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# Tax awareness and perceived cost of sugar-sweetened beverages in four countries between 2017 and 2019: findings from the International Food Policy Study

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26 **DECLARATIONS**

27

28 **Ethical approval and consent to participate:** Ethical approval for the study was received from the  
29 Office of Research Ethics at the University of Waterloo (ORE #30829). All participants provided  
30 informed consent.

31

32 **Consent for publication:** Not applicable

33

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36

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68 **ABSTRACT**

69

70 **BACKGROUND**

71 The public health benefits of sugar-sweetened beverage (SSB) taxes often rely on, among other  
72 things, changes to consumer purchases. Thus, perceived cost of SSBs and signalling effects—via  
73 awareness of the tax—may impact the effectiveness of SSB taxes on consumer purchases.

74 **OBJECTIVE**

75 The study sought to examine perceived cost of SSBs, tax awareness, and changes in beverage  
76 purchasing over time and across four countries with and without SSB taxes.

77 **METHODS**

78 The study used data from the 2017, 2018 and 2019 waves of the International Food Policy Study.  
79 Annual cross-sectional online surveys were conducted in Australia, Mexico, UK and US, which  
80 captured perceived cost of SSBs relative to non-SSBs in all countries (with Australia as a no-tax  
81 comparator), and measures of tax awareness and participants' reported changes in beverage  
82 purchasing in response to SSB taxes in Mexico (tax implemented in 2014), UK (tax implemented  
83 in 2018) and US (subnational taxes since 2015). Logistic regression models evaluated the  
84 measures across years and socio-demographic groups.

85 **RESULTS**

86 Perceived cost of SSBs relative to non-SSBs was higher in Mexico (all three years) and the UK  
87 (2018 and 2019 following tax implementation) than Australia and the US. Tax awareness was

88 higher in UK than Mexico, and decreased over time among Mexican respondents. Patterns of  
89 reported beverage purchasing changes in response to the tax were similar across Mexico, UK and  
90 US, with the largest changes reported by Mexican respondents. Respondents with characteristics  
91 corresponding to lower socioeconomic status were less likely to be aware of an SSB tax, but  
92 more likely to perceive SSBs to cost more than non-SSBs and report changes in purchasing in  
93 response to the tax, where there was one.

#### 94 **CONCLUSIONS**

95 This study suggests that in countries where a national SSB tax was present (Mexico, UK),  
96 perceived cost of SSBs and tax awareness were higher compared to countries with no SSB tax  
97 (Australia) or subnational SSB taxes (US), respectively, and suggests that perceived cost and tax  
98 awareness represent distinct constructs. Improving the 'signalling effect' of existing SSB taxes  
99 may be warranted, particularly in tax settings where consumer behaviour change is a policy  
100 objective.

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## 108 INTRODUCTION

109 Sugar-sweetened beverages (SSBs) remain a prominent target for public health interventions  
110 due to their contribution to sugar and energy intake and association with increased risk of type 2  
111 diabetes, obesity, heart disease, dental caries, and other obesity-related diseases.[1]

112 Consequently, there is a growing interest in many countries for strategies to reduce SSB  
113 consumption at the population level.[2]

114 One strategy for reducing SSB consumption is taxation. Over 40 countries and cities have  
115 implemented SSB taxes,[3] which aim to reduce purchasing and consumption of the targeted  
116 beverages, incentivize product reformulation by the beverage industry, and/or generate  
117 revenue, which is often reinvested towards other public health endeavors. Observational  
118 evidence to date from evaluations of national and city-level SSB taxes suggests that these  
119 policies can be effective at one or more of the following: increasing prices;[4–11] reducing  
120 purchasing and consumption;[6–9,12–23] and encouraging the beverage industry to reformulate  
121 the sugar content of their beverage offerings.[24–27]

122 There is, however, substantial variability in the magnitude of impacts observed in relation to  
123 existing SSB taxes, which may be largely explained by differences in tax design. The majority of  
124 SSB taxes implemented to date are excise taxes that are levied on the manufacturer and may or  
125 may not be intended to be passed down to the consumer. Most taxes apply volume-specific  
126 price increases to qualifying SSB products (e.g., 1 peso/litre in Mexico, or \$0.01-0.02/fl oz in city-  
127 level taxes in the United States (US)).[28] In contrast, other excise SSB taxes—such as the soft  
128 drinks industry levy (SDIL) in the United Kingdom (UK)—utilize a sugar-specific design, which

129 assigns 'tiered' or continuous price increases based on the sugar content of beverages, and tend  
130 to emphasize product reformulation on the part of the manufacturer rather than consumer  
131 behaviour change.[29,30] Given the differences in design and policy objectives across SSB taxes,  
132 some taxes may rely to a greater extent on certain mechanisms of action than others, such as  
133 price responsiveness, signalling via awareness of the tax, and reformulation.

134 The most common mechanism of SSB and other public health taxes is the economic theory that  
135 as the price of a good increases, demand for that good decreases.[31] Evidence suggests that  
136 consumers respond to price increases whether or not they are aware of the tax itself[32], and  
137 that their response may be conscious or unconscious.[33] A recent meta-analysis summarized  
138 that consumers reduce their SSB purchases by an average of 10% when SSB prices are raised by  
139 10%.[18] However, price responsiveness varies across different consumer groups. For example,  
140 individuals who consume SSBs more frequently tend to be more responsive to SSB taxes, as do  
141 consumers of lower income.[21,31,34] The extent to which an excise tax is passed on to  
142 consumers is also an important factor determining how consumers respond to the price  
143 increases: estimates of pass-through rates from real-world SSB taxes range from less than 50% to  
144 over 100% pass-through.[35]

145 Evidence also suggests that the 'signalling effects' of an SSB tax may play an important role in  
146 changing consumer behaviour, independent of price effects.[36–38] Signalling effects refer to  
147 the ways in which the implementation of a tax may signal to consumers that consumption of the  
148 taxed goods should be reduced, beyond the mechanism of price increases.[38] Signals may be  
149 implicit (e.g., the fact that the government is taxing a product may suggest to consumers that  
150 consumption should be reduced; related to the 'expressive function of law'[39]), or explicit (e.g.,

151 when governments communicate specific information on the health harms associated with the  
152 taxed products).[40] Scant research has explored signalling effects in the context of SSB taxes,  
153 and has predominantly focused on the explicit impacts of health communication campaigns,  
154 political debate, and media attention. Two studies, one evaluating soda sales in Berkeley, US[41]  
155 and another surveying a cross-sectional sample of South African adults[42], found that soda sales  
156 dropped and knowledge of the health harms of SSBs and intention to reduce consumption  
157 increased, respectively, *prior* to tax implementation, suggesting that media coverage and pro-tax  
158 campaigns in these jurisdictions had impacts beyond that of price.

159 Evidence on consumer awareness of SSB taxes can also provide insight into potential signalling  
160 effects of SSB taxes, given that awareness is required for signalling effects to occur. Overall,  
161 observational studies assessing awareness of existing SSB taxes demonstrate heterogeneity  
162 within and across jurisdictions. A study assessing adults in Mexico found that 65% reported being  
163 aware of the national SSB tax of 1 peso/L approximately two years post-implementation,[36]  
164 whereas in focus groups involving adolescents in north-west Mexico, the majority of  
165 respondents were not aware of the SSB tax.[43] In South Africa, focus groups among adults three  
166 months prior to implementation of their national SSB tax (ZAR 2.1 cents/g sugar) found the  
167 majority of participants were not aware of the upcoming tax. [44]

168 Lastly, some SSB taxes—such as the UK’s SDIL—are designed by a governing body with the  
169 primary intention of encouraging product reformulation by targeting beverage manufacturers  
170 directly, with no explicit intention of influencing consumer behaviour.[45] In such cases, neither  
171 price effects nor signalling effects are primary policy objectives, but may nonetheless impact  
172 consumer behaviour. For example, recent evaluations in the UK have suggested that the



173 introduction of the tiered levy has prompted substantial reformulation of sugary drinks by the  
174 beverage industry, with an increasing number of lower-calorie options being introduced.[24,46]  
175 And although consumer perceptions and behaviour were not explicitly targeted by the SDIL, a  
176 recent cross-sectional analysis of parents in the UK found that 92% of respondents reported  
177 being aware of the SDIL, and 41% reported an intention to reduce their family's SSB  
178 consumption following the levy introduction.[47]

179 Given the differences in mechanisms relied upon by existing SSB taxes and the apparent  
180 heterogeneity of price responsiveness and tax awareness across settings, comprehensive  
181 assessments of such measures across jurisdictions are warranted. Evaluating consumers'  
182 perceived cost of SSBs and awareness of SSB taxes may help to increase our understanding of  
183 how price and signalling effects contribute to consumer purchasing behaviour in settings with  
184 different SSB tax designs. While there is an established link between price perceptions and  
185 purchase intention and behaviour,[48] to our knowledge, no published studies have compared  
186 measures of price perceptions or tax awareness over time or across multiple countries with and  
187 without SSB taxes. In addition, research has seldom examined consumers' self-reported changes  
188 in purchasing behaviour in response to such taxes, which could help to complement existing  
189 evidence from sales data, particularly in settings where consumer behaviour change is not a  
190 primary policy objective and other mechanisms (i.e., reformulation) may be more impactful.

191 In this study we use data from the International Food Policy Study (IFPS), which performs annual  
192 repeat cross-sectional surveys in Australia, Mexico, the UK and the US. The IFPS provides a  
193 unique opportunity to examine measures of perceived SSB cost, tax awareness and self-reported  
194 impacts over time and across multiple countries. National SSB taxes were implemented in

195 Mexico and the UK in January 2014 and April 2018, respectively, and seven city-level taxes in the  
196 US (Albany CA, Berkeley CA, Boulder CO, Oakland CA, Philadelphia PA, San Francisco CA, Seattle  
197 WA) have been implemented and upheld since 2015. Australia, where no SSB tax has been  
198 implemented, was included as a comparator.

199 In this study, we aimed to examine three primary measures: 1) perceived cost of SSBs (relative to  
200 non-SSBs) over time in Australia, Mexico, the UK and the US; 2) self-reported awareness of SSB  
201 taxes in years where taxes were present in Mexico, the UK and the US; and 3) self-reported  
202 changes in beverage purchases in response to SSB taxes in years where taxes were present, and  
203 whether or not this was influenced by perceived cost of drinks with sugar. Potential associations  
204 between the outcomes of interest and socio-demographic variables were also explored.

205

## 206 **METHODS**

207 We analysed data from the IFPS 2017, 2018 and 2019 waves. Online surveys were conducted in  
208 December 2017 (N=16,739), November-December 2018 (N=18,427), and November-December  
209 2019 (N=16,861) in Australia, Mexico, the UK, and the US. Full methods of the IFPS surveys are  
210 reported elsewhere.[49] The study was reviewed by and received ethics clearance through a  
211 University of Waterloo Research Ethics Committee (ORE #30829).

212

### 213 **SAMPLE RECRUITMENT**

214 The IFPS samples were recruited through Nielsen Consumer Insights Global Panel, using a  
215 standardized recruitment sampling strategy employing both probability and non-probability  
216 sampling methods across countries. Quotas for age and sex were applied to facilitate  
217 recruitment of a diverse sample that approximated the known proportions in each country for  
218 males and females across age groups.[49–51]

219 Eligibility criteria included being 18-64 (2017) or  $\geq 18$  years of age (2018-2019) and residing in a  
220 target country. Email invitations with a unique link were sent to a random sample of panelists  
221 that met inclusion criteria. If deemed eligible, potential respondents were provided with  
222 information about the study and provided consent prior to participating. Surveys were  
223 conducted in the primary language(s) spoken in each country. Respondents received  
224 remuneration in accordance with their panel’s usual incentive structure. A data integrity check  
225 was included part way through the survey, and additional data integrity analyses were  
226 conducted during data cleaning.

### 227 *Sampling weights*

228 Post-stratification sample weights were constructed each year for each country separately based  
229 on known population totals by age, sex at birth, region, ethnicity (except in 2017), and education  
230 (except in Mexico and 2017).[49–51]

231

232 SURVEY MEASURES

233 The main outcome measures used in this study were adapted from traditional tax and price  
234 measures used in fields outside of nutrition, such as tobacco[52], and based on well-established  
235 economic concepts of price perceptions.[53]

236 To assess perceived cost of SSBs in countries with and without SSB taxes, participants in all four  
237 countries in 2017, 2018 and 2019 were asked, “Do drinks with sugar (e.g., Coke) cost more than  
238 drinks without sugar (e.g., Diet Coke) in [Australia/Mexico/the UK/the US]?”, with response  
239 options ‘No’, ‘Yes – a little more’, ‘Yes – a lot more’, ‘Don’t know’, and ‘Refuse to answer’. The  
240 “correct” response was ‘No’ for Australian and US respondents in all three years (aside from US  
241 respondents living in cities with an SSB tax), ‘Yes’ for Mexican respondents in all three years, and  
242 ‘No’ for UK respondents in 2017 and ‘Yes’ in 2018-2019.

243 To assess awareness of SSB taxes in countries that have national or local taxes, participants in  
244 Mexico (2017, 2018, 2019); UK (2018, 2019); and US (2019) were asked, “Is there a special tax on  
245 sugary drinks in [Mexico/the UK/the US] that makes them more expensive to buy?”, with  
246 response options ‘No’, ‘Yes’, ‘Don’t know’ and ‘Refuse to answer’. The “correct” response was  
247 ‘Yes’ for Mexican and UK respondents in all available years, and ‘No’ for US respondents overall  
248 (aside from US respondents living in cities with an SSB tax).

249 Participants who responded ‘Yes’ to the tax awareness question above were then asked, “Has  
250 the tax changed whether you buy the following drinks for you or your family?” for 14 sugary and  
251 non-sugary beverage categories. ‘Regular bottled water’ was only included in waves 2018 and  
252 2019. The beverage categories were described using country-specific wording (e.g., “regular  
253 soda or pop” in the US versus “fizzy drinks” in the UK). Response options for each beverage

254 category were 'Buy less', 'Buy more', 'No change', 'Don't know', and 'Refuse to answer'. To  
255 assess a summary of participants' reported changes in purchases of taxed beverages, we  
256 constructed a categorical variable summarizing participants' responses as 'Bought less'  
257 (reporting 'buy less' for at least one taxed beverage and no 'buy more' for any taxed beverage),  
258 'Bought more' (reporting 'buy more' for at least one taxed beverage and no 'buy less' for any  
259 taxed beverage), or 'Mixed responses / No change' (any other combination of responses across  
260 the taxed beverages, including 'Don't know'). A parallel variable was constructed for untaxed  
261 beverages. Taxed beverage categories were established based on beverage types that would  
262 typically be included under SSB taxation schemes, and included regular (e.g., not diet or light)  
263 soda, sweetened fruit drinks, regular flavoured waters/vitamin waters, regular sports drinks, and  
264 regular energy drinks, which broadly encompass the taxed beverages in all jurisdictions except  
265 the City of Philadelphia in the US, where artificially sweetened ("diet") beverages are also taxed.  
266 Untaxed beverages included all remaining categories.

#### 267 *Socio-demographic and SSB perception measures*

268 Socio-demographic information was collected using measures drawn from government-led  
269 national surveys in each country [54–59] and responses were recoded to allow comparison  
270 across countries. Socio-demographic variables included age, sex[54], ethnicity[55–58] (recoded  
271 to 'majority group' or 'minority group'), education[55,56,58,59] (recoded to 'low', 'medium' or  
272 'high'), body mass index (BMI), and subjective income adequacy.[60] An indicator of perceived  
273 healthfulness of SSBs (see Table 1) was also examined. Further details on the survey measures  
274 and their development are available publicly.[61]

275 US zip code data were collected in 2018 and 2019. The zip code data were first compared to a  
276 database of valid US zip codes to identify and remove any invalid entries. Valid zip codes were  
277 then used to construct a variable indicating whether or not respondents lived in any of the seven  
278 cities that enforced a municipal SSB tax as of 2018 ('non-tax city' vs. 'SSB tax city').

279

## 280 STATISTICAL ANALYSES

281 Respondents were excluded from the analyses if they had missing data (including 'Refuse to  
282 answer') for any of the outcome or socio-demographic variables (n=3,103), excluding BMI, for  
283 which missing responses were retained as a valid response category. The final analytical sample  
284 consisted of 48,924 respondents across the three years.

285 Binary logistic regression models were used to assess the odds of participants perceiving drinks  
286 with sugar to cost more than drinks without sugar ('Yes – a little / Yes – a lot' versus 'No / Don't  
287 know') in all four countries, stratified by country.

288 Binary logistic regression models were also used to evaluate respondents' awareness of SSB  
289 taxes in countries with national or subnational taxes (Mexico, UK, US). These models assessed  
290 the odds of participants responding 'Yes' versus 'No / Don't know' to whether there is a special  
291 tax on sugary drinks in their respective country.

292 Multinomial logistic regression models were used to evaluate whether participants 'Bought less'  
293 or 'Bought more' (versus 'Mixed response / No change') for taxed and untaxed beverage  
294 categories, separately for Mexico, the UK, and the US.

295 Descriptive statistics examined unadjusted percentages for all outcomes of interest, and for  
296 responses from participants in US SSB tax cities versus non-tax cities. Results were not  
297 disaggregated for participants from Philadelphia (where artificially-sweetened beverages were  
298 included in a tax) due to the small number of respondents reporting a Philadelphia zip code.

299 All descriptive statistics and regression models were run with the post-stratification sample  
300 weights applied. Each regression model included variables for year, age, sex, ethnicity,  
301 education, income adequacy, and SSB healthfulness perceptions, due to their known  
302 associations with dietary patterns and SSB intake.[62,63] BMI was not included in models due to  
303 its high number of missing responses. Models assessing reported changes in beverage  
304 purchasing also included a variable for perceived cost of SSBs. 99% confidence intervals were  
305 used to account for the large sample size and high number of statistical tests.

306

## 307 **RESULTS**

308 Weighted socio-demographic characteristics of the sample, by country, are presented in **Table 1**.  
309 The majority of the sample in each country was female; identified as a majority ethnicity;  
310 reported height and weights corresponding to BMIs of 18.5 to 29.9; reported higher income  
311 adequacy; and perceived SSBs to be unhealthy. Distribution of education levels varied across  
312 countries, with a smaller proportion of participants with “low” education levels in Mexico. In the  
313 US, 1.1% (n=89) of participants reported zip codes corresponding to a city with an SSB tax.

314

315 *[Insert Table 1]*

316

317 PERCEIVED COST OF SSBs

318 **Figure 1** presents the unadjusted percentages of participants in Australia, Mexico, the UK and  
319 the US who reported that drinks with sugar cost ‘a little’ or ‘a lot’ more than drinks without sugar  
320 in their respective country across 2017, 2018 and 2019. Among respondents who perceived  
321 drinks with sugar to cost more than non-sugary drinks, a greater proportion reported they cost ‘a  
322 little more’ rather than ‘a lot more’ in all countries. The highest prevalences of perceiving sugary  
323 drinks to cost more than non-sugary drinks were observed in Mexico in all three years, and the  
324 UK in 2018 and 2019.

325 Results from the binary logistic regression models investigating perceived cost of SSBs are  
326 presented in **Table 2**. In all countries but Australia, there was a higher likelihood of perceiving  
327 drinks with sugar to cost more than drinks without sugar in 2018 and 2019 compared to 2017,  
328 as well as in 2019 compared to 2018 in the UK. There were no differences in perceived cost of  
329 drinks with sugar over time in Australia. Across all countries with and without SSB taxes, the  
330 likelihood of perceiving SSBs to cost more than drinks without sugar was higher among the  
331 youngest age group and respondents who perceived SSBs as healthy compared to older age  
332 groups and those who perceived SSBs as unhealthy. In all countries aside from the UK,  
333 perceiving drinks with sugar to cost more than drinks without sugar was higher among male  
334 respondents and respondents belonging to a minority ethnicity compared to female and  
335 majority ethnicity respondents. UK respondents reporting low education were more likely than



336 those with high education to perceive drinks with sugar to cost more than drinks without sugar,  
337 but no other differences across education levels were observed.

338

339 *[Insert Table 2]*

340

341 Descriptive results from the US (**Additional file 1**) show that a greater proportion of respondents  
342 living in a city with an SSB tax reported that drinks with sugar cost more than drinks without  
343 sugar compared to those reporting a zip code with no SSB tax, in both 2018 and 2019.

344

#### 345 TAX AWARENESS

346 The unadjusted percentages of respondents who reported being aware of a special tax on SSBs  
347 after taxes were implemented in Mexico (2017, 2018 and 2019), the UK (2018 and 2019) and the  
348 US (2019) are presented in **Figure 2**. UK respondents' awareness of their national SSB tax was  
349 higher than that in Mexico, and showed no change between 2018 and 2019.

350 Results from binary logistic regression models assessing awareness of SSB taxes are presented in  
351 **Table 3**. In Mexico, the likelihood of reporting being aware of the national SSB tax was lower with  
352 each consecutive year. Younger Mexican respondents were less likely to be aware of the SSB tax  
353 compared to those aged 30-64 years, whereas UK respondents aged  $\geq 65$  years were less likely to  
354 be aware of a tax than the youngest respondents. In Mexico and the UK, the likelihood of being  
355 aware of a tax was lower among female respondents than males, but there were no differences

356 by sex in the US. UK respondents belonging to a minority ethnicity group were less likely to be  
357 aware of an SSB tax compared to majority ethnicities, while the opposite was true in the US.  
358 Awareness of a tax in Mexico and the UK was lower among respondents reporting 'low' or  
359 'medium' education levels than those reporting 'high' education levels, and respondents in the  
360 UK and US who perceived SSBs as healthy were less and more likely, respectively, to be aware of  
361 a tax than those who perceived SSBs as unhealthy.

362

363 *[Insert Table 3]*

364

365 Unadjusted percentages from the US (Additional file 1) suggest that a greater proportion of  
366 respondents living in a city with an SSB tax reported that there was a special tax on sugary drinks  
367 in the US in 2019, compared to those living in cities without a tax.

368

369 REPORTED CHANGES IN PURCHASING BEHAVIOUR IN RESPONSE TO AN SSB TAX

370 **Figure 3** presents the unadjusted percentages of participants who reported that the tax led them  
371 to 'buy less', 'buy more', or 'no change / don't know' for taxed and untaxed beverages, collapsed  
372 across all available years of data. Overall, a similar pattern of responses across beverages  
373 categories was seen in Mexico, the UK and the US, with the highest magnitudes of change  
374 reported by Mexican consumers, followed by the US and the UK. In all three countries, the most  
375 common response was 'no change / don't know'. However, a substantial proportion of the

376 respondents reported buying 'less' of most of the taxed beverage categories and 'more' of plain  
377 bottled water, while also reporting buying 'less' of untaxed beverages such as diet soda, low-/no-  
378 calorie sports drinks, and chocolate/flavoured milk. **Additional file 2** presents the unadjusted  
379 percentages of respondents reporting 'buy less' or 'buy more' by year, for taxed and untaxed  
380 beverages in Mexico, the UK and the US.

381 Results from multinomial logistic regression models assessing a summary of respondents'  
382 reported changes in taxed beverage purchases, among those who were aware of an SSB tax in  
383 their country, are presented in **Table 4**. Overall, respondents in Mexico were more likely to  
384 report buying 'less' taxed beverages (versus 'no change / don't know') in 2018 and 2019  
385 compared to 2017. Mexican respondents were also more likely to report buying 'more' taxed  
386 beverages (versus 'no change / don't know') in 2018 and 2019 compared to 2017; however, the  
387 proportion of respondents reporting 'buy more' was much smaller than those reporting 'buy  
388 less'. The likelihood of buying 'more' taxed beverages was lower among participants aged 45-64  
389 years old in Mexico and 45-64 and  $\geq 65$  years in the UK compared to the youngest respondents.  
390 There were no differences by sex in any of the countries, but respondents reporting a majority  
391 ethnicity were less likely to report buying 'more' taxed beverages than those reporting a  
392 minority ethnicity in Mexico and the UK. The probability of buying 'less' taxed beverages was  
393 higher among respondents who perceived the cost of sugary drinks to be 'a little more' than  
394 drinks without sugar in Mexico, and those who perceived them to be 'a little more' and 'a lot  
395 more' in the UK, compared to those who perceived no difference in sugary drink prices. The  
396 probability of buying 'more' taxed beverages was also higher among respondents who reported  
397 sugary drinks to cost 'a little more' and 'a lot more' than drinks without sugar in Mexico, the UK,

398 and the US than those who perceived no price difference. There were further differences by  
399 education level, income adequacy, and SSB healthfulness perceptions (Table 4). Parallel results  
400 for changes in *untaxed* beverages purchases are presented in **Additional file 3**.

401

402 *[Insert Table 4]*

403

404 Unadjusted percentages from US respondents (Additional file 1) shows that a greater proportion  
405 of participants living in an SSB tax city reported buying less of both the taxed and untaxed  
406 beverages, compared to those living in a non-tax city.

407

408

## 409 **DISCUSSION**

410 In this study we presented new evidence on consumer awareness and responses to SSB taxes  
411 from three years of a repeat-cross sectional survey, including differences between countries and  
412 across key socio-demographic groups. To summarize, the study found that the perceived costs of  
413 drinks with sugar increased from 2017 to 2018 and 2019 in Mexico, the UK and the US, and from  
414 2018 to 2019 in the UK, with no changes in Australia. Awareness of the tax was highest in the UK  
415 and did not differ between waves, while there were decreases in awareness of the tax in Mexico

416 in each subsequent wave. A substantial proportion of participants reported an impact of the tax  
417 on purchasing taxed (i.e., less healthy) beverages, and this impact was highest in the Mexico.

418

#### 419 SUMMARY OF FINDINGS & RELATIONSHIP TO EXISTING KNOWLEDGE

420 Perceived cost of SSBs may play an important role in the relationship between SSB taxes and  
421 consumer behaviour. Perceived cost of SSBs relative to drinks without sugar was highest in  
422 Mexico across all three years, where a national SSB tax has been implemented since January  
423 2014 and increases in SSB prices relative to non-SSBs were observed,[3,5,64] and lowest in our  
424 'control' country of Australia, where no SSB tax has been implemented. Most importantly, our  
425 results demonstrate that perceived cost increased in the UK between 2017 and 2018 following  
426 the implementation of their national SSB tax in April 2018,[45] despite the industry-focused  
427 nature of the levy and variable pass-through rates observed.[24] Observational evidence thus far  
428 on actual price changes in the UK are mixed, with one controlled interrupted time series analysis  
429 finding that the prices of some levied beverage categories increased, while others  
430 decreased.[24] In a sample of UK parents in 2018, 44% noticed increases in the price of soft  
431 drinks as a result of the levy.[47]

432 Overall, in settings with an SSB tax, the proportion of respondents who perceived drinks with  
433 sugar to cost 'a little' or 'a lot' more than non-sugary drinks was reasonably high (approximately  
434 half); however, this suggests that raised SSB prices were not salient to about half of all  
435 consumers in jurisdictions with an SSB tax. In settings such as the UK, where consumer behaviour  
436 change was not a primary objective of the levy, this may be acceptable. In settings where

437 consumer behaviour change is a primary goal (i.e., Mexico and some US cities), the proportion of  
438 consumers who did not perceive SSBs to cost more than non-SSBs may be largely made up of  
439 less price-sensitive consumers, such as those who do not frequently purchase or consume SSBs,  
440 as was suggested in our findings. Notably, almost 20% of respondents in Australia and the US—  
441 where no national SSB taxes are implemented—also reported that sugary drinks cost more than  
442 drinks without sugar. It is possible that media coverage of international or city-level SSB taxes  
443 may have led some participants to attribute higher SSB prices to their country.

444 The estimates of tax awareness obtained in this study reflect the tax status of the jurisdictions  
445 assessed, and are similar to those reported in previous literature. Awareness of a national SSB  
446 tax was highest among UK respondents (where the tax had been implemented most recently in  
447 2018), followed closely by Mexico (where a national tax was implemented in 2014), and lowest  
448 among respondents in the US, where no national SSB tax is in place. In the US, about three  
449 quarters of respondents living in cities with an SSB tax reported being aware of a tax, compared  
450 to only 18% among participants in cities without an SSB tax. The proportion of respondents  
451 aware of the Mexican SSB tax in this study (57% in 2017, 52% in 2018, 46% in 2019) suggest a  
452 gradual decrease in awareness over time, which follows the estimated 65% tax awareness in  
453 2016 reported by Álvarez-Sánchez et al.[36] These decreases in awareness may also suggest that  
454 taxes could be increased periodically to maintain their saliency, a practice which has been used  
455 successfully in the context of tobacco products.[65] The rates of tax awareness among UK  
456 respondents in this study (69% in 2018, 68% in 2019) were lower than those reported by Gillison  
457 et al. (92% in 2018).[47] These differences, however, may be largely attributed to differences in  
458 sample profile and data collection methods: the sample recruited by Gillison et al. comprised

459 parents of young children, and respondents were prompted with a full definition of the SDIL  
460 prior to being queried about their awareness.

461 The decrease in tax awareness over time observed in Mexico is in direct contrast to the increases  
462 observed for perceived cost of SSBs. The contrast between these two measures may indicate  
463 that although awareness of the tax regulation has gradually decreased, the actual price  
464 differences between SSBs and non-SSBs remain salient to consumers. Decreased awareness of  
465 the Mexican SSB tax may be partially explained by the introduction of more recent nutrition  
466 efforts in Mexico (e.g., new front-of-package nutrition labels, television-based healthy eating  
467 campaigns[66,67]), which may have detracted attention from the tax over time, and may also  
468 explain some of the differences in magnitude of awareness observed between the UK and  
469 Mexico. Given that tax awareness appears to be consistently decreasing in Mexico, and the  
470 policy does rely in part on consumer awareness, education campaigns that help to enhance a  
471 'signalling effect' and awareness of the tax may be warranted.

472 The third measure in this study, reported changes in beverage purchasing due to an SSB tax  
473 (among participants who were aware of an SSB tax), varied across countries. The pattern of  
474 participants buying 'less' or 'more' across all beverage categories was similar in Mexico, the UK  
475 and the US; however, the magnitude of reported changes in response to an SSB tax were largest  
476 among the Mexican sample. More modest responses observed in the UK may reflect the  
477 industry-focused nature of the SDIL, which encouraged industry reformulation rather than  
478 targeting behaviour change by UK consumers,[45] as well as the incomplete pass-through of the  
479 tax observed in a recent evaluation.[24] In previous studies, approximately 20% of Mexican  
480 adults thought the SSB tax was helping to decrease the purchase of SSBs[36]—lower than the

481 32-41% of respondents in this study stating that the tax led them to buy fewer taxed beverages.  
482 In the UK, 41% of a sample of parents expressed intention to reduce SSB consumption for  
483 themselves or their family,[47] and 71% of a separate sample of UK adults in 2017 believed that  
484 the SDIL would be effective.[47] These higher values reported previously (compared to the 10-  
485 24% reporting 'buy less' for taxed beverages in our study) may again be due to differences in  
486 sample profile or question design.

487 When examining individual beverage categories, a substantial proportion of the respondents  
488 reported buying less of most of the taxed beverage categories and more of plain bottled water  
489 (this is in contrast to a recent study that found reduced bottled water purchases in the UK  
490 following the introduction of the SDIL,[68] although this finding may have resulted from a  
491 concurrent media focus on the environmental problems of single use plastics), but also reported  
492 buying less of untaxed beverages such as diet soda, low-/no-calorie drinks, and  
493 chocolate/flavoured milk. Although these results do not necessarily reflect the price mechanisms  
494 of the tax, shifting consumers away from artificially-sweetened beverages—whose health effects  
495 are still debated[69,70]—may be a positive outcome. These results also suggest that the majority  
496 of consumers are not substituting reductions in sugary drinks with increases in diet drinks,  
497 possibly because of concerns about sugar substitutes[71,72], which reflects patterns of beverage  
498 consumption observed in recent years.[73]

499 Across all of the outcome measures, some socio-demographic patterns emerged. Participants  
500 who were younger, male, belonging to a minority ethnicity group, and who gave neutral or  
501 positive healthfulness ratings to SSBs were more likely to perceive the cost of SSBs to be higher  
502 than drinks without sugar, across most or all countries regardless of tax status. Existing evidence



503 suggests that consumers with these characteristics consume SSBs more frequently[74], and thus  
504 may be more sensitive to price changes regardless of taxation.

505 Patterns across socio-demographic groups for tax awareness often contrasted those observed  
506 for perceived SSB cost. For example, Mexican respondents who were younger and UK  
507 respondents with 'low' education were less likely to report awareness of a national SSB tax,  
508 despite these groups reporting a higher perceived cost of SSBs relative to drinks without sugar.  
509 These groups tend to be more likely to purchase and consume SSBs[74], making them more  
510 sensitive to price increases, but may be less aware that the price differences are a result of a tax,  
511 possibly due to differing exposure to media sources or government messaging upon tax  
512 implementation. Although perceived cost and tax awareness may be linked, they are likely to  
513 have unique and separate effects on consumer purchasing behaviour, and may be largely  
514 dependent on the extent to which the signalling effects of a tax reach different groups of  
515 consumers.

516 Fewer socio-demographic correlates were identified for reported changes in purchasing  
517 behaviour; however, patterns tended to reflect those observed for perceived SSB cost, with a  
518 greater proportion reporting that they bought less taxed beverages among participants  
519 belonging to a minority ethnicity, reporting 'low' education, and indicating lower income  
520 adequacy. Perceived cost of SSBs appeared to be a strong influence on reported behaviour  
521 change, with higher perception of SSB cost associated with a greater proportion of respondents  
522 reporting they 'bought less' taxed beverages. These results are in line with previous research  
523 suggesting that consumers of lower socioeconomic status are likely to be more responsive to  
524 price increases.[75]

525

526 STRENGTHS & LIMITATIONS

527 Our study represents the first analysis of cost perceptions, tax awareness, and reported  
528 purchasing behaviours in response to SSB taxes across multiple countries with and without SSB  
529 taxes. However, several limitations should be noted. Respondents were recruited using  
530 nonprobability-based sampling; therefore, the findings do not provide nationally representative  
531 estimates. For example, although the data were weighted by age, sex, and region, the Mexico  
532 sample had higher levels of education than census estimates, while BMI was somewhat lower  
533 than national estimates in each of the four countries. The sample of US respondents reporting  
534 zip codes from cities with an SSB tax was small, and comparisons to respondents in non-tax cities  
535 should be interpreted with caution. Respondent zip code data were not available in 2017;  
536 therefore, the authors could not disaggregate results by US city tax status in 2017, which could  
537 have influenced perceived cost of SSBs. However, given the small number of US respondents  
538 residing in tax cities in 2018 and 2019, this would have been unlikely to have a substantial impact  
539 on the overall results. Further, although the acceptable use of self-report methods in diet and  
540 nutrition research has been well-established[76,77], the self-report nature of the survey  
541 measures may limit the accuracy of our predictions of changes in purchasing behaviour. In  
542 particular, in the UK, the industry-focused nature of the SDIL may have led to some ambiguity  
543 among respondents when asked whether there a “special tax on sugar drinks in the UK that  
544 makes them more expensive to buy”. In the US, respondents were asked whether there is special  
545 tax on sugary drinks ‘in the US’, which some participants—both in cities with and without SSB  
546 taxes—may have interpreted as a national-level tax, while others may have interpreted as ‘any’

547 tax on sugary drinks in the US. Further, substantial reformulation of SSBs in the UK following SDIL  
548 implementation[24] (i.e., reductions in sugar content such that previously taxed beverages now  
549 fall below the tax threshold) may mean that some ‘taxed’ beverage categories in this study may  
550 have included a subset of untaxed beverages in the UK.

551

## 552 CONCLUSIONS & AREAS FOR FUTURE RESEARCH

553 Perceived cost of SSBs and tax awareness were higher in countries where a national SSB tax was  
554 present (Mexico, UK), and reported changes in purchasing behaviour were highest in response to  
555 Mexico’s national SSB tax. The results suggest that perceived cost and tax awareness represent  
556 two distinct constructs, and that there may be room for awareness (of both SSB tax measures  
557 and price differentials) to be improved in tax settings where consumer behaviour change is an  
558 objective. Increased awareness may be achieved through education campaigns that enhance  
559 signalling effects, but must be tailored to each country based on country-specific relationships  
560 with taxed beverages. Consumers with characteristics traditionally corresponding to lower  
561 socioeconomic status may be less likely to be aware of an SSB tax, but more likely to perceive  
562 SSBs to cost more than non-SSBs and respond by reducing their purchasing of those products.  
563 Future research should continue to examine tax awareness and responses in countries with SSB  
564 taxes to explore why such measures may change over time and across socio-demographic  
565 groups.

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895 **TABLES**

896 **Table 1.** Characteristics of respondents in the International Food Policy Study (weighted), 2017, 2018 and  
 897 2019 (N=48,924)

|                              | Total<br>N=48,924<br>% (n) | Australia<br>N=11,588<br>% (n) | Mexico<br>N=11,610<br>% (n) | UK<br>N=12,945<br>% (n) | US<br>N=12,781<br>% (n) |
|------------------------------|----------------------------|--------------------------------|-----------------------------|-------------------------|-------------------------|
| <b>Year</b>                  |                            |                                |                             |                         |                         |
| 2017                         | 32.3 (15,802)              | 31.0 (3,595)                   | 32.3 (3,751)                | 29.4 (3,805)            | 36.4 (4,651)            |
| 2018                         | 35.5 (17,347)              | 34.0 (3,939)                   | 33.3 (3,869)                | 40.5 (5,239)            | 33.6 (4,301)            |
| 2019                         | 32.2 (15,775)              | 35.0 (4,054)                   | 34.4 (3,990)                | 30.1 (3,901)            | 30.0 (3,829)            |
| <b>Age</b>                   |                            |                                |                             |                         |                         |
| 18-29 years                  | 23.7 (11,615)              | 22.6 (2,618)                   | 30.4 (3,533)                | 20.2 (2,612)            | 22.3 (2,852)            |
| 30-44 years                  | 28.6 (13,994)              | 28.6 (3,319)                   | 33.1 (3,838)                | 26.8 (3,467)            | 26.4 (3,369)            |
| 45-64 years                  | 36.8 (17,983)              | 36.8 (4,259)                   | 33.7 (3,912)                | 36.7 (4,751)            | 39.6 (5,061)            |
| ≥65 years                    | 10.9 (5,332)               | 12.0 (1,392)                   | 2.8 (326)                   | 16.3 (2,115)            | 11.7 (1,500)            |
| <b>Sex</b>                   |                            |                                |                             |                         |                         |
| Female                       | 51.3 (25,105)              | 50.8 (5,890)                   | 52.2 (6,061)                | 51.3 (6,644)            | 50.9 (6,510)            |
| Male                         | 48.7 (23,819)              | 49.2 (5,698)                   | 47.8 (5,549)                | 48.7 (6,301)            | 49.1 (6,271)            |
| <b>Ethnicity<sup>a</sup></b> |                            |                                |                             |                         |                         |
| Majority group               | 80.4 (39,345)              | 77.7 (9,003)                   | 82.1 (9,530)                | 89.5 (11,591)           | 72.2 (9,222)            |

|  |               |               |              |               |               |
|--|---------------|---------------|--------------|---------------|---------------|
| Minority group                                   | 19.6 (9,579)  | 22.3 (2,586)  | 17.9 (2,080) | 10.5 (1,355)  | 27.8 (3,559)  |
| <b>Education level<sup>b</sup></b>               |               |               |              |               |               |
| Low  | 36.1 (17,669) | 37.0 (4,292)  | 19.3 (2,235) | 42.3 (5,479)  | 44.3 (5,663)  |
| Medium   | 20.8 (10,192) | 33.4 (3,874)  | 12.9 (1,494) | 24.0 (3,112)  | 13.4 (1,713)  |
| High   | 43.1 (21,063) | 29.5 (3,423)  | 67.9 (7,881) | 33.6 (4,354)  | 42.3 (5,405)  |
| <b>BMI</b>                                       |               |               |              |               |               |
| <18.5  | 3.0 (1,462)   | 3.2 (370)     | 2.3 (272)    | 3.1 (400)     | 3.3 (420)     |
| 18.5-24.9  | 36.0 (17,612) | 36.4 (4,213)  | 40.9 (4,743) | 34.0 (4,397)  | 33.3 (4,258)  |
| 25.0-29.9  | 29.1 (14,219) | 27.0 (3,134)  | 33.4 (3,879) | 26.1 (3,380)  | 29.9 (3,825)  |
| ≥30.0  | 20.0 (9,776)  | 20.8 (2,414)  | 16.5 (1,914) | 16.4 (2,119)  | 26.0 (3,329)  |
| Missing  | 12.0 (5,855)  | 12.6 (1,457)  | 6.9 (802)    | 20.5 (2,648)  | 7.4 (949)     |
| <b>Income adequacy<sup>c</sup></b>               |               |               |              |               |               |
| High   | 69.9 (34,207) | 72.4 (8,390)  | 57.5 (6,675) | 75.1 (9,728)  | 73.7 (9,413)  |
| Low  | 30.1 (14,717) | 27.6 (3,198)  | 42.5 (4,934) | 24.9 (3,218)  | 26.3 (3,367)  |
| <b>SSB healthfulness perceptions<sup>d</sup></b> |               |               |              |               |               |
| Healthy  | 10.3 (5,020)  | 6.0 (690)     | 16.6 (1,932) | 7.3 (942)     | 11.4 (1,457)  |
| Unhealthy  | 89.7 (43,904) | 94.0 (10,899) | 83.4 (9,678) | 92.7 (12,003) | 88.6 (11,324) |
| <b>US city tax status<sup>e</sup></b>            |               |               |              |               |               |
| Non-tax city                                     | .             | .             | .            | .             | 98.9 (8,041)  |
| SSB tax city                                     | .             | .             | .            | .             | 1.1 (89)      |

UK, United Kingdom; US, United States; BMI, body mass index; SSB, sugar sweetened beverage

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<sup>a</sup> Ethnicity categories as per census questions asked in each country: 1) Australia majority=only speaks English at home, minority=speaks a language besides English at home; 2) Canada majority=White, minority=other ethnicity; 3) Mexico majority=Non-indigenous, minority=indigenous; 4) United Kingdom majority=White, minority=other ethnicity; 5) US majority=White, minority=other ethnicity.

<sup>b</sup> Participants were asked, “What is the highest level of formal education that you have completed?” Responses were categorized as ‘low’ (completed secondary school or less), ‘medium’ (some post-secondary qualifications), or ‘high’ (university degree or higher) according to country-specific criteria.

<sup>c</sup> Participants were asked, “Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?”, with response options ‘Very easy’, ‘Easy’ and ‘Neither easy nor difficult’ categorized as “High”, and ‘Difficult’ and ‘Very difficult’ categorized as “Low”.

<sup>d</sup> Participants were shown a 500mL bottle of regular soda and asked, “In your opinion, how unhealthy or healthy is this type of drink?”, with response options ‘Very healthy’, ‘Healthy’, ‘A little healthy’ and ‘Neither healthy nor unhealthy’ categorized as “Healthy”, and ‘A little unhealthy’, ‘Unhealthy’ and ‘Very unhealthy’ categorized as “Unhealthy”.

<sup>e</sup> US city/zip code data was only collected in 2018 and 2019.

**Table 2.** Binary logistic regression models investigating perceived relative cost of beverages with sugar in four countries.

|                               | Australia (N=11,588)                      |                    | Mexico (N=11,610)            |                    | UK (N=12,945)                |                    | US (N=12,781)                |                    |
|-------------------------------|---|--------------------|------------------------------|--------------------|------------------------------|--------------------|------------------------------|--------------------|
|                               | 'A little more / A lot more' <sup>a</sup> |                    | 'A little more / A lot more' |                    | 'A little more / A lot more' |                    | 'A little more / A lot more' |                    |
|                               | Adjusted                                  | OR (99% CI)        | Adjusted                     | OR (99% CI)        | Adjusted                     | OR (99% CI)        | Adjusted                     | OR (99% CI)        |
|                               | Prevalence                                |                    | Prevalence                   |                    | Prevalence                   |                    | Prevalence                   |                    |
| <b>Year <sup>b</sup></b>      |   |                    |                              |                    |                              |                    |                              |                    |
| 2017                          | 32.7%                                     | [ref]              |                              | [ref]              | 22.7%                        | [ref]              | 22.4%                        | [ref]              |
| 2018                          | 32.1%                                     | 0.97 (0.81, 1.16)  |                              | 1.41 (1.22, 1.63)* | 54.9%                        | 4.15 (3.56, 4.83)* | 30.0%                        | 1.48 (1.24, 1.77)* |
| 2019                          | 31.0%                                     | 0.92 (0.78, 1.10)  |                              | 1.40 (1.22, 1.62)* | 59.5%                        | 5.00 (4.26, 5.88)* | 30.9%                        | 1.55 (1.29, 1.86)* |
| <b>Age</b>                    |   |                    |                              |                    |                              |                    |                              |                    |
| 18-29 years                   | 47.3%                                     | [ref]              |                              | [ref]              | 62.0%                        | [ref]              | 40.1%                        | [ref]              |
| 30-44 years                   | 39.8%                                     | 0.74 (0.61, 0.89)* |                              | 0.79 (0.70, 0.90)* | 55.7%                        | 0.77 (0.65, 0.92)* | 39.1%                        | 0.96 (0.80, 1.15)  |
| 45-64 years                   | 24.0%                                     | 0.35 (0.29, 0.43)* |                              | 0.47 (0.40, 0.55)* | 39.4%                        | 0.40 (0.34, 0.47)* | 21.9%                        | 0.42 (0.34, 0.51)* |
| ≥65 years                     | 20.4%                                     | 0.29 (0.21, 0.38)* |                              | 0.41 (0.25, 0.68)* | 24.2%                        | 0.20 (0.16, 0.24)* | 14.8%                        | 0.26 (0.19, 0.35)* |
| <b>Sex</b>                    |   |                    |                              |                    |                              |                    |                              |                    |
| Female                        | 28.8%                                     | 0.75 (0.65, 0.86)* |                              | 0.83 (0.74, 0.93)* | 43.9%                        | 0.94 (0.83, 1.06)  | 25.1%                        | 0.77 (0.67, 0.90)* |
| Male                          | 35.2%                                     | [ref]              |                              | [ref]              | 45.5%                        | [ref]              | 30.3%                        | [ref]              |
| <b>Ethnicity <sup>c</sup></b> |   |                    |                              |                    |                              |                    |                              |                    |

|  |       |                    |                    |       |                    |       |                    |
|--|-------|--------------------|--------------------|-------|--------------------|-------|--------------------|
| Majority group                                   | 25.5% | 0.54 (0.45, 0.64)* | 0.57 (0.48, 0.67)* | 42.3% | 0.83 (0.66, 1.03)  | 20.6% | 0.46 (0.39, 0.54)* |
| Minority group                                   | 39.0% | [ref]              | [ref]              | 47.1% | [ref]              | 35.9% | [ref]              |
| <b>Education level<sup>d</sup></b>               |       |                    |                    |       |                    |       |                    |
| Low  | 33.2% | 1.16 (0.96, 1.40)  | 1.04 (0.89, 1.21)  | 47.3% | 1.24 (1.08, 1.42)* | 29.0% | 1.09 (0.93, 1.28)  |
| Medium   | 32.7% | 1.13 (0.95, 1.35)  | 1.19 (0.98, 1.43)  | 44.7% | 1.11 (0.97, 1.27)  | 26.7% | 0.97 (0.79, 1.19)  |
| High   | 29.9% | [ref]              | [ref]              | 42.1% | [ref]              | 27.2% | [ref]              |
| <b>Income adequacy<sup>e</sup></b>               |       |                    |                    |       |                    |       |                    |
| High   | 30.3% | 0.86 (0.73, 1.01)  | 1.01 (0.89, 1.14)  | 43.0% | 0.87 (0.75, 1.00)  | 25.9% | 0.84 (0.71, 1.00)  |
| Low  | 33.6% | [ref]              | [ref]              | 46.4% | [ref]              | 29.3% | [ref]              |
| <b>SSB healthfulness perceptions<sup>f</sup></b> |       |                    |                    |       |                    |       |                    |
| Healthy  | 44.6% | 2.94 (2.28, 3.80)* | 1.23 (1.05, 1.44)* | 49.3% | 1.45 (1.12, 1.86)* | 36.6% | 2.30 (1.87, 2.82)* |
| Unhealthy  | 21.5% | [ref]              | [ref]              | 40.2% | [ref]              | 20.1% | [ref]              |

Results from binary logistic regression models investigating correlates of participants perceiving beverages with sugar to cost ‘a little more’ or ‘a lot more’ versus ‘no different’ than beverages without sugar in Australia, Mexico, the United Kingdom, and the United States.

UK, United Kingdom; US, United States; OR, odds ratio; CI, confidence interval; SSB, sugar sweetened beverage



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\*Significantly different (compared to reference group) at  $p < .01$ .

<sup>a</sup> Participants responding 'Yes – a little more / Yes – a lot more' versus 'No change / Don't know' when asked, "Do drinks with sugar (e.g., Coke) cost more than drinks without sugar (e.g., Diet Coke) in [country]?"

<sup>b</sup> Results for all year comparisons are provided in Additional File 4.

<sup>c</sup> Ethnicity categories as per census questions asked in each country: 1) Australia majority=only speaks English at home, minority=speaks a language besides English at home; 2) Canada majority=White, minority=other ethnicity; 3) Mexico majority=Non-indigenous, minority=indigenous; 4) United Kingdom majority=White, minority=other ethnicity; 5) US majority=White, minority=other ethnicity.

<sup>d</sup> Participants were asked, "What is the highest level of formal education that you have completed?" Responses were categorized as 'low' (completed secondary school or less), 'medium' (some post-secondary qualifications), or 'high' (university degree or higher) according to country-specific criteria.

<sup>e</sup> Participants were asked, "Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?", with response options 'Very easy', 'Easy' and 'Neither easy nor difficult' categorized as "High", and 'Difficult' and 'Very difficult' categorized as "Low".

<sup>f</sup> Participants were shown a 500mL bottle of regular soda and asked, "In your opinion, how unhealthy or healthy is this type of drink?", with response options 'Very healthy', 'Healthy', 'A little healthy' and 'Neither healthy nor unhealthy' categorized as "Healthy", and 'A little unhealthy', 'Unhealthy' and 'Very unhealthy' categorized as "Unhealthy".

**Table 3.** Binary logistic regression models investigating awareness of sugar-sweetened beverage taxes in three countries.

|                         | Mexico (n=11,610)   |                    | UK (n=9,140)        |                    | US (n=3,829)        |                   |
|-------------------------|---------------------|--------------------|---------------------|--------------------|---------------------|-------------------|
|                         | 'Yes' <sup>a</sup>  |                    | 'Yes'               |                    | 'Yes'               |                   |
|                         | Adjusted prevalence | OR (99% CI)        | Adjusted prevalence | OR (99% CI)        | Adjusted prevalence | OR (99% CI)       |
| <b>Year<sup>b</sup></b> |                     |                    |                     |                    |                     |                   |
| 2017                    | 52.0%               | [ref]              | .                   | .                  | .                   | .                 |
| 2018                    | 47.1%               | 0.82 (0.71, 0.95)* | 60.4%               | [ref]              | .                   | .                 |
| 2019                    | 41.1%               | 0.64 (0.56, 0.74)* | 59.4%               | 0.96 (0.83, 1.11)  | 21.7%               | .                 |
| <b>Age</b>              |                     |                    |                     |                    |                     |                   |
| 18-29 years             | 38.5%               | [ref]              | 63.1%               | [ref]              | 25.5%               | [ref]             |
| 30-44 years             | 49.0%               | 1.54 (1.35, 1.75)* | 62.6%               | 0.98 (0.78, 1.22)  | 24.6%               | 0.95 (0.64, 1.41) |
| 45-64 years             | 51.4%               | 1.69 (1.45, 1.97)* | 62.6%               | 0.98 (0.78, 1.22)  | 19.1%               | 0.69 (0.47, 1.02) |
| ≥65 years               | 48.2%               | 1.49 (0.94, 2.35)  | 51.1%               | 0.61 (0.49, 0.77)* | 18.0%               | 0.64 (0.41, 1.00) |
| <b>Sex</b>              |                     |                    |                     |                    |                     |                   |
| Female                  | 41.3%               | 0.64 (0.57, 0.72)* | 58.2%               | 0.86 (0.75, 0.99)* | 19.6%               | 0.78 (0.60, 1.02) |

|  |       |                    |       |                    |       |                    |
|--|-------|--------------------|-------|--------------------|-------|--------------------|
| Male   | 52.2% | [ref]              | 61.7% | [ref]              | 23.8% | [ref]              |
| <b>Ethnicity<sup>c</sup></b>                     |       |                    |       |                    |       |                    |
| Majority group                                   | 48.0% | 1.11 (0.93, 1.31)  | 65.5% | 1.61 (1.25, 2.08)* | 19.1% | 0.73 (0.54, 1.00)* |
| Minority group                                   | 45.5% | [ref]              | 54.1% | [ref]              | 24.4% | [ref]              |
| <b>Education level<sup>d</sup></b>               |       |                    |       |                    |       |                    |
| Low  | 41.0% | 0.58 (0.50, 0.67)* | 58.2% | 0.82 (0.70, 0.97)* | 22.6% | 0.97 (0.74, 1.27)  |
| Medium   | 44.8% | 0.68 (0.56, 0.82)* | 58.7% | 0.84 (0.72, 0.99)* | 19.3% | 0.79 (0.57, 1.10)  |
| High   | 54.5% | [ref]              | 62.8% | [ref]              | 23.1% | [ref]              |
| <b>Income adequacy<sup>e</sup></b>               |       |                    |       |                    |       |                    |
| High   | 47.2% | 1.04 (0.92, 1.17)  | 57.9% | 0.85 (0.71, 1.01)  | 20.8% | 0.90 (0.67, 1.22)  |
| Low  | 46.3% | [ref]              | 61.9% | [ref]              | 22.5% | [ref]              |
| <b>SSB healthfulness perceptions<sup>f</sup></b> |       |                    |       |                    |       |                    |
| Healthy  | 45.7% | 0.92 (0.78, 1.08)  | 52.5% | 0.54 (0.42, 0.71)* | 25.2% | 1.50 (1.05, 2.14)* |
| Unhealthy  | 47.8% | [ref]              | 67.0% | [ref]              | 18.4% | [ref]              |

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Results from binary logistic regression models investigating correlates of awareness of sugar sweetened beverage taxes in Mexico, the United Kingdom, and the United States

UK, United Kingdom; US, United States; OR, odds ratio; CI, 99% confidence interval; SSB, sugar sweetened beverage

\*Significantly different (compared to reference group) at  $p < .01$

<sup>a</sup> Participants responding 'Yes' versus 'No / Don't know' when asked, "Is there a special tax on sugary drinks in [country] that makes them more expensive to buy?".

<sup>b</sup> Results for all year comparisons are provided in Additional File 4.

<sup>c</sup> Ethnicity categories as per census questions asked in each country: 1) Australia majority=only speaks English at home, minority=speaks a language besides English at home; 2) Canada majority=White, minority=other ethnicity; 3) Mexico majority=Non-indigenous, minority=indigenous; 4) United Kingdom majority=White, minority=other ethnicity; 5) US majority=White, minority=other ethnicity.

<sup>d</sup> Participants were asked, "What is the highest level of formal education that you have completed?" Responses were categorized as 'low' (completed secondary school or less), 'medium' (some post-secondary qualifications), or 'high' (university degree or higher) according to country-specific criteria.

<sup>e</sup> Participants were asked, "Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?", with response options 'Very easy', 'Easy' and 'Neither easy nor difficult' categorized as "High", and 'Difficult' and 'Very difficult' categorized as "Low".

<sup>f</sup> Participants were shown a 500mL bottle of regular soda and asked, "In your opinion, how unhealthy or healthy is this type of drink?", with response options 'Very healthy', 'Healthy', 'A little healthy' and 'Neither healthy nor unhealthy' categorized as "Healthy", and 'A little unhealthy', 'Unhealthy' and 'Very unhealthy' categorized as "Unhealthy".



**Table 4.** Multinomial logistic regression models investigating reported purchase changes in response to a sugar-sweetened beverage tax, among participants who were aware of a tax in their country.

|                         | Mexico (n=5,971)         |                    |             |                    | UK (n=6,271) |                   |             |                    | US (n=712)  |                   |             |                   |
|-------------------------|--------------------------|--------------------|-------------|--------------------|--------------|-------------------|-------------|--------------------|-------------|-------------------|-------------|-------------------|
|                         | Bought less <sup>a</sup> |                    | Bought more |                    | Bought less  |                   | Bought more |                    | Bought less |                   | Bought more |                   |
|                         | Adjusted                 | OR                 | Adjusted    | OR                 | Adjusted     | OR                | Adjusted    | OR                 | Adjusted    | OR                | Adjusted    | OR                |
|                         | Prevalence               | (99% CI)           | Prevalence  | (99% CI)           | Prevalence   | (99% CI)          | Prevalence  | (99% CI)           | Prevalence  | (99% CI)          | Prevalence  | (99% CI)          |
| <b>Year<sup>b</sup></b> |                          |                    |             |                    |              |                   |             |                    |             |                   |             |                   |
| 2017                    | 36.4%                    | [ref]              | 5.0%        | [ref]              | .            | .                 | .           | .                  | .           | .                 | .           | .                 |
| 2018                    | 41.6%                    | 1.32 (1.07, 1.62)* | 7.6%        | 1.74 (1.12, 2.73)* | 22.0%        | [ref]             | 4.8%        | [ref]              | .           | .                 | .           | .                 |
| 2019                    | 41.4%                    | 1.29 (1.05, 1.59)* | 7.0%        | 1.58 (1.01, 2.47)* | 22.2%        | 1.02 (0.84, 1.24) | 5.5%        | 1.16 (0.71, 1.89)  | 21.9%       | .                 | 6.8%        | .                 |
| <b>Age</b>              |                          |                    |             |                    |              |                   |             |                    |             |                   |             |                   |
| 18-29 years             | 35.7%                    | [ref]              | 8.5%        | [ref]              | 22.9%        | [ref]             | 8.7%        | [ref]              | 15.4%       | [ref]             | 10.7%       | [ref]             |
| 30-44 years             | 39.0%                    | 1.13 (0.93, 1.38)  | 7.1%        | 0.86 (0.58, 1.28)  | 18.9%        | 0.78 (0.58, 1.05) | 8.4%        | 0.92 (0.50, 1.69)  | 17.3%       | 1.12 (0.41, 3.02) | 8.2%        | 0.76 (0.26, 2.21) |
| 45-64 years             | 42.2%                    | 1.21 (0.97, 1.51)  | 3.4%        | 0.41 (0.24, 0.69)* | 21.9%        | 0.88 (0.66, 1.17) | 3.5%        | 0.37 (0.18, 0.78)* | 25.6%       | 1.78 (0.67, 4.71) | 5.2%        | 0.53 (0.14, 2.01) |

|                                    |       |                       |      |                       |       |                       |      |                       |       |                      |      |                      |
|------------------------------------|-------|-----------------------|------|-----------------------|-------|-----------------------|------|-----------------------|-------|----------------------|------|----------------------|
| ≥65 years                          | 42.0% | 1.32<br>(0.69, 2.54)  | 8.3% | 1.09 (0.25,<br>4.70)  | 24.3% | 1.00 (0.72,<br>1.38)  | 2.7% | 0.29 (0.11,<br>0.75)* | 30.8% | 2.25 (0.74,<br>6.86) | 3.4% | 0.36 (0.04,<br>3.43) |
| <b>Sex</b>                         |       |                       |      |                       |       |                       |      |                       |       |                      |      |                      |
| Female                             | 41.8% | 1.14 (0.96,<br>1.35)  | 5.4% | 0.72 (0.49,<br>1.08)  | 22.8% | 1.07 (0.88,<br>1.30)  | 4.7% | 0.84 (0.51,<br>1.39)  | 25.3% | 1.43 (0.77,<br>2.67) | 4.5% | 0.52 (0.18,<br>1.51) |
| Male                               | 37.8% | [ref]                 | 7.7% | [ref]                 | 21.4% | [ref]                 | 5.6% | [ref]                 | 18.4% | [ref]                | 8.9% | [ref]                |
| <b>Ethnicity<sup>c</sup></b>       |       |                       |      |                       |       |                       |      |                       |       |                      |      |                      |
| Majority<br>group                  | 39.9% | 0.95 (0.73,<br>1.23)  | 4.9% | 0.55 (0.35,<br>0.86)* | 19.7% | 0.72 (0.50,<br>1.03)  | 3.6% | 0.44 (0.21,<br>0.91)* | 18.3% | 0.62 (0.31,<br>1.23) | 4.6% | 0.45 (0.18,<br>1.12) |
| Minority<br>group                  | 39.6% | [ref]                 | 8.5% | [ref]                 | 24.4% | [ref]                 | 7.3% | [ref]                 | 25.3% | [ref]                | 8.7% | [ref]                |
| <b>Education level<sup>d</sup></b> |       |                       |      |                       |       |                       |      |                       |       |                      |      |                      |
| Low                                | 43.7% | 1.39 (1.09,<br>1.76)* | 5.5% | 0.81 (0.48,<br>1.36)  | 23.9% | 1.39 (1.12,<br>1.73)* | 8.1% | 2.67 (1.53,<br>4.64)* | 30.0% | 1.58 (0.83,<br>3.01) | 5.0% | 0.63 (0.25,<br>1.57) |
| Medium                             | 40.7% | 1.25 (0.93,<br>1.66)  | 6.6% | 0.94 (0.50,<br>1.78)  | 22.8% | 1.24 (0.99,<br>1.55)  | 4.8% | 1.49 (0.85,<br>2.61)  | 16.0% | 0.70 (0.30,<br>1.65) | 5.9% | 0.62 (0.16,<br>2.43) |
| High                               | 35.3% | [ref]                 | 7.6% | [ref]                 | 19.5% | [ref]                 | 3.4% | [ref]                 | 20.6% | [ref]                | 8.6% | [ref]                |

|  |       |                    |      |                    |       |                    |      |                    |       |                   |       |                     |
|--|-------|--------------------|------|--------------------|-------|--------------------|------|--------------------|-------|-------------------|-------|---------------------|
| <b>Income adequacy</b>                           |       |                    |      |                    |       |                    |      |                    |       |                   |       |                     |
| <b>e</b>   |       |                    |      |                    |       |                    |      |                    |       |                   |       |                     |
| High   | 37.2% | 0.80 (0.67, 0.95)* | 6.6% | 0.95 (0.65, 1.41)  | 19.5% | 0.73 (0.58, 0.91)* | 5.4% | 1.02 (0.59, 1.76)  | 18.9% | 0.74 (0.38, 1.45) | 8.2%  | 1.61 (0.55, 4.72)   |
| Low  | 42.5% | [ref]              | 6.3% | [ref]              | 25.0% | [ref]              | 4.9% | [ref]              | 24.7% | [ref]             | 4.9%  | [ref]               |
| <b>SSB healthfulness perceptions<sup>f</sup></b> |       |                    |      |                    |       |                    |      |                    |       |                   |       |                     |
| Healthy  | 35.4% | 0.73 (0.57, 0.93)* | 8.6% | 1.64 (1.05, 2.55)* | 16.8% | 0.55 (0.34, 0.88)* | 8.8% | 2.76 (1.51, 5.04)* | 17.8% | 0.65 (0.25, 1.69) | 8.9%  | 1.86 (0.69, 5.01)   |
| Unhealthy  | 44.3% | [ref]              | 4.8% | [ref]              | 28.2% | [ref]              | 2.9% | [ref]              | 26.1% | [ref]             | 4.5%  | [ref]               |
| <b>Perceived cost of SSBs</b>                    |       |                    |      |                    |       |                    |      |                    |       |                   |       |                     |
| Yes – a little more                              | 41.4% | 1.24 (1.03, 1.49)* | 7.0% | 1.68 (1.11, 2.53)* | 20.2% | 1.43 (1.14, 1.80)* | 6.6% | 2.25 (1.18, 4.27)* | 18.9% | 1.20 (0.56, 2.57) | 8.5%  | 3.64 (1.10, 12.05)* |
| Yes – a lot more                                 | 40.4% | 1.21 (0.90, 1.63)  | 8.2% | 1.96 (1.10, 3.49)* | 32.4% | 2.74 (2.04, 3.67)* | 6.0% | 2.42 (1.06, 5.56)* | 29.2% | 2.27 (0.92, 5.60) | 11.3% | 5.96 (1.61, 22.11)* |



|                 |       |       |      |       |       |       |      |       |       |       |      |       |
|-----------------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|-------|
| No / Don't know | 37.5% | [ref] | 4.7% | [ref] | 15.6% | [ref] | 3.3% | [ref] | 17.3% | [ref] | 2.6% | [ref] |
|-----------------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|-------|

Results from multinomial logistic regression models investigating correlates of participants in Mexico, the United Kingdom and the United States reporting that they 'bought less' or 'bought more' taxed beverages (versus 'mixed response / no change') in response to a sugar-sweetened beverage tax.

UK, United Kingdom; US, United States; OR, odds ratio; CI, confidence interval; SSB, sugar sweetened beverage

\*Significantly different (compared to reference group) at  $p < .01$

<sup>a</sup> Participants reporting that they 'Bought less' (at least one 'buy less' and no 'buy more' for taxed beverages) or 'Bought more' (at least one 'buy more' and no 'buy less' for taxed beverages) versus 'Mixed response / No change' when asked, "Has the tax changed whether you buy the following drinks for you or your family?"

<sup>b</sup> Results for all year comparisons are provided in Additional File 4.

<sup>c</sup> Ethnicity categories as per census questions asked in each country: 1) Australia majority=only speaks English at home, minority=speaks a language besides English at home; 2) Canada majority=White, minority=other ethnicity; 3) Mexico majority=Non-indigenous, minority=indigenous; 4) United Kingdom majority=White, minority=other ethnicity; 5) US majority=White, minority=other ethnicity.

<sup>d</sup> Participants were asked, "What is the highest level of formal education that you have completed?" Responses were categorized as 'low' (completed secondary school or less), 'medium' (some post-secondary qualifications), or 'high' (university degree or higher) according to country-specific criteria.

<sup>e</sup> Participants were asked, "Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?", with response options 'Very easy', 'Easy' and 'Neither easy nor difficult' categorized as "High", and 'Difficult' and 'Very difficult' categorized as "Low".

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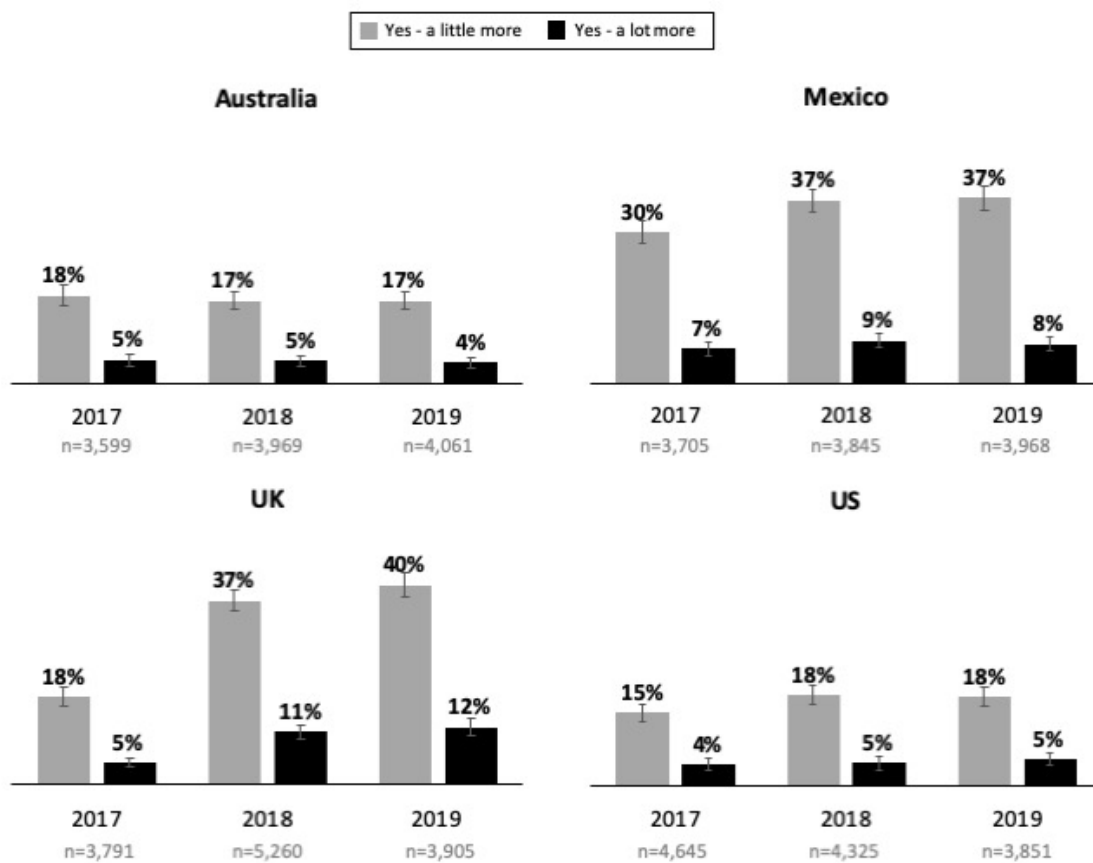
<sup>f</sup> Participants were shown a 500mL bottle of regular soda and asked, “In your opinion, how unhealthy or healthy is this type of drink?”, with response options ‘Very healthy’, ‘Healthy’, ‘A little healthy’ and ‘Neither healthy nor unhealthy’ categorized as “Healthy”, and ‘A little unhealthy’, ‘Unhealthy’ and ‘Very unhealthy’ categorized as “Unhealthy”.

## FIGURES

**Figure 1.** Unadjusted percentages of participants reporting drinks with sugar cost more than drinks without sugar (weighted).

*Legend:*

Unadjusted percentages of participants in Australia, Mexico, the United Kingdom and the United States reporting that drinks with sugar cost ‘a little’ or ‘a lot’ more than drinks without sugar in 2017, 2018 and 2019 (weighted). Error bars represent 99% confidence intervals.



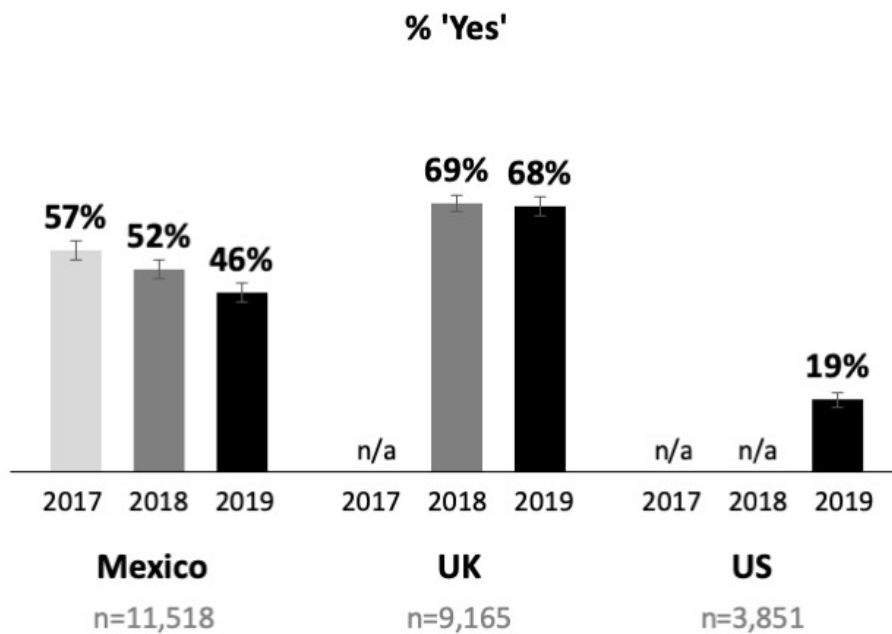
Additional file

**Figure 2.** Unadjusted percentages of participants who reported being aware of a tax on sugary drinks (weighted).

*Legend:*

Unadjusted percentages of participants in Mexico, the United Kingdom and the United States who reported being aware of a special tax on sugary drinks, across available years of data (weighted). Error bars represent 99% confidence intervals.

Note: Tax awareness was only queried in countries following the implementation of an SSB tax (2017, 2018 and 2019 in Mexico; 2018 and 2019 in the UK; and 2019 in the US).

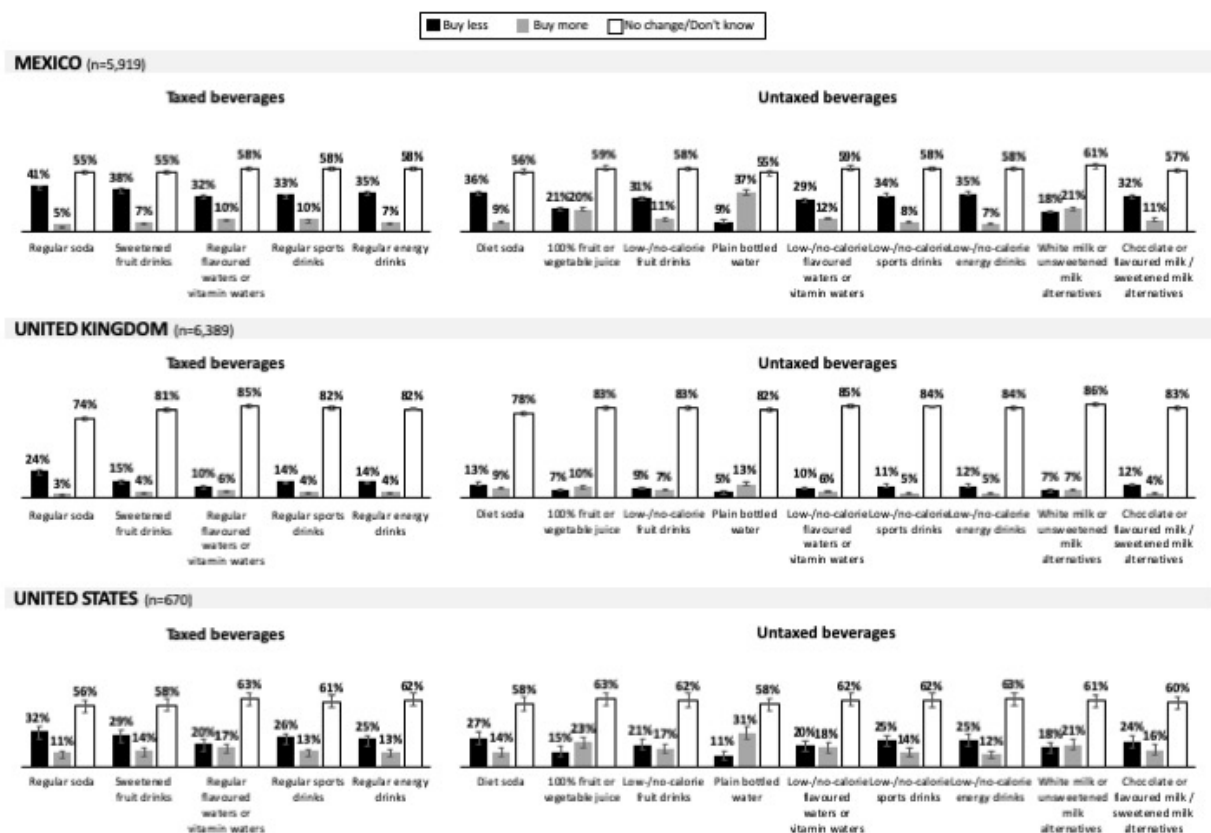


**Figure 3.** Unadjusted percentages of participants reporting ‘buy less’ or ‘buy more’ taxed and untaxed beverages (weighted). Error bars represent 99% confidence intervals.

*Legend:*

Unadjusted percentages of participants responding that the SSB tax led them to ‘buy less’ or ‘buy more’ taxed and untaxed beverages, among those who reported being aware of an SSB tax in Mexico, the United Kingdom and the United States, averaged across all available years of data (weighted).

Note: Changes in beverage purchasing was only queried in countries following the implementation of an SSB tax (2017, 2018 and 2019 in Mexico; 2018 and 2019 in the UK; and 2019 in the US).



Additional file

## **ADDITIONAL FILES**

### *Additional file 1.docx*

Unadjusted percentages for all outcomes, among US respondents living in a city with an SSB tax versus without an SSB tax (weighted).

### *Additional file 2.docx*

Unadjusted percentages of participants responding that the SSB tax changed whether they buy drinks for themselves or their family, in Mexico (2017, 2018 and 2019) the United Kingdom (2018 and 2019) and the United States (2019). ('Buy less' or 'buy more' for taxed and untaxed beverage categories, respectively.)

### *Additional file 3.docx*

Results from multinomial logistic regression models investigating correlates of participants in Mexico, the United Kingdom and the United States reporting that they 'bought less' and 'bought more' untaxed beverages (versus 'mixed response / no change') in response to a sugar-sweetened beverage tax.

### *Additional file 4.docx*

Full year comparisons from binary and multinomial logistic regression models investigating perceived cost of beverages with sugar, awareness of sugar-sweetened beverage taxes, and reported purchase changes in response to a sugar-sweetened beverage tax.

**Additional file 1.** Unadjusted percentages for all outcomes, among US respondents living in a city with an SSB tax versus without an SSB tax (weighted)

|  | SSB tax city <sup>a</sup><br>% (n) | Non-tax city<br>% (n) |
|--|------------------------------------|-----------------------|
| <b>Do drinks with sugar (e.g., Coke) cost more than drinks without sugar (e.g., Diet Coke) in the US?</b>    |                                    |                       |
| <b>2018</b>  |                                    |                       |
| Yes – a little more  | 40.3% (18)                         | 18.2% (772)           |
| Yes – a lot more   | 11.7% (5)                          | 4.5% (190)            |
| No / Don't know  | 48.0% (22)                         | 77.4% (3292)          |
| <b>2019</b>  |                                    |                       |
| Yes – a little more  | 22.8% (10)                         | 18.0% (682)           |
| Yes – a lot more   | 14.9% (6)                          | 5.1% (195)            |
| No / Don't know  | 62.4% (27)                         | 76.9% (2910)          |
| <b>Is there a special tax on sugary drinks in the US that makes them more expensive to buy? <sup>b</sup></b> |                                    |                       |
| Yes  | 74.9% (33)                         | 18.0% (680)           |
| No / Don't know  | 25.1% (11)                         | 82.0% (3106)          |
| <b>Has the tax changed whether you buy the following drinks for you or your family? <sup>b,c</sup></b>       |                                    |                       |
| <b>Taxed beverages <sup>d</sup></b>  |                                    |                       |
| Bought less  | 35.5% (12)                         | 22.6% (153)           |
| Mixed response / No change   | 60.2% (20)                         | 69.8% (474)           |
| Bought more  | 4.3% (1)                           | 7.7% (52)             |
| <b>Untaxed beverages <sup>e</sup></b>  |                                    |                       |
| Bought less  | 17.5% (6)                          | 10.8% (74)            |
| Mixed response / No change   | 73.0% (24)                         | 77.2% (524)           |
| Bought more  | 9.5% (3)                           | 12.0% (81)            |

<sup>a</sup> US tax city status only available in 2018 and 2019.

<sup>b</sup> Data only available for 2019.

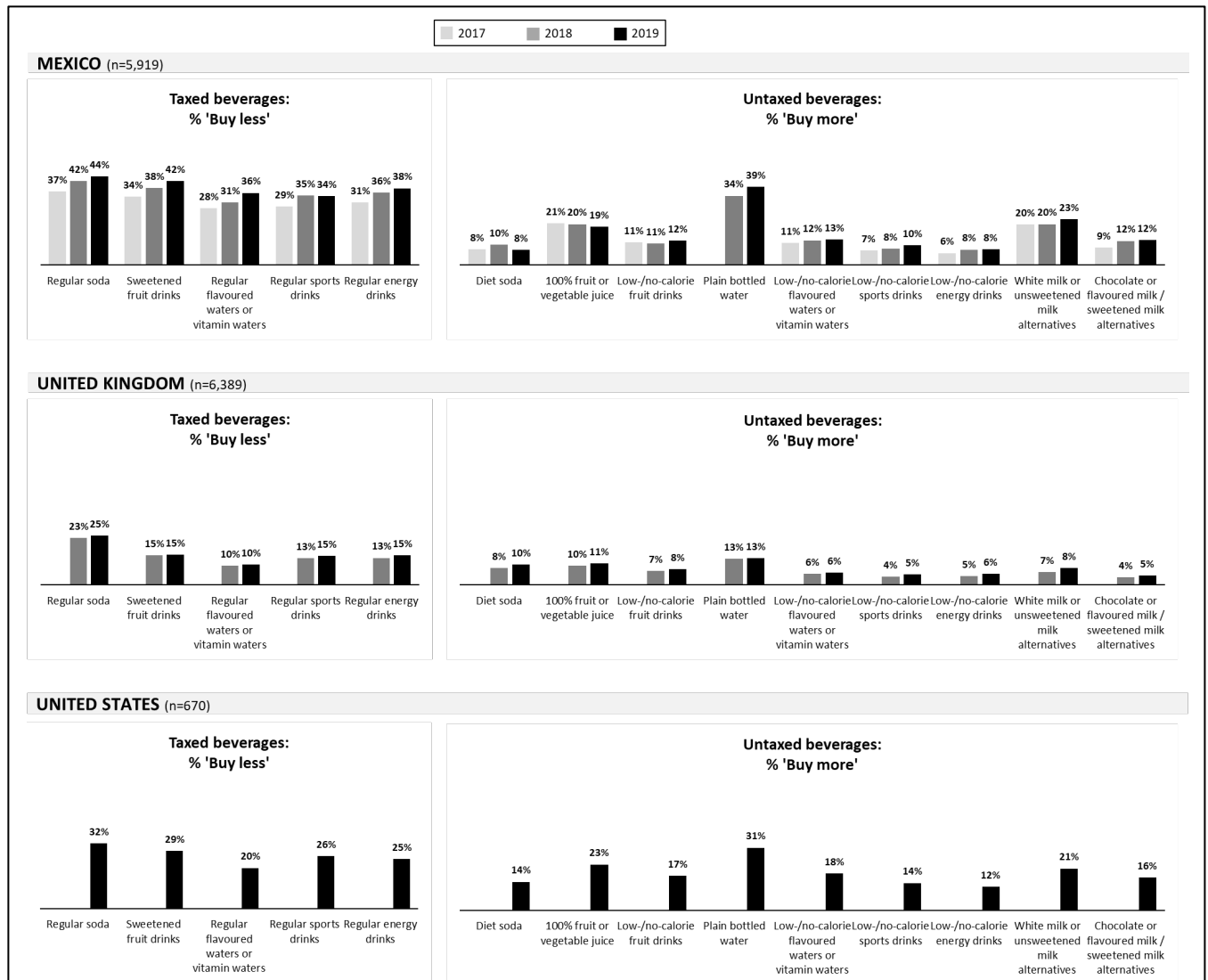
<sup>c</sup> Only asked among participants who responded 'Yes' to "Is there a special tax on sugary drinks in the US that makes them more expensive to buy?"

<sup>d</sup> Participants reporting that they 'Bought less' (at least one 'buy less' and no 'buy more' for taxed beverages), 'Bought more' (at least one 'buy more' and no 'buy less' for taxed beverages), or 'Mixed response / No change' (any other combination of responses across the taxed beverage categories).

<sup>e</sup> Participants reporting that they 'Bought less' (at least one 'buy less' and no 'buy more' for untaxed beverages), 'Bought more' (at least one 'buy more' and no 'buy less' for untaxed beverages), or 'Mixed response / No change' (any other combination of responses across the untaxed beverage categories).

## Additional file

**Additional File 2.** Unadjusted percentages of participants responding that the SSB tax changed whether they buy drinks for themselves or their family, in Mexico (2017, 2018 and 2019) the United Kingdom (2018 and 2019) and the United States (2019). ('Buy less' or 'buy more' for taxed and untaxed beverage categories, respectively.)



Note: Changes in beverage purchasing was only queried in countries following the implementation of an SSB tax (2017, 2018 and 2019 in Mexico; 2018 and 2019 in the UK; and 2019 in the US).



## Additional file

**Additional File 3.** Results from multinomial logistic regression models investigating correlates of participants in Mexico, the United Kingdom and the United States reporting that they ‘bought less’ and ‘bought more’ untaxed beverages (versus ‘mixed response / no change’) in response to a sugar-sweetened beverage tax.

|                                    | Mexico (n=5,962)         |                    |                     |                    | UK (n=6,271)        |                    |                          |                    | US (n=712)          |                   |                     |                   |
|------------------------------------|--------------------------|--------------------|---------------------|--------------------|---------------------|--------------------|--------------------------|--------------------|---------------------|-------------------|---------------------|-------------------|
|                                    | Bought less <sup>a</sup> |                    | Bought more         |                    | Bought less         |                    | Bought less <sup>a</sup> |                    | Bought more         |                   | Bought less         |                   |
|                                    | Adjusted Prevalence      | OR (99% CI)        | Adjusted Prevalence | OR (99% CI)        | Adjusted Prevalence | OR (99% CI)        | Adjusted Prevalence      | OR (99% CI)        | Adjusted Prevalence | OR (99% CI)       | Adjusted Prevalence | OR (99% CI)       |
| <b>Year<sup>b</sup></b>            |                          |                    |                     |                    |                     |                    |                          |                    |                     |                   |                     |                   |
| 2017                               | 23.3%                    | [ref]              | 7.4%                | [ref]              | .                   | .                  | .                        | .                  | .                   | .                 | .                   | .                 |
| 2018                               | 19.9%                    | 0.86 (0.67, 1.11)  | 11.6%               | 1.58 (1.08, 2.30)* | 10.3%               | [ref]              | 11.6%                    | [ref]              | .                   | .                 | .                   | .                 |
| 2019                               | 19.7%                    | 0.84 (0.65, 1.08)  | 10.5%               | 1.40 (0.96, 2.03)  | 9.5%                | 0.92 (0.68, 1.25)  | 12.1%                    | 1.03 (0.80, 1.33)  | 7.3%                | .                 | 15.8%               | .                 |
| <b>Age</b>                         |                          |                    |                     |                    |                     |                    |                          |                    |                     |                   |                     |                   |
| 18-29 years                        | 17.9%                    | [ref]              | 7.8%                | [ref]              | 9.0%                | [ref]              | 14.8%                    | [ref]              | 8.4%                | [ref]             | 15.7%               | [ref]             |
| 30-44 years                        | 20.1%                    | 1.17 (0.91, 1.49)  | 8.5%                | 1.13 (0.80, 1.60)  | 7.4%                | 0.77 (0.48, 1.24)  | 11.1%                    | 0.70 (0.49, 1.01)  | 5.5%                | 0.60 (0.16, 2.18) | 12.2%               | 0.72 (0.26, 1.99) |
| 45-64 years                        | 20.8%                    | 1.18 (0.90, 1.55)  | 6.3%                | 0.82 (0.54, 1.25)  | 10.4%               | 1.11 (0.70, 1.77)  | 10.0%                    | 0.65 (0.45, 0.93)* | 9.5%                | 1.21 (0.36, 4.10) | 19.8%               | 1.35 (0.51, 3.56) |
| ≥65 years                          | 24.2%                    | 1.78 (0.84, 3.77)  | 19.6%               | 3.30 (1.34, 8.12)* | 13.6%               | 1.54 (0.93, 2.55)  | 11.8%                    | 0.81 (0.55, 1.21)  | 6.1%                | 0.69 (0.16, 2.93) | 14.8%               | 0.90 (0.25, 3.26) |
| <b>Sex</b>                         |                          |                    |                     |                    |                     |                    |                          |                    |                     |                   |                     |                   |
| Female                             | 21.3%                    | 1.03 (0.84, 1.28)  | 9.4%                | 0.94 (0.68, 1.29)  | 10.6%               | 1.14 (0.84, 1.54)  | 11.2%                    | 0.90 (0.70, 1.16)  | 8.7%                | 1.48 (0.61, 3.59) | 14.5%               | 0.88 (0.41, 1.87) |
| Male                               | 20.6%                    | [ref]              | 10.0%               | [ref]              | 9.3%                | [ref]              | 12.5%                    | [ref]              | 5.9%                | [ref]             | 16.5%               | [ref]             |
| <b>Ethnicity<sup>c</sup></b>       |                          |                    |                     |                    |                     |                    |                          |                    |                     |                   |                     |                   |
| Majority group                     | 19.9%                    | 0.85 (0.62, 1.17)  | 8.8%                | 0.78 (0.51, 1.19)  | 8.0%                | 0.61 (0.36, 1.03)  | 11.1%                    | 0.83 (0.51, 1.35)  | 9.4%                | 1.61 (0.54, 4.83) | 11.1%               | 0.49 (0.24, 1.00) |
| Minority group                     | 22.1%                    | [ref]              | 10.7%               | [ref]              | 12.2%               | [ref]              | 12.5%                    | [ref]              | 5.4%                | [ref]             | 21.1%               | [ref]             |
| <b>Education level<sup>d</sup></b> |                          |                    |                     |                    |                     |                    |                          |                    |                     |                   |                     |                   |
| Low                                | 23.6%                    | 1.38 (1.04, 1.84)* | 10.4%               | 1.11 (0.71, 1.73)  | 11.3%               | 1.40 (1.00, 1.95)* | 12.8%                    | 1.22 (0.92, 1.63)  | 11.2%               | 1.84 (0.77, 4.39) | 13.3%               | 0.76 (0.34, 1.69) |
| Medium                             | 21.1%                    | 1.16 (0.82, 1.64)  | 8.6%                | 0.86 (0.51, 1.47)  | 9.9%                | 1.19 (0.83, 1.69)  | 11.6%                    | 1.07 (0.81, 1.42)  | 5.3%                | 0.83 (0.26, 2.66) | 15.5%               | 0.84 (0.30, 2.36) |

## Additional file

|  |       |                    |       |                   |       |                    |       |                    |      |                   |       |                    |
|--|-------|--------------------|-------|-------------------|-------|--------------------|-------|--------------------|------|-------------------|-------|--------------------|
| High   | 18.5% | [ref]              | 10.1% | [ref]             | 8.6%  | [ref]              | 11.1% | [ref]              | 6.2% | [ref]             | 17.7% | [ref]              |
| <b>Income adequacy<sup>e</sup></b>               |       |                    |       |                   |       |                    |       |                    |      |                   |       |                    |
| High   | 17.9% | 0.69 (0.56, 0.85)* | 10.7% | 1.15 (0.84, 1.59) | 8.2%  | 0.66 (0.46, 0.93)* | 12.1% | 1.02 (0.75, 1.38)  | 7.1% | 1.05 (0.40, 2.74) | 18.4% | 1.53 (0.62, 3.75)  |
| Low  | 24.4% | [ref]              | 8.7%  | [ref]             | 11.9% | [ref]              | 11.5% | [ref]              | 7.3% | [ref]             | 12.9% | [ref]              |
| <b>SSB healthfulness perceptions<sup>f</sup></b> |       |                    |       |                   |       |                    |       |                    |      |                   |       |                    |
| Healthy  | 19.3% | 0.81 (0.60, 1.11)  | 9.7%  | 0.96 (0.63, 1.46) | 9.2%  | 0.83 (0.42, 1.61)  | 11.1% | 0.84 (0.51, 1.40)  | 5.8% | 0.75 (0.18, 3.22) | 22.6% | 2.47 (1.05, 5.79)* |
| Unhealthy  | 22.7% | [ref]              | 9.6%  | [ref]             | 10.7% | [ref]              | 12.6% | [ref]              | 8.7% | [ref]             | 10.3% | [ref]              |
| <b>Perceived cost of SSBs</b>                    |       |                    |       |                   |       |                    |       |                    |      |                   |       |                    |
| Yes – a little more                              | 21.6% | 1.03 (0.82, 1.29)  | 10.2% | 1.17 (0.83, 1.64) | 8.6%  | 1.10 (0.78, 1.55)  | 13.4% | 2.00 (1.48, 2.70)* | 5.9% | 0.99 (0.32, 3.08) | 17.5% | 1.93 (0.86, 4.36)  |
| Yes – a lot more                                 | 20.0% | 0.93 (0.64, 1.34)  | 9.9%  | 1.11 (0.67, 1.82) | 12.9% | 1.82 (1.17, 2.83)* | 16.4% | 2.69 (1.81, 4.00)* | 9.6% | 1.78 (0.52, 6.11) | 20.8% | 2.52 (0.94, 6.79)  |
| No / Don't know                                  | 21.4% | [ref]              | 8.9%  | [ref]             | 8.4%  | [ref]              | 7.3%  | [ref]              | 6.5% | [ref]             | 9.9%  | [ref]              |

Results from multinomial logistic regression models investigating correlates of participants in Mexico, the United Kingdom and the United States reporting that they 'bought less' or 'bought more' taxed beverages (versus 'mixed response / no change') in response to a sugar-sweetened beverage tax.

UK, United Kingdom; US, United States; OR, odds ratio; CI, confidence interval; SSB, sugar sweetened beverage

\*Significantly different (compared to reference group) at  $p < .01$

<sup>a</sup> Participants reporting that they 'Bought less' (at least one 'buy less' and no 'buy more' for untaxed beverages) or 'Bought more' (at least one 'buy more' and no 'buy less' for untaxed beverages) versus 'Mixed response / No change' when asked, "Has the tax changed whether you buy the following drinks for you or your family?"

<sup>b</sup> Results for all year comparisons are provided in Additional File 4.

<sup>c</sup> Ethnicity categories as per census questions asked in each country: 1) Australia majority=only speaks English at home, minority=speaks a language besides English at home; 2) Canada majority=White, minority=other ethnicity; 3) Mexico majority=Non-indigenous, minority=indigenous; 4) United Kingdom majority=White, minority=other ethnicity; 5) US majority=White, minority=other ethnicity.

<sup>d</sup> Participants were asked, "What is the highest level of formal education that you have completed?" Responses were categorized as 'low' (completed secondary school or less), 'medium' (some post-secondary qualifications), or 'high' (university degree or higher) according to country-specific criteria.

## Additional file

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<sup>e</sup> Participants were asked, “Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?”, with response options ‘Very easy’, ‘Easy’ and ‘Neither easy nor difficult’ categorized as “High”, and ‘Difficult’ and ‘Very difficult’ categorized as “Low”.

<sup>f</sup> Participants were shown a 500mL bottle of regular soda and asked, “In your opinion, how unhealthy or healthy is this type of drink?”, with response options ‘Very healthy’, ‘Healthy’, ‘A little healthy’ and ‘Neither healthy nor unhealthy’ categorized as “Healthy”, and ‘A little unhealthy’, ‘Unhealthy’ and ‘Very unhealthy’ categorized as “Unhealthy”.

Additional file

**Additional File 4.** Full year comparisons from binary and multinomial logistic regression models investigating perceived cost of beverages with sugar, awareness of sugar-sweetened beverage taxes, and reported purchase changes in response to a sugar-sweetened beverage tax.

| PERCEIVED COST OF DRINKS WITH SUGAR          |  |  |  |  |                               |                               |                               |
|--|--|--|--|--|-------------------------------|-------------------------------|-------------------------------|
|  | Australia (N=11,588)<br>'A little more / A lot more' <sup>a</sup><br>OR (99% CI) | Mexico (N=11,610)<br>'A little more / A lot more'<br>OR (99% CI) | UK (N=12,945)<br>'A little more / A lot more'<br>OR (99% CI) | US (N=12,781)<br>'A little more / A lot more'<br>OR (99% CI) |                               |                               |                               |
| <b>Year</b>                                  |  |  |  |  |                               |                               |                               |
| 2018 vs. 2017                                | 0.97 (0.81, 1.16)  | 1.41 (1.22, 1.63)*   | 4.15 (3.56, 4.83)*   | 1.48 (1.24, 1.77)*   |                               |                               |                               |
| 2019 vs. 2017                                | 0.92 (0.78, 1.10)  | 1.40 (1.22, 1.62)*   | 5.00 (4.26, 5.88)*   | 1.55 (1.29, 1.86)*   |                               |                               |                               |
| 2019 vs. 2018                                | 0.95 (0.80, 1.13)  | 1.00 (0.86, 1.15)  | 1.21 (1.05, 1.39)*   | 1.04 (0.87, 1.25)  |                               |                               |                               |
| AWARENESS OF SSB TAXES                       |  |  |  |  |                               |                               |                               |
|  |  | Mexico (n=11,610)<br>'Yes' <sup>b</sup><br>OR (99% CI)           | UK (n=9,140)<br>'Yes'<br>OR (99% CI)                         | US (n=3,829)<br>'Yes'<br>OR (99% CI)                         |                               |                               |                               |
| <b>Year</b>                                  |  |  |  |  |                               |                               |                               |
| 2018 vs. 2017                                |  | 0.82 (0.71, 0.95)*   | .  | .  |                               |                               |                               |
| 2019 vs. 2017                                |  | 0.64 (0.56, 0.74)*   | .  | .  |                               |                               |                               |
| 2019 vs. 2018                                |  | 0.78 (0.68, 0.90)*   | 0.96 (0.83, 1.11)  | .  |                               |                               |                               |
| REPORTED PURCHASE CHANGES OF TAXED BEVERAGES |  |  |  |  |                               |                               |                               |
|  |  | Mexico (n=5,971)   |  | UK (n=6,271)   |                               | US (n=712)                    |                               |
|  |  | Bought less <sup>c</sup><br>OR (99% CI)                          | Bought more<br>OR (99% CI)                                   | Bought less<br>OR<br>(99% CI)                                | Bought more<br>OR<br>(99% CI) | Bought less<br>OR<br>(99% CI) | Bought more<br>OR<br>(99% CI) |
| <b>Year</b>                                  |  |  |  |  |                               |                               |                               |
| 2018 vs. 2017                                |  | 1.32 (1.07, 1.62)*   | 1.74 (1.12, 2.73)*   | .  | .                             | .                             | .                             |
| 2019 vs. 2017                                |  | 1.29 (1.05, 1.59)*   | 1.58 (1.01, 2.47)*   | .  | .                             | .                             | .                             |
| 2019 vs. 2018                                |  | 0.98 (0.80, 1.21)  | 0.90 (0.58, 1.40)  | 1.02 (0.84, 1.24)  | 1.16 (0.71, 1.89)             | .                             | .                             |

| REPORTED PURCHASE CHANGES OF UNTAXED BEVERAGES |  |   |                            |                               |                               |                               |                               |
|--|--|---|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
|  |  | Mexico (n=5,962)                        |                            | UK (n=6,389)                  |                               | US (n=670)                    |                               |
|  |  | Bought less <sup>d</sup><br>OR (99% CI) | Bought more<br>OR (99% CI) | Bought less<br>OR<br>(99% CI) | Bought more<br>OR<br>(99% CI) | Bought less<br>OR<br>(99% CI) | Bought more<br>OR<br>(99% CI) |
| <b>Year</b>                                    |  |   |                            |                               |                               |                               |                               |
| 2018 vs. 2017                                  |  | 0.86 (0.67, 1.11)                       | 1.58 (1.08, 2.30)*         | .                             | .                             | .                             | .                             |
| 2019 vs. 2017                                  |  | 0.84 (0.65, 1.08)                       | 1.40 (0.96, 2.03)          | .                             | .                             | .                             | .                             |
| 2019 vs. 2018                                  |  | 0.97 (0.75, 1.27)                       | 0.88 (0.62, 1.26)          | 0.92 (0.68, 1.25)             | 1.03 (0.80, 1.33)             | .                             | .                             |

UK, United Kingdom; US, United States; OR, odds ratio; CI, confidence interval; SSB, sugar-sweetened beverage

\*p<.01

<sup>a</sup> Participants responding ‘Yes – a little more / Yes – a lot more’ versus ‘No change / Don’t know’ when asked, “Do drinks with sugar (e.g., Coke) cost more than drinks without sugar (e.g., Diet Coke) in [country]?”

<sup>b</sup> Participants responding ‘Yes’ versus ‘No / Don’t know’ when asked, “Is there a special tax on sugary drinks in [country] that makes them more expensive to buy?”.

<sup>c</sup> Participants reporting that they ‘Bought less’ (at least one ‘buy less’ and no ‘buy more’ for taxed beverages) or ‘Bought more’ (at least one ‘buy more’ and no ‘buy less’ for taxed beverages) versus ‘Mixed response / No change’ when asked, “Has the tax changed whether you buy the following drinks for you or your family?”

<sup>d</sup> Participants reporting that they ‘Bought less’ (at least one ‘buy less’ and no ‘buy more’ for untaxed beverages) or ‘Bought more’ (at least one ‘buy more’ and no ‘buy less’ for untaxed beverages) versus ‘Mixed response / No change’ when asked, “Has the tax changed whether you buy the following drinks for you or your family?”