beverages. Findings from this study document that targeted taxes achieve an overall reduction in ethanol intake that is almost three times that which is achieved by broad-based taxes.

2. Unlike in a standard DCE, our VCE allows respondents to choose from more than one option, including the possibility of purchasing from all beverage categories or none. Additionally, respondents have the possibility to specify the number of units to purchase from each of the chosen options. This better mimics real market situations in which alcohol consumers can buy many units from multiple beverage types. An experimental design with an information structure maximizing a D_0-optimal criterion was adopted to compute 40 choice sets that were further divided into eight blocks (five-choice sets each) and that were randomly administered to respondents.
3. In another scenario, we impose an MUP equal to the maximum willingness to pay rather than the average price respondents report willing to pay for vodka mix/alcopops. We however fail to find a decrease in ethanol intake. This might be explained by the fact that alcopops remain the cheapest alcoholic option among cash-strapped students.
4. We assume that premature death occurs at maximum age 29 years and that workers retire at 64 years. The average monthly salary is USD1000/month in 2015, and the probability of working for youth is 35% (as per labour date in 2014 by the Central Agency for Statistics). To calculate the present value, the discount rate inclusive of inflation adjustment is assumed at 3% for that time frame.

References

Alcohol and Public Policy Group. 2010. Alcohol: no ordinary commodity–a summary of the second edition. *Addiction* **105**: 769–79.

Anderson P, Chisholm D, Fuhr DC. 2009. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. *The Lancet* **373**: 2234–46.

Angus C, Holmes J, Pryce R, Meier P, Brennan A. 2016. Model-based appraisal of the comparative impact of minimum unit pricing and taxation policies in Scotland an adaptation of the Sheffield Alcohol Policy Model version 3. ScHARR, University of Sheffield.

Australian National Preventive Health Agency. 2012. Exploring the public interest case for a minimum (floor) price for alcohol, Canberra.

Brennan A, Meng Y, Holmes J, Hill-McManus D, Meier PS. 2014. Potential benefits of minimum unit pricing for alcohol versus a ban on below cost selling in England 2014: modelling study. *BMJ* **349**: g5452.

Brennan A, Purshouse R, Taylor K, Rafia R. 2008. Independent review of the effects of alcohol pricing and promotion: Part B. Modelling the potential impact of pricing and promotion policies for alcohol in England: results from the Sheffield Alcohol Policy Model version 2008 (1-1). ScHARR University of Sheffield.

Burton R, Henn C, Lavoie D *et al.* 2017. A rapid evidence review of the effectiveness and cost-effectiveness of alcohol control policies: an English perspective. *The Lancet* **389**: 1558–80.

Chalak A, Ghandour L, Anouti S *et al.* 2020. The impact of broad-based vs targeted taxation on youth alcohol consumption in Lebanon. *Health Policy and Planning* **35**: 625–34.

Choueiri EM, Choueiri GM, Choueiri BM. 2010. Analysis of accident patterns in Lebanon. *4th International Symposium on Highway Geometric Design*, 1–22.

Choueiri EM, Choueiri GM, Choueiri BM. 2015. Road safety in Lebanon: magnitude, cost and potential countermeasures. *Advances in Transportation Studies* **35**: 73–88.

Cnossen S. 2005. *Theory and Practice of Excise Taxation: Smoking, Drinking, Gambling, Polluting, and Driving*. New York: Oxford University Press.

Collins DJ, Lapsley HM. 1996. National Drug Strategy Monograph Series No. 30. http://www.health.gov.au/pubhlth/publicat/document/mono30.pdf.

Delipalla S, Keen M. 1992. The comparison between ad valorem and specific taxation under imperfect competition. *Journal of Public Economics* **49**: 351–67.

Department of Health Ireland. 2015. *The Public Health (Alcohol) Bill 2015*. http://health.gov.ie/blog/publications/public-health-alcohol-bill-2015/, accessed 25 April 2021.

Devlin NJ, Scuffham PA, Bunt LJ. 1997. The social costs of alcohol abuse in New Zealand. *Addiction* **92**: 1491–505.

ESPAD Group. 2020. *ESPAD Report 2019: Results from the European School Survey Project on Alcohol and Other Drugs. EMCDDA Joint Publications, Publications Office of the European Union, Luxembourg*. http://www.espad.org/sites/espad.org/files/2020.3878_EN_04.pdf, accessed 25 April 2021.

Fenoglio P, Parel V, Kopp P. 2003. The social cost of alcohol,tobacco and illicit drugs in France, 1997. *European Addiction Research* **9**: 18–28.

Friedman J, Levinsohn J. 2002. The distributional impacts of Indonesia's financial crisis on household welfare: a "rapid response" methodology. *The World Bank Economic Review* **16**: 397–423.

Ghandour L, Chalak A, El-Aily A *et al.* 2016. Alcohol consumption in the Arab region: what do we know, why does it matter, and what are the policy implications for youth harm reduction? *International Journal of Drug Policy* **28**: 10–33.

Griffith R, Leicester A, O'Connell M. 2013. Price-based measures to reduce alcohol consumption. *IFS Briefing Note BN138*. London: Institute for Fiscal Studies. March 2013.

Hill-McManus D, Brennan A, Stockwell T *et al.* 2012. *Model-based Appraisal of Alcohol Minimum Pricing in Ontario and British Columbia: A Canadian Adaptation of the Sheffield Alcohol Policy Model Version 2*. ScHARR, Sheffield, UK: University of Sheffield.

Hirshleifer J, Glazer A, Hirshleifer D. 2005. *Price Theory and Applications*. New York: Cambridge University Press.

Holmes J, Meng Y, Meier PS *et al.* 2014. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. *The Lancet* **383**: 1655–64.

Jarl J, Johansson P, Eriksson A *et al.* 2008. The societal cost of alcohol consumption: an estimation of the economic and human cost including health effects in Sweden, 2002. *The European Journal of Health Economics : HEPAC : Health Economics in Prevention and Care* **9**: 351–60.

Jernigan DH and WHO. 2001. Global status report: alcohol and young people (No. WHO/MSD/MSB/01.1). World Health Organization.

Jiang H, Livingston M, Room R, Callinan S. 2016. Price elasticity of on-and off-premises demand for alcoholic drinks: a Tobit analysis. *Drug and Alcohol Dependence* **163**: 222–8.

Khatib H. 2002. Counting the cost of road accidents. 27 February. *The Daily Star*. https://www.dailystar.com.lb/ArticlePrint.aspx?id=35125&mode=print, accessed 23 April 2021.

Louviere J, Ribeiro T, Carson RT. 2016. Volumetric choice experiments. *19th Sawtooth Software Conference; September 26-30, 2016*. Park City, Utah.

Lu H, Hess S, Daly A, Rohr C. 2017. Measuring the impact of alcohol multi-buy promotions on consumers' purchase behaviour. *Journal of Choice Modelling* **24**: 75–95.

Ludbrook A, Petrie D, McKenzie L, Farrar S. 2012. Tackling alcohol misuse: purchasing patterns affected by minimum pricing for alcohol. *Applied Health Economics and Health Policy* **10**: 51–63.

Maloy TK. 2017. AUB: Lebanese youth drinking earlier and more often in dangerous trend. *An-Nahar*. 2 February. https://www.annahar.com/english/article/533474-aub-lebanese-youth-drinking-earlier-and-more-often-in-dangerous-trend, accessed 23 April 2021.

Mandil A. 2009. Commentary: Mosaic Arab world, health and development. *International Journal of Public Health* **54**: 361–2.

Martineau F, Tyner E, Lorenc T, Petticrew M, Lock K. 2013. Population-level interventions to reduce alcohol-related harm: an overview of systematic reviews. *Preventive Medicine* **57**: 278–96.

Meier PS, Purshouse R, Brennan A. 2010. Policy options for alcohol price regulation: the importance of modelling population heterogeneity. *Addiction* **105**: 383–93.

Meng Y, Hill-McManus D, Brennan A, Meier P. 2012. Model-based appraisal of alcohol minimum pricing and off-licensed trade discount bans in Scotland using the Sheffield alcohol policy model (v 2): second update based on newly available data. Sheffield: ScHARR, University of Sheffield.

National Institute on Drug Abuse. 2020. *Monitoring the Future 2020 Survey Results*. https://www.drugabuse.gov/drug-topics/related-topics/trends-statistics/infographics/monitoring-future-2020-survey-results, accessed 21 April 2021.

New Zealand Ministry of Justice. 2020. *Alcohol Minimum Pricing Policies*. https://justice.govt.nz/justice-sector-policy/key-initiatives/sale-and-supply-of-alcohol/alcohol-minimum-pricing-report/, accessed 3 May 2021.

The Partnerships for SDGs Online Platform. 2017. *International Alliance for Responsible Drinking (IARD)*. 28 June. https://sustainabledevelopment.un.org/partnership/?p=11935, accessed 23 April 2021.

Pechey R, Burge P, Mentzakis E, Suhrcke M, Marteau TM. 2014. Public acceptability of population-level interventions to reduce alcohol consumption: a discrete choice experiment. *Social Science & Medicine* **113**: 104–9.

Purshouse R, Meng Y, Rafia R, Brennan A, Meier P. 2009. Model-based appraisal of alcohol minimum pricing and off-licensed trade discount bans in Scotland: a Scottish adaptation of the Sheffield alcohol policy, model version 2. Sheffield, England: ScHARR, University of Sheffield.

Purshouse RC, Meier PS, Brennan A *et al.* 2010. Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model. *The Lancet* **375**: 1355–64.

Rehm J, Room R, Graham K *et al.* 2003. The relationship of average volume of alcohol consumption and patterns of drinking to burden of disease: an overview. *Addiction* **98**: 1209–28.

Scottish Government. 2019. *Alcohol and Drugs: Minimum Unit Pricing*. https://www.gov.scot/policies/alcohol-and-drugs/minimum-unit-pricing/, accessed 23 April 2021.

Sharma A, Etilé F, Sinha K. 2016. The effect of introducing a minimum price on the distribution of alcohol purchase: a counterfactual analysis. *Health Economics* **25**: 1182–200.

Shield KD, Parry C, Rehm J. 2014. Chronic diseases and conditions related to alcohol use. *Alcohol Research: Current Reviews* **35**: 155–73.

Sornpaisarn B, Shield KD, Rehm J. 2012. Alcohol taxation policy in Thailand: implications for other low- to middle-income countries. *Addiction* **107**: 1372–84.

Stockwell T, Auld MC, Zhao J, Martin G. 2012. Does minimum pricing reduce alcohol consumption? The experience of a Canadian province. *Addiction* **107**: 912–20.

Thavorncharoensap M, Teerawattananon Y, Yothasamut J *et al.* 2010. The economic costs of alcohol consumption in Thailand, 2006. *BMC Public Health* **10**: 1–12.

Vandenberg B, Sharma A. 2016. Are alcohol taxation and pricing policies regressive? Product-level effects of a specific tax and a minimum unit price for alcohol. *Alcohol and Alcoholism* **51**: 493–502.

Varian HR. 2003. *Intermediate Microeconomics: A Modern Approach*. (6th ed.). New York, London: W. W. Norton and Company.

Wagenaar AC, Salois MJ, Komro KA. 2009. Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 estimates from 112 studies. *Addiction* **104**: 179–90.

Wagenaar AC, Tobler AL, Komro KA. 2010. Effects of alcohol tax and price policies on morbidity and mortality: a systematic review. *American Journal of Public Health* **100**: 2270–8.

WHO. 2014. European status report on alcohol and health 2014. Pricing policies. *World Health Organization*. http://www.euro.who.int/__data/assets/pdf_file/0003/244902/Pricing-policies.pdf, accessed 25 April 2021.

WHO. 2018. *Global Status Report on Alcohol and Health 2018*. Geneva, Switzerland: World Health Organization.

Zhao J, Stockwell T, Martin G *et al.* 2013. The relationship between minimum alcohol prices, outlet densities and alcohol-attributable deaths in British Columbia, 2002–09. *Addiction* **108**: 1059–69.

Appendix

Table 1. The effects of targeted MUP on ethanol intake by subgroups

	Gender		Binge drinking		Alcohol type preference	
Targeted MUP	Female	Male	Past-month binge drinkers[a]	Non past-month binge drinkers	High-ethanol drinkers[b]	Low-ethanol drinkers
Ethanol intake change (ml/month)						
Beer	113.14	51.29	1834	4.58	65 479	19.84
Wine	0.37	29.01	46.35	−13.64	36.06	13.03
Spirit	−158.16	−193.9	−208.19	−132.92	−230.96	−164.08
Vodka mix/alcopop	6.715	−5.46	9.07	−4	20.03	−4.04
Arak	−163.04	−76.03	−89.02	−127.19	−82.4	−76.41
Total ethanol intake reduction (ml/month)	−200.98	−195.09	1592.21	−273.17	65 221.73	−211.66
Pre-MUP ethanol intake (ml/month)	614.42	917.9	917.02	630.79	1405.318	577.88
% Ethanol intake reduction	−32.71%	−21.25%	173.63%	−43.31%	4641.06%	−36.62%

[a]Consumed 5+ drinks at least once in the past month (binge drinking).
[b]Consumed high-ethanol drinks on as many or more occasions as low-ethanol drinks in past month (alcohol type preference).