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Understanding the heterogeneous nature of the demand for soft drinks in Mexico: why social determinants also matter.

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ABSTRACT

Background. Soft drink consumption is a risk factor for obesity and non-communicable chronic diseases, and policies to reduce it have been proposed around the world, including taxation. Little is known about the role of other social and economic factors on the demand of such goods. In addition, heterogeneity of the demand due to different levels of consumption has been rarely explored. The aim of this study is to analyse the heterogeneous nature of the demand for soft drinks to understand the role of economic and social factors (provision of safe water /local food market conditions) and draw recommendations for the design of obesity prevention. **Methods.** Population, cross-sectional analysis of household data from the Mexican Family Life Survey, grouped into three consumption groups (low/medium/high consumers, defined by the proportion of total household expenditure devoted to soft drink purchases) and three economic poverty groups (defined by extreme and moderate income poverty lines). Multivariate probit regressions were applied to explore factors associated to the probability to be a consumer, and simultaneous multivariate quantile regressions were used to model the quantity purchased of soft drinks. Heckman's procedure was used to control for identification bias. **Results.** The adjusted probability that a household becomes a consumer is significantly higher with male, educated heads of households and higher household income. Living in localities where access to safe water for drinking and cooking needs is not universal significantly increases the probability to consume soft drinks while living in localities with convenience stores and supermarkets (local food market condition) significantly decreases it, especially in households facing extreme poverty. Demand from low-consumption households is price-inelastic (-0.97) compared with high-consumers (-1.2). Yet when the population is grouped by poverty, households in extreme poverty have a higher significant price-elasticity (-1.5) than those above moderate poverty line (-1.3). **Conclusions.** In order to design policies that adequately affect the demand for soft drinks on high consumers and benefit the poor, social factors should be considered. A comprehensive obesity prevention strategy should complement taxes with policies that affect social determinants such as the local provision of safe water and local food market conditions.

Keywords: household consumption; obesity; soft drink; heterogeneity; prices; poverty; Mexico

Introduction

The increasing prevalence of obesity is of global concern as it represents a risk factor for non-communicable chronic diseases (NCCD) such as diabetes, cardiovascular diseases and some types of cancer. [1] These health problems are responsible for 1% to 3% of total health expenditure in the world, requiring high-cost technologies for their treatment [2] and high levels of health fund spending in the medium and long term. [3,4] On a global scale, obesity is related to the average loss of 3,371,232 disability-adjusted life years. [5] According to projections of the Organisation for Economic Co-operation and Development (OECD), more than two out of three adults in the world will be overweight in 2020.¹[2]

Soft drink consumption is related to the development of obesity, [6-7] and NCCD like diabetes, [8-9] and cardiovascular diseases, [10-11] causing near to 184,000 deaths around the world. [12] The consumption of soft drinks is associated with both individual and household factors (sex and age of the head of household, number and age of the members in the household), and factors such as the food and beverage availability and accessibility, globalization, urbanization and migratory processes, combined with demographic and epidemiological transitions.

Given the increasing prevalence and burden of disease of obesity, [5] international agencies such as the World Health Organization (WHO) [14] and the OECD [4] have recommended the design and implementation of public health initiatives that reduce soft drink consumption, including mass media campaigns to promote plain water consumption, soft drinks' sale restrictions in schools, and taxation schemes. [14-16] Evidence to support these initiatives is based on studies of the demand for soft drinks, which calculate price-elasticity on different settings. Price change through taxation is expected to induce positive consumption pattern changes such as the intake of healthier beverages and other outcomes promoting body weight loss. [17-20] Additionally, this strategy is expected to generate an increase of fiscal revenues, which could be directed to finance other actions on health promotion, including disease prevention (which itself could be an indirect effect of taxation policies).

Despite such promise, studies indicate that consumers have limited responsiveness to soft drink taxes. [21-22] Evidence from the United States shows that there is no significant association between state-level soft drink taxes and body mass index, [21-22] a result that could be explained more by the presence of low tax rates than by the price sensitivity of the demand, as some researchers claim. Nevertheless, a growing number of studies are supporting the idea that a tax could have potential effects on consumption and health on the base of mathematical modelling using economic data of average consumers.

Since a tax policy on soft drinks could eventually have a direct impact in reducing demand and household income, characterizing the heterogeneity of the demand for soft drinks considering differences in the levels of household income and soft drink consumption would allow designing more effective and equitable obesity prevention initiatives. Thus, without considering this type of heterogeneity, the evaluation of policies designed to change consumers' behaviour would provide only partial information regarding their effects (redistributive, revenue and health-related, among others) on populations with different levels of consumption (high, medium and low), expenses and income. Those effects have been emphasized in other studies related to soft drinks and alcohol demand. [23-24]

The aim of this study is to analyse the heterogeneous nature of the demand for soft drinks including relevant economic (price/income) and social factors (provision of safe water /local food market conditions), and considering different levels of soft drink consumption and poverty, to draw recommendations for the design of obesity prevention initiatives. We used Mexican data as Mexico stands out as the world's largest soft drink consumer per capita. According to The Coca-Cola Company's 2011 Annual Review, Mexicans annually drink 165.5 litres of the company's products, vastly surpassing the consumption of other countries such as the United States. [25] An average of three out of four Mexicans consumes soft drinks on a daily basis. [26-27] About 2.4% and 4.7% of the daily energy intake of children aged 0 to 4 and 5 to 11, respectively, is obtained from soft drinks, [26] whereas in teenagers this proportion rises to 6.6%. [26-29]

METHODS

A cross-sectional analysis on the demand for soft drinks was carried out using the Mexican Family Live Survey (*ENNVIH*, as per its Spanish acronym), a multipurpose survey that collects information on various dimensions of well-being of the Mexican population.² This survey has a probabilistic, stratified, multistage and clustered sample design. It is representative at the national, rural-urban and regional level. The first phase of this survey was implemented in 2002 and included interviews with members of 8,440 households in 150 localities in 16 Mexican states. The second phase was implemented during the first semester of 2005, although fieldwork was extended until 2006 in order to track individuals who had moved since 2002. [30] As a result, re-contact rates higher than 90% were obtained. A total number of 8,434 households completed the second phase. Even though a third phase was implemented in 2008-2009, data is not publicly available.

For this work we focused on household consumption registers in the week preceding the survey. The person who regularly was responsible for household purchases (head of household or spouse) was asked the quantity, the amount disbursed and the price paid for a range of perishable and non-perishable products, including self-consumption and gifts. Additionally, the market price for standardized products was collected using a local-level survey applied to commercial establishments. In addition to weekly information, data on monthly consumption were collected for those households that reported zero consumption during the week prior to the survey in order to reduce distortions due to the short length of the reference period (seven days).

The unit of analysis was the household. From a total of 8,434 households interviewed, we excluded households with incomplete information on characteristics of the household head (gender, age, schooling, indigenous status, etc.), household expenditure and local prices. Thus, the final sample was composed of

7,501 households (88.9%), from which 4,921 (65.6%) reported having consumed soft drinks over the last month/week.

Variables

The amounts of litres purchased and expenditure on soft drinks on a monthly basis were included as dependent variables, representing the total soft drink household consumption (demand). These variables were expressed per capita, adjusted by adult equivalence scales using the Engel method. [31] For the purpose of this study, "soft drinks" were defined as carbonated beverages without distinction of taste or whether they are diet or regular.³ Soft drink demand was estimated from all purchase records on soft drinks during the week/month prior to the survey.

Expenditure on soft drinks was expressed as a percentage of monthly household expenditure. Monthly household expenditure was estimated by adding all purchase records of perishable and non-perishable goods. Spline functions representing terciles were used to soften the expenditure distribution. [32] Theoretically, household expenditure is a good average approximation of household income. [33]

Monthly household food expenditure includes purchases in the following groups of products: fruits and vegetables, cereals and grains, meat and animal products, industrialized products, tortillas, bakery products and soft drinks. The price of the most representative good in terms of expenditure within each food group has been included. The price per litre of soft drink at the locality level has been obtained as the average price per litre in bottles of 600 ml and cans of 355 ml reported at the locality level.

Characteristics of the household head considered as potential confounders were age, education, sex, and indigenous status. Additionally, we included the proportion of household members of different age groups, the geographical region where the household is located, the size of the locality (rural $\leq 2,500$ inhabitants), the level of municipal deprivation published by the *Consejo Nacional de Población*

(National Population Council), [34] and the percentage of households with safe drinking water in the locality. Seasonality was controlled by including the period of the year during which information was collected, as it could influence both the decision and the amount of soft drinks consumed, as reported in the available literature. [35] In addition, the type of establishment from which food prices were obtained at the local level (supermarkets and convenience stores, small stands, marketplaces, and itinerant markets) was included as an explanatory variable since it allows controlling for the availability of food and soft drinks. We presume that due to the high cost of preserving perishable goods, establishments in small localities (frequently small stands) are more likely to have a greater share of products on offer to be industrialized food and beverages (such as soft drinks) than fruits, vegetables, and plain water.

To analyse heterogeneity attributable to poverty, households were grouped by income poverty thresholds (extreme poverty and moderate poverty⁴) following the criteria established by the National Council for Social Development Policy Evaluation (*CONEVAL*, as per its Spanish acronym). [36] Household expenditure per equivalent adult [31] in rural areas and urban areas⁵ was used as a proxy to income. To evaluate heterogeneity due to the intensity of consumption, households were grouped in terciles of the distribution of soft drink expenditure as a proportion of food expenditure. In doing so, households where soft drink expenditure represents 3.4% or less of their food spending are considered *low* consumers (Tercile 1); those whose soft drink expenditure rises above 3.4% without exceeding 7% of their food spending are considered *medium* consumers (Tercile 2); and households whose soft drink expenditure is greater than 7% of their food spending are considered *high* consumers (Tercile 3).

Methods

The heterogeneity of the Mexican demand for soft drinks is examined in two ways. The first one presents multivariate regressions for different levels of household poverty. The second one applies multivariate regressions for different levels of consumption, as carried out in other studies on soft drinks, [23] alcohol, [24] fruits and vegetables, [37] and cigarettes. [38] In both strategies, coefficients represent elasticities,

which indicate the percentage variation of soft drink consumption, given a variation of one percent in the price of the soft drink (price elasticity) or in the household income (income elasticity). Elasticity coefficients correspond to the regression coefficients in log-log regression models.

The general model used in this study is defined as follows:

$$\ln q_{refi} = \alpha + \beta_1 \ln p_{ref} + \beta_2 \ln p_{other} + \beta_3 \ln y_i + \beta_4 X + \varepsilon_i \quad (1)$$

where q_{ij} is the soft drink consumption per household i , $q_{ij} \in (0, \infty)$; p_{ref} is the price of soft drinks; p_{other} is a vector of the prices of other goods; y_{ij} is the household income; and X are control variables such as sex, age, education, and indigenous status of the household head, the total number of household members, the proportion of household members by age group, the size of the locality, the level of municipal deprivation, the percentage of households with access to piped water (as per availability in the locality), the season during which information was collected, and the geographical area where the household is located.

In a log-log model, β_1 represents the income-compensated price elasticity (Hicksian) and β_3 the income elasticity of demand. Tests carried out to detect multicollinearity in the model indicated the absence of such a phenomenon with the considered specification. This general model has been applied to all households, as well as the following sub-samples: non-consumers (consumption=0), consumers (consumption>0), consumers by socioeconomic level, consumers by poverty level, and consumers by intensity of soft drink consumption.

Correction by selection bias

In recognition of the possibility of a selection bias due to the number of households reporting zero consumption of soft drinks, models for each sub-population were estimated through a two-step Heckman procedure. First, we estimated the probability that the household consumes soft drinks, given prices, household expenditure and other household characteristics, using a probit model. For each sample observation, the inverse Mills ratio (lambda, λ) is estimated. The λ is significantly different from zero if a

selection process of the households exists at the time of consumption. Taking this indicator into account, the quantity consumed is estimated by ordinary least squares.

We selected two different variables as possible determinants of the likelihood of consumption of soft drinks: a) the percentage of households with piped drinking water as a source for drinking and cooking purposes in the locality, considering that in these localities where the provision of piped water is less than 100%, the households are more likely to consume soft drinks; and b) the presence of supermarkets and/or convenience stores in the locality, on the assumption that households living in localities with no large retailers have a limited range of available foods and beverages, a situation that increases the probability of consuming soft drinks due to the lack of other alternative beverages. In both cases, it was examined whether those variables were most related to the probability to consume rather than to the quantity consumed itself.

After examining all the possible combinations of these identifiers, we chose the one that includes the variable b as a unique identifier. Therefore, controlling by the drinking water provision in the locality, the presence of supermarkets and/or convenience stores is an identifier that has a negative coefficient (negative lambda, -0.85) and is significantly different from zero at 95%. The lambda statistical significance warns about potential bias to deal with if there is not a correction of the selection, while its negative value informs that the non-observables which determine the selection by consumption are the same that once being consumed they lead to less and less consumption. These results are similar to the ones obtained by the information criteria from Akaike and Schwarz, which point out that this specification is the best one to characterize the demand for soft drinks.

Full price elasticity of demand

The calculation of the full price elasticity combined substitution effects (how much consumption is changed, given a constant income) and income effects (facing the loss of income due to the price

increase). Combining price and income elasticities of the equation (1), we built the Slutsky's using elasticities as:

$$\text{Full price elasticity of demand} = \beta_1 - (\text{Spending in soft drinks} / \text{Total spending of the household}) * \beta_3 \quad (2)$$

All analyses were performed using Stata/IC 12.1 for Windows. [35] The design effect of the survey, and the survey population weights have been considered. This study was approved by the review boards on ethics, biosafety and research of the Mexican National Institute of Public Health (*Instituto Nacional de Salud Pública*), between December 2011 and March 2012.

RESULTS

Characterization of the consumption of soft drinks in the households by their socioeconomic status

Table 1 describes the variation of consumption indicators (Section I) and the relative level of consumption (Section II) for the full sample as well as subgroups of poverty. On average, 35.4% of the households reported not consuming soft drinks. This proportion increases as households have fewer resources. Just over half (52.9%) of the households in extreme poverty are consumers while this proportion is higher (74.0%) in households living in moderate poverty (Table 1, columns 3-5).

On average, the surveyed Mexican households consumed 4.7 litres per capita per month — equivalent to 157 ml daily — and spent 35.6 pesos per capita for their monthly purchase. These amounts are higher as the household receives higher income: households with higher income consume an average of 6.9 litres of soft drinks monthly (230 ml daily, approximately), an amount that is more than double the consumption for low-income households (2.6 litres, equivalent to 96 ml daily); (Table 1, Section I). With regards to the expenditure in soft drinks related to total expenditure of each household, the households spent 3.3% of their total expenditure and 6.1% of their total food expenditure in purchasing soft drinks, on average. Households with extreme poverty spent a bigger proportion of their total and food expenditure in

purchasing soft drinks than wealthier households, although in terms of level of consumption they consumed a smaller amount of litres in a monthly basis (Table 1, Section I).

The quantity of soft drinks consumed augments as resources increase in the households, according to the distribution of households based on their monthly expenditure on soft drinks per capita (Table 1, Section II). Slightly less than one third of households in extreme poverty exceeded the average amount of food expenditure in soft drinks, spending 7% or more of their total expenditure (they are high consumers). The proportion is lower in high-income households. Nevertheless, one out of every four high-income households is also high consumer.

Characterization of the households analysed in their level of consumption

Table 2 shows household characteristics in different types and levels of consumption. On average, members of consumer households are younger than non-consumer households. With respect to socioeconomic levels, the consumer households of soft drinks tend to have a higher total expenditure and live in localities with more than 2,500 inhabitants in comparison with the non-consumer households. Consumers with lower expenditure and who are living in small localities have the highest consumption in comparison with other consumers.

Analysis of the determinants of probability of consuming soft drinks

Table 3 presents the report on the outcomes of multivariate probit regression model of the probability that a household become a soft drink consumer. The adjusted probability that a household becomes a consumer is 64% on average, which is significantly higher with male heads of households and higher household expenditure. Households headed by individuals with higher education have less probability to be consumers compared with those with illiterate heads. Additionally, the relative number of children (members from 5 to 10 years of age) and teenagers (from 10 to 15) in the household has been linked to a significant increase in the probability that a household might be a consumer (Table 3, column 2).

The probability of a household to be a consumer fluctuates according to poverty level (Table 3, columns 3-5). A household in a situation of food poverty has a 65% of probability of being a soft drink consumer. Otherwise, a household that is above the poverty level has a probability of 73%. Taking account of the variables associated with these probabilities, low-income households significantly increase their probability to consume with higher income. Yet at the same time, the presence of heads of households with higher education reduces the probability to consume (though only for low-income households). Thus, the effect of the household's demographic composition is varied. Having children and adolescents significantly increases the consumption only for households in food poverty situation.

Living in localities where access to safe water for drinking and cooking needs is not universal (100%) significantly increases the probability to consume soft drinks. This effect is declining as the number of households covered by this service (safe water) is increasing and it is significant for the disadvantaged populations (with low SES and high poverty). On the other hand, living in localities with convenience stores and supermarkets significantly decreases the probability that a household consumes soft drinks, especially in households facing great poverty.

Analysis of the factors associated with soft drink demand

Table 4 presents factors associated with soft drink demand (in litres per capita) and compares the results of the classical model (OLS) with the results of the models adjusted to selection, for general population and for households in different SES, levels of poverty, and consumption. According to the OLS model, soft drink consumption in a household significantly decreases when prices are higher and the number of members is greater, but it increases when expenditure is higher and when the proportion of members from 10 to 15 years of age is greater. When the model is corrected by selection — estimating the probability to consume considering the presence of stores and supermarkets as an identifier variable, as shown in Table 3 — the positive effect in consumption when young people are living in the household is no longer significant and the expenditure effect is reduced.

It is important to note the variation in the value of the price elasticity of demand without selection correction (-1.04), which differs from the calculated value via Heckman selection model (-1.01). This indicates that taking into account the household decision to consume soft drinks, the demand for soft drinks is low sensitive to price changes.

Analysis of the price elasticity of demand for soft drinks

Table 4 results show that the sensitivity of demand to price changes varies depending on the intensity of consumption and the family income level. Price changes modify significantly the quantity demanded when we compare high- and low-consumers. Demand from low-consumption households is inelastic (-0.97) compared with the elasticity of high-consumers (-1.2). Yet when the population is grouped by poverty, households in extreme poverty have a higher significant price-elasticity (-1.5) than those above moderate poverty line (-1.3).

Table 5 presents the total elasticity of demand to price changes, following Slutsky identity. Because the proportion of the household total expenditure allocated to purchasing soft drinks does not overcome 10%, the total elasticity of demand (Marshallian) does not differ in magnitude from the price elasticity compensated by income (Hicksian).

DISCUSSION

The demand for soft drinks is of heterogeneous nature in Mexico. The response of the demand to changes on prices and household income is different according to consumption levels and the poverty condition of households. We found that changes in prices modify the demand of soft drinks more significantly on the high-consumption groups and, to a lesser extent, the low-consumption groups, as similarly reported in a Norwegian survey. [23] This implies that a tax policy could impact the targeting group of population, i.e. the high soft drink consumers. However, in the Mexican context, we also found that the total elasticity of demand is higher in lower-income households, who are also the highest soft drink consumers. In this scenario, a tax policy could impose a welfare loss on the poorest households. Further research should

analyse if the positive effect on the reduction of consumption and prevention of health problems among the poorest compensate the welfare loss attributed to a tax.

Regarding the economic and social factors our results show that increasing total household expenditure will increase both the probability of a household to become a consumer of soft drinks and the quantity purchased, which is consistent with other empirical results applied in Mexico and Brazil. [41-44]

However, we found that increments in income among the poorest households have a significant effect on the probability of becoming a consumer of soft drinks (as found in other studies that analysed the effect of cash-transfer programs on consumption of poor populations). [45-46] Given that more education among poor groups of population can reduce the likelihood of being soft drink consumer, behaviour change communication strategies among the low-income groups could be a key strategy to complement a tax measure and to compensate for the income effect on soft-drink consumption.

One relevant finding was that local infrastructure is a major determinant of the probability to consume soft drinks. Our results emphasize the importance of insuring the supply of safe water to households, especially to the poorest ones in order to prevent consuming soft drinks. Also, the results underscore the role of commercial companies like stores and supermarkets in the decision to consume. In spatial studies on food provision it has been pointed out that the presence of supermarkets and stores that supply fresh food in rural areas is associated with a higher purchase of healthy food. [47-49] The absence of such facilities leads to households to invest more time and money to purchase healthy food (a higher opportunity cost for accessing healthy food). Both results pointed out the need to improve social conditions in which households are living, with special attention needed in poor and marginalized areas where social determinants of health and predispose them to consume unhealthy food and beverages.

As in other cases, a range of constraints is relevant to this study. One concerns the reported consumption of soft drinks. Figures obtained regarding the average quantity of litres consumed are smaller than figures of reported sales by the soft drink industry, [25] although they are similar to the amounts calculated

through household surveys. [26-27] Possible explanations concerning such divergence are the difficulty in making a distinction between consumption in and out of the household, the existence of annual stocks of soft drinks calculated by industry, and possible recall biases that make informants better remember the amount spent than quantities consumed. In order to control the third explanation, the information regarding the quantity consumed has been revised through the household expenditure and the price in the locality. The results from this control exercise did not differ very much from the outcomes obtained through the report on quantities purchased.

A second limitation is related to the choice between modelling soft drink demand using a unique equation versus a demand system. The use of demand systems has an advantage regarding the evaluation of the substitution effects and complementarities between goods, and they offer the possibility of controlling the endogeneity of variables such as prices. However, the restrictions imposed for such a system's estimation limit the modelling of heterogeneous demands, which is the reason why other surveys used unique equations. [23] Moreover, our results are not different from the results obtained through equations systems. [42-43] Ultimately, as opposed to other surveys realized to date, the prices used in this work are not calculated from data regarding expenditure and purchase amounts, a decision that strengthens the results obtained and reduces the need to use simultaneous equations.

A third aspect concerns the product specification to be taxed. Although in this work we focus on soft drink demand, soft drinks are only one type of the various sugar-sweetened beverages consumed by the Mexican population. If the main objective of the tax is to reduce calorie intake, all the beverages with added sugar should be taxed as recommended by other studies, [50] with legislation also preventing any substitution effects between beverages.

A final limitation to consider is the soft drink supply modelling, which establishes the product's sensitivity to changing prices and its heterogeneity. Furthermore, it is necessary to consider that the price

per litre of soft drinks is not linear according to the presentation (bottles, cans). Given this background, one alternative policy option is the determination of a minimum price per litre of soft drink, provided that the effects an excess supply can have on the creation of a black market are buffered.

Given the current interest in designing obesity prevention initiatives in Mexico, we bring into discussion some issues that might be considered for the implementation of a better tax scheme design. The first one is the need to clearly define the main objective of the tax measure. Is it to collect funds in order to finance actions for preventing obesity? This would imply a clear definition of the allocation of resources collected through the tax, in order to enhance the effectiveness of obesity prevention actions. Is it aimed at reducing calorie intake in order to obtain results in nutrition, in health, or both?, this would require a high tax rates in order to ensure reductions in consumption levels, with high welfare costs among the population. Or is it focused only on the reduction of soft drink consumption regardless the potential effect on calorie's reduction?

In December 2013 the Mexican Congress approved a tax rate of 10% on soft drink consumption. Price-elasticities of this study showed that the average effect of this level of tax would reduce by 16 ml the amount of soft drink consumption daily, equivalent to 6.29 calories on daily basis. However results considering groups of high consumption of soft drinks and different socioeconomic levels are different. Households with higher consumption levels will reduce by 38 ml the amount of soft drink consumption daily, equivalent to 15 calories daily, this suggests a higher impact in terms of the reduction of calories daily intake in this group compared to the average. However this impact on calories intake on a daily basis is more limited among groups of people living in extreme poverty. Households in extreme poverty would decrease only 20 ml, equivalent to 8 calories daily with a slightly greater decrement of soft drink consumption of 25 ml, equivalent to only 10 calories daily intake, among high consumption households in extreme poverty. These results suggest that although the effect of a 10% tax is considerably higher among the high consumption groups, this effect is limiting among the groups with the highest levels of poverty.

This calls to the discussion of the gains in terms of the reduction of calories daily intake among extreme poverty groups and the welfare losses among this group of population derived of the imposition of a 10% tax. Major studies regarding the impact of taxation taking into account the heterogeneity of the population are currently being conducted.

The present work brings evidence to the design of efficient and equitable policies, and spreads awareness about the bias of a possible calculation of tax imposition if the presence of different types of populations according to their consumption patterns and socioeconomic condition is not envisaged. The analysis of the heterogeneity in the impact of such a measure, has been previously analysed in other context such as the Norway study but in this context it seems that a carefully crafted tax on soft drinks is an attractive alternative for both tax collection and decrease of kilocalories ingested by the Mexican population. Since the population with lower resources is the most sensitive to price changes, and in consideration of the evidence regarding the factors that influence the likelihood that a household is a consumer of soft drinks, taxes on soft drink consumption should be accompanied by measures to ensure the provision of safe drinking water and access to a wider range of products in the poorest communities.

COMPETING INTERESTS

The authors declare they have no competing interests.

AUTHOR'S CONTRIBUTIONS

LCH contributed to the conception, design of this study, analysis of the data, and the interpretation of the data. SGSR contributed to the conception, design of this study, analysis of the data, and interpretation of the data. LRP contributed to the conception, design of this study and revised critically the manuscript. PP contributed to the design of this study, analysis of the data, interpretation of the data, and revised critically the manuscript. GRO to the conception, design of this study, and interpretation of the data. ESM contributed to the interpretation of the data. All authors contributed to the development of the draft, revised, and final manuscript. All authors read and approved the final version.

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Table 1. Soft drink consumption of Mexican households, by socioeconomic status and poverty level. Mexican Family Life Survey, 2005 (MXFLS 2)

Mean (standard error)

	1	2	3			4		5	
			Poverty level‡						
		Total	Extreme poverty		Moderate poverty		Above moderate poverty		
Households (n)		7,501	2,335		2,989		2,177		
Households (weighted)		22,471,741	7,480,260		8,609,908		6,381,573		
Non consumers (%)		35.4	47.8		31.2		26.5		
I. Soft drink consumption									
Litres purchased of soft drink per capita, month		4.7 (4.5)	2.6	(1.4)	4.3	(1.5)	7.1	(3.3)	
Monthly expenditure on soft drinks, Mexican pesos, per capita		35.6 (1.0)	17.1	(0.6)	31.0	(0.8)	56.9	(2.7)	
Monthly expenditure on soft drinks, as a proportion of total household expenditure (%)		3.3 (0.1)	4.5	(0.2)	3.3	(0.1)	2.3	(0.1)	
Monthly expenditure on soft drinks, as a proportion of household expenditure on food (%)		6.1 (0.1)	6.8	(0.2)	6.0	(0.2)	5.8	(0.2)	
II. Soft drink consumption groups¥									
Low (%)		38.5 (1.0)	32.1	(2.0)	38.9	(1.6)	43.5	(1.9)	
Medium (%)		32.1 (0.9)	34.3	(1.9)	31.5	(1.4)	31.0	(1.7)	
High (%)		29.4 (0.9)	33.6	(1.9)	29.7	(1.4)	25.5	(1.6)	

Notes

§ Per capita estimates adjusted by adult equivalence and household economies of scale (Engel method)

¥ *Soft drink consumption groups* indicate household consumption position in the distribution of the proportion of monthly total food expenditure devoted to soft drink purchases, expressed in terciles: Low (0.1%, 3.4%); Medium (3.5%, 7.0%); High (7.1%, more).

‡ According to the Mexican National Council on Evaluation of Social Development Policy, *extreme poverty* is the condition where households were living with less than 733 Mexican pesos (US\$69) a month in urban areas, and less than 510 Mexican pesos (US\$48) a month in rural areas in 2005. This amount equals the minimum amount of monetary means required to afford nutrition, also known as the basic goods basket, for all members of the household. *Moderate poverty* is the condition where households were living with less than 1684 (US\$158) Mexican pesos a month in rural areas and less than 1040 Mexican pesos (US\$98) a month in rural areas. Combined with the basic goods baskets, moderate poverty line measure the minimum required to afford basic health care and education as well.

Table 2. Household characteristics by level of consumption. Mexican Family Life Survey, 2005 (MXFLS 2)
Mean (standard error)

	1		2		3		4		5		6		7	
					Non		Total		Consumers		Soft drink consumption groups*			
					consumers				Low		Medium		High	
Households (n)	7,501		2,580		4,921		1,641		1,640		1,640			
Households (weighted)	22,471,741		7,959,206		14,512,535		5,594,267		4,653,328		4,264,940			
Litres purchased of soft drinks per capita, month	5.1	(0)			5.1	(0)	2.5	(0)	4.8	(0)	8.9	(0)		
Monthly expenditure on soft drinks, per capita	38.4	(1)			38.4	(1)	14.7	(0)	34.7	(1)	73.3	(3)		
Local soft-drink price	12.2	(0)	12.2	(0)	12.2	(0)	12.3	(0)	12.3	(0)	12.2	(0)		
Total household expenditure (average monthly amount)	4,805	(74)	3,655 ^a	(106)	5,451	(96)	6,007 ^b	(159)	5,204	(137)	4,992 ^b	(202)		
I. Head of household characteristics														
Male=1	77.8	(1)	73.7 ^a	(1)	80.1	(1)	80.8	(1)	78.7	(2)	80.6	(2)		
Age														
15-19	0.7	(0)	0.5	(0)	0.8	(0)	0.7	(0)	0.7	(0)	1.2	(0)		
20-29	10.3	(0)	8.3 ^a	(1)	11.5	(1)	11.7	(1)	11.0	(1)	11.6	(1)		
30-39	22.2	(1)	19.2 ^a	(1)	23.9	(1)	23.6	(2)	22.3	(1)	26.2	(2)		
40-49	22.6	(1)	20.7 ^a	(1)	23.8	(1)	25.1	(2)	24.9	(2)	20.8	(1)		
50-59	19.3	(1)	19.2	(1)	19.3	(1)	17.7	(1)	19.6	(1)	21.0	(2)		
60-69	13.3	(1)	15.4 ^a	(1)	12.1	(1)	15.4 ^b	(1)	15.4	(1)	15.4	(1)		
≥70	11.5	(1)	16.7 ^a	(1)	8.6	(1)	7.4	(1)	10.4	(1)	8.3	(1)		
Schooling														
No education	15.7	(1)	21.4 ^a	(1)	12.5	(1)	11.8	(1)	13.6	(1)	12.4	(1)		
Incomplete elementary school	21.4	(1)	22.8 ^a	(1)	20.6	(1)	18.0	(1)	21.6	(1)	22.9 ^b	(1)		
Elementary school	19.5	(1)	18.6 ^a	(1)	19.9	(1)	22.2 ^b	(2)	18.3	(1)	18.8	(1)		
Secondary	21.4	(1)	19.6 ^a	(1)	22.4	(1)	21.0	(1)	22.5	(2)	23.9	(2)		
High school	10.5	(1)	7.7	(1)	12.2	(1)	12.5	(1)	11.8	(1)	12.2	(1)		
University or more	11.5	(1)	9.9 ^a	(1)	12.4	(1)	14.6 ^b	(1)	12.2	(1)	9.8 ^b	(1)		
Indigenous condition (1=speaks an indigenous language)	11.5	(0)	11.4	(1)	11.6	(1)	8.0 ^b	(1)	12.7	(1)	14.9	(1)		
II. Household characteristics														
Members	4.6	(4)	4.3 ^a	(6)	4.8	(5)	4.8	(9)	4.8	(8)	4.7	(8)		
Members by group age (%)														
0_4	9.1	(0)	8.2 ^a	(0)	9.6	(0)	10.1	(0)	9.6	(1)	8.9	(1)		
5_9	8.0	(0)	6.8 ^a	(0)	8.8	(0)	9.1	(1)	8.6	(0)	8.7	(1)		
10_14	9.2	(0)	7.8 ^a	(0)	9.9	(0)	9.7	(1)	9.4	(0)	10.9	(1)		
15_19	10.0	(0)	9.1 ^a	(0)	10.4	(0)	9.9	(1)	10.7	(1)	10.9	(1)		
20_29	17.5	(0)	16.1	(1)	18.3	(0)	19.0	(1)	17.2	(1)	18.4	(1)		
30_39	13.7	(0)	12.6 ^a	(1)	14.3	(0)	14.4	(1)	14.1	(1)	14.4	(1)		
40_49	10.7	(0)	10.8 ^a	(1)	10.7	(0)	10.7	(1)	11.3	(1)	10.0	(1)		
50_59	8.9	(0)	10.1 ^a	(1)	8.3	(0)	7.7	(1)	8.7	(1)	8.5	(1)		
60_69	6.6	(0)	8.9 ^a	(1)	5.2	(0)	5.2	(0)	5.7	(1)	4.8	(0)		
≥70	6.3	(0)	9.6 ^a	(1)	4.5	(0)	4.2	(1)	4.7	(0)	4.5	(1)		
III. Community characteristics														
Size (1=<2,500 inhabitants)	20.8	(0)	24.4	(1)	18.7	(0)	14.2	(1)	20.6	(1)	22.6 ^b	(1)		
Deprivation index														
Low & very low	72.7	(1)	69.1 ^a	(1)	74.7	(1)	79.5	(1)	72.1	(1)	71.4	(2)		
Medium	14.5	(1)	16.2 ^a	(1)	13.6	(1)	11.6 ^b	(1)	14.6	(1)	15.1	(1)		
High & very high	12.8	(0)	14.7 ^a	(1)	11.7	(1)	8.9	(1)	13.3	(1)	13.5	(1)		
Geographical region														
South- South East	22.2	(1)	21.8	(1)	22.4	(1)	19.0	(1)	23.1	(1)	25.9	(2)		
Centre	32.2	(1)	33.6 ^a	(1)	31.4	(1)	37.9 ^b	(2)	30.8	(2)	23.8 ^b	(2)		
Occidental Centre	22.4	(1)	25.4 ^a	(1)	20.8	(1)	24.5 ^b	(1)	20.2	(1)	16.8 ^b	(1)		
North West	8.7	(0)	7.2 ^a	(0)	9.5	(0)	8.6 ^b	(1)	10.0	(1)	10.0	(1)		
North East	14.5	(0)	12.0 ^a	(1)	15.9	(1)	10.0 ^b	(1)	15.9	(1)	23.5 ^b	(1)		

Table 3. Probability of soft drink consumption and associated factors, by socioeconomic level and poverty level. Mexican Family Life Survey, 2005 (MXFLS 2) - Probit estimation. Mean (standard error)

	1	2	3	4	5
			Poverty‡		
	Total	Extreme poverty	Moderate poverty	Above moderate poverty	
Households (n)	7,501	2,335	2,989	2,177	
Households (weighted)	22,471,741	7,480,260	8,609,908	6,381,573	
Probability of soft drink consumption	0.6 (0.0)	0.6 (0.0)	0.7 (0.0)	0.7 (0.0)	
Local soft drink Price	-0.1 (0.3)	-0.3 (0.5)	-0.4 (0.4)	0.1 (0.5)	
Total household expenditure	0.5 (0.0) ***	0.6 (0.1) ***	0.7 (0.2) ***	0.1 (0.1)	
I. Head of household characteristics					
Male	0.1 (0.1) **	0.1 (0.1)	0.2 (0.1) *	0.2 (0.1)	
Schooling (reference group: no education)					
University or more	-0.2 (0.1) *	-0.5 (0.2) **	-0.1 (0.2)	0.0 (0.2)	
Indigenous condition	0.1 (0.1)	0.2 (0.1)	0.1 (0.1)	0.2 (0.2)	
II. Household characteristics					
Members by group age (% of the total number of members)					
0_4 years	0.4 (0.3)	0.3 (0.5)	0.4 (0.4)	0.6 (0.5)	
5_9 years	0.6 (0.3) **	0.3 (0.4)	1.0 (0.4) **	0.7 (0.6)	
10_14 years	0.6 (0.3) **	0.0 (0.4)	0.9 (0.4) **	0.6 (0.5)	
15_19 years	0.3 (0.2)	0.0 (0.4)	0.4 (0.4)	0.7 (0.5)	
III. Community characteristics					
Households with safe water as the main source for cooking and drinking (%)					
<80%	0.1 (0.1) *	0.2 (0.1)	0.0 (0.1)	0.0 (0.1)	
80-90%	0.1 (0.1) *	0.3 (0.1) **	0.0 (0.1)	0.1 (0.1)	
90-95%	0.0 (0.1)	0.1 (0.1)	-0.1 (0.1)	-0.1 (0.1)	
Localities with supermarkets and stores (%)	-0.2 (0.1) ***	-0.2 (0.1) **	0.0 (0.1)	-0.1 (0.1)	

Notes:

‡ According to the Mexican National Council on Evaluation of Social Development Policy, *extreme poverty* is the condition where households were living with less than 733 Mexican pesos (US\$69) a month in urban areas, and less than 510 Mexican pesos (US\$48) a month in rural areas in 2005. This amount equals the minimum amount of monetary means required to afford nutrition, also known as the basic goods basket, for all members of the household. *Moderate poverty* is the condition where households were living with less than 1684 (US\$158) Mexican pesos a month in rural areas and less than 1040 Mexican pesos (US\$98) a month in rural areas. Combined with the basic goods baskets, moderate poverty line measure the minimum required to afford basic health care and education as well.

* p<10% ; ** p<5% ;*** p<1%

Table 4. Associated factors with monthly soft drink consumption (lts per capita). Mexican Family Life Survey, 2005 (MXFLS 2)

Mean (standard error)

1	2		3		4		5		6		7		8		9	
	OLS		Heckman selection model													
			Total		Poverty‡				Soft drink consumption groups¥							
					Extreme poverty		Moderate poverty		Above moderate poverty		Low		Medium		High	
Households (n)	7,501		7,501		2,335		2,989		2,177		1,641		1,640		1,640	
Households (weighted)	22,471,741		22,471,741		7,480,260		8,609,908		6,381,573		5,594,267		4,653,328		4,264,940	
R²	0.22										0.33		0.49		0.33	
Inverse Mills ratio (lambda)			-1.5 -0.1 **		-0.4 -0.4		0.18 -0.2		-0.99 -0.2							
Local soft drink Price	-1.04	-0.2 ***	-1.01	-0.3 ***	-1.49	-0.6 ***	-0.51	-0.4	-1.34	-0.4 ***	-0.97	-0.3 ***	-0.1	-0.3	-1.2	-0.3 ***
Total household expenditure	0.4	0 ***	0.18	0 ***	0.29	-0.2 *	0.62	-0.1 ***	0.31	-0.1 ***	0.63	-0.1 ***	0.59	0 ***	0.54	0 ***
I. Head of household characteristics																
Male	0.07	-0.1	0.02	-0.1	-0.05	-0.1	0.12	-0.1	0.07	-0.1	0.09	-0.1	0.04	-0.1	0.04	-0.1
Schooling (reference group: no education)																
Secondary	0.09	-0.1	0.08	-0.1	-0.12	-0.1	0.28	-0.1 ***	-0.06	-0.2	0.01	-0.1	0.13	-0.1 *	-0.03	-0.1
High school	0.09	-0.1	0.06	-0.1	0.02	-0.2	0.29	-0.1 **	-0.13	-0.2	0.03	-0.2	0.06	-0.1	-0.1	-0.1
University or more	-0.03	-0.1	0.04	-0.1	0.51	-0.2 **	0.15	-0.2	-0.15	-0.2	-0.08	-0.1	0.05	-0.1	-0.3	-0.2 **
Indigenous condition	0.13	-0.1 *	0.05	-0.1	0.01	-0.1	0.3	-0.1 ***	-0.07	-0.2	0.03	-0.1	0.01	-0.1	-0.01	-0.1
II. Household characteristics																
Members (total number)	-0.08	0 ***	-0.11	0 ***	-0.1	0 ***	-0.04	0 **	-0.11	0 ***	-0.06	0 ***	-0.1	0 ***	-0.02	0 *
Members by group age (%) (reference group: ≥70)																
5_9 years	0.04	-0.2	-0.4	-0.3	-0.53	-0.5	0.09	-0.3	0.38	-0.5	1.21	-0.4 ***	0.18	-0.2	-0.17	-0.3
10_14 years	0.34	-0.2	-0.08	-0.3	-0.27	-0.4	0.53	-0.3	0.39	-0.5	1.17	-0.4 ***	0.43	-0.2 **	-0.23	-0.3
15_19 years	0.32	-0.2	-0.01	-0.2	0.15	-0.4	0.42	-0.3	0.17	-0.5	0.87	-0.3 ***	0.36	-0.2 *	-0.16	-0.2
20_29 years	0.16	-0.2	0.01	-0.2	-0.12	-0.4	0	-0.3	0.3	-0.4	0.63	-0.3 **	0.07	-0.2	-0.31	-0.2
30_39 years	0.1	-0.2	-0.02	-0.2	-0.81	-0.4 *	0.5	-0.3 *	0.21	-0.4	0.46	-0.3	0.08	-0.2	0.02	-0.2

Notes

§ Per capita estimates adjusted by adult equivalence and household economies of scale (Engel method)

‡ According to the Mexican National Council on Evaluation of Social Development Policy, *extreme poverty* is the condition where households were living with less than 733 Mexican pesos (US\$69) a month in urban areas, and less than 510 Mexican pesos (US\$48) a month in rural areas in 2005. This amount equals the minimum amount of monetary means required to afford nutrition, also known as the basic goods basket, for all members of the household. *Moderate poverty* is the condition where households were living with less than 1684 (US\$158) Mexican pesos a month in rural areas and less than 1040 Mexican pesos (US\$98) a month in rural areas. Combined with the basic goods baskets, moderate poverty line measure the minimum required to afford basic health care and education as well.

¥ *Soft drink consumption groups* indicate household consumption position in the distribution of the proportion of monthly total food expenditure devoted to soft drink purchases, expressed in terciles: Low (0.1%, 3.4%); Medium (3.5%, 7.0%); High (7.1%, more).

* p<10%; ** p<5% ; *** p<1%

Table 1. Adjusted price elasticity of soft drink demand. Mexican Family Life Survey, 2005 (MXFLS 2)

Mean (standard error)

	1	2	3	4	5	6	
		Monthly expenditure in soft drinks, as a proportion of household expenditure on food (%)		Price elasticity (compensated by income)		Income elasticity	Total price elasticity
	N	(a)	(b)	(c)	(b) - (a)*(c)		
Average consumer (Heckman)	7501	3.3 (0.1)	-1.01 (0.3) ***	0.18 (0.0) ***	-1.01 (0.3) ***		
Soft drink consumption groups [¥]							
Low	1640	1.1 (0.0)	-0.91 (0.3) ***	0.57 (0.1) ***	-0.92 (0.3) ***		
Medium	1641	2.8 (0.0)	-0.14 (0.2) ***	0.57 (0.0) ***	-0.16 (0.2) ***		
High	1640	6.7 (0.2)	-1.18 (0.3) ***	0.49 (0.0) ***	-1.21 (0.3) ***		
Poverty [‡]							
Extreme poverty	2633	4.5 (0.2)	-1.49 (0.6) ***	0.29 (0.2) *	-1.50 (0.6) ***		
Moderate poverty	2938	3.3 (0.1)	-0.51 (0.4) ***	0.62 (0.1) ***	-0.53 (0.4) ***		
Above moderate poverty	1930	2.3 (0.1)	-1.34 (0.4) ***	0.31 (0.1) ***	-1.35 (0.4) ***		

Notes

[¥] *Soft drink consumption groups* indicate household consumption position in the distribution of the proportion of monthly total food expenditure devoted to soft drink purchases, expressed in terciles: Low (0.1%, 3.4%); Medium (3.5%, 7.0%); High (7.1%, more).

[‡] According to the Mexican National Council on Evaluation of Social Development Policy, *extreme poverty* is the condition where households were living with less than 733 Mexican pesos (US\$69) a month in urban areas, and less than 510 Mexican pesos (US\$48) a month in rural areas in 2005. This amount equals the minimum amount of monetary means required to afford nutrition, also known as the basic goods basket, for all members of the household. *Moderate poverty* is the condition where households were living with less than 1684 (US\$158) Mexican pesos a month in rural areas and less than 1040 Mexican pesos (US\$98) a month in rural areas. Combined with the basic goods baskets, moderate poverty line measure the minimum required to afford basic health care and education as well.

* p<10%; ** p<5%; *** p<1%

ENDNOTES

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- ¹ The body mass index (BMI) is the most commonly used indicator for assessing excess weight. This index is calculated as the weight in kilograms divided by height in meters squared (kg/m^2). The World Health Organization (WHO) defines individuals with a BMI equal to or greater than 25 as “overweight”. Additionally, individuals classified as “overweight” can be further divided into “pre-obese” (with a BMI value of 25-30) and “obese” (with a BMI equal to or greater than 30).
- ² Mexico has a long statistical tradition collecting household data. The most important surveys to collect expenditure and economic household decisions data are the Mexican Household Income and Expenditure Survey (ENIGH, its acronym in Spanish) and MXFLS. Despite ENIGH is the source of official calculations of income and expenditure, in this study we selected MXFLS data because ENIGH is limited to collect amounts spent by households and not prices at community level, which limits demand estimations because of price endogeneity. The advantage to use MXFLS is that collects community level data, which in this paper is used for controlling the bias generated by differences between those who demand and those who do not demand soft-drinks and also for including local market characteristics in the empirical analysis.
- ³ Even though the distinction of diet products and non-diet soft drinks could not be established by the data gathered by ENNVIH, we could assume that the vast majority of soft drinks consumed were non-diet as the industry reported that 95% of 2008 soft drinks sales in Mexico were sugar and fructose sweetened soft drinks. (ANPRAC 2008 Annual report).
- ⁴ Extreme poverty measures the minimum amount of income required to afford nutrition, also known as the basic good basket, for all members of the household. The average value of this basket was equivalent to 510 Mexican pesos per month per capita in rural areas, and 733 Mexican pesos per month per capita in urban areas in 2005. Moderate poverty measures the minimum income required to afford nutrition, as well as basic health care and education. The average amount of that basket was equivalent to 1040 Mexican pesos per month per capita in rural areas and 1684 Mexican pesos per month per capita in urban areas in 2005.
- ⁵ Thresholds of monthly expenditure per equivalent adult in the household are defined based on the data collected from the households surveyed (2005 Mexican pesos). Low SES: rural (0.0,491); urban (0.0,819). Medium SES: rural (491, 921); urban (819, 1549). High SES: rural (921, more); urban (1549, more)