





Impact of sugar-sweetened beverage taxes on price, import and sale volumes in an island: interrupted time series analysis

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Abstract

Objective: To evaluate the impact of changes in import tariffs on sweetened beverages.

Design: Interrupted time series analysis was used to examine sweetened beverage tariff increases of 40–60 % in 2008 and to 75 % in 2012, and an approximately 11 % decrease in 2014 when an excise tax replaced the tariff. Post-tax trends were compared with a counterfactual modelled on the pre-tax trend for: quarterly price of an indicator beverage, monthly beverage import volumes (both 2001–2017) and quarterly sales volumes (2012–2017). In a controlled analysis, taxed beverage imports were compared with a sugary snacks control.

Setting: Cook Islands.

Participants: NA.

Results: In the first year, after the 2008 tariff increase the price of the selected indicator soft drink increased by 7.3 % (95 % CI 6.3 %, 8.3 %) but after the 2012 tariff increase it decreased by 13.9 % (95 % CI –14.9 %, –12.8 %). At the same time, the import volumes of taxed beverages decreased by 13.2 % (95 % CI –38.1 %, 17.8 %) and 2.9 % (95 % CI –41.6 %, 72.5 %), respectively, and decreased by 24.8 % (95 % CI –36.9, –9.8) and 10.2 % (95 % CI –37.1, 37.5) in the controlled analysis. After the 2014 tax decrease, the price of the indicator soft drink decreased by 23.6 % (95 % CI –26.0 %, –21.1 %), sweetened beverage imports increased by 4.5 % (95 % CI –39.5 %, 156.0 %) and sales of full-sugar soft drinks increased by 31 % (95 % CI –21 %, 243 %).

Conclusions: The increased import tariffs on sweetened beverages appeared to be effective for reducing import volumes, but this was partly reversed by the reduced tax/tariff in 2014.

Keywords
Cook Islands
Pacific
Tax
Excise
Tariff
Sugary drinks
Soft drinks

The WHO recommends sugar-sweetened beverages (SSB) taxes as one of the strategies to address the obesogenic environment^(1–3). Pacific Island countries and territories and other Small Island Developing States and middle-income countries have implemented a range of SSB tax regimes; however, few have evaluated its ability to reduce the consumption of SSB and improve diets^(4–9). While SSB excise studies in Tonga suggest some potential benefits from a public health perspective (with increased prices, reduced import volumes of taxed beverages and increased local bottled water and soft drink manufacturing)^(4,10), evidence is limited on whether SSB tax effects persist long term, how context impacts on consumer responses, which

beverages people switch to and which types of SSB taxes are most effective⁽¹¹⁾.

The Cook Islands is a self-governing, middle-income (World Bank 2016) Small Island Developing States in the Pacific region. It has a population of 17 000 residents with an annual visitor population of 170 000. The Cook Islands has a high prevalence of obesity (62 % of adults) and SSB consumption^(12,13). Import tariffs on sweetened beverages (harmonised code (HS) 2202) were increased in 2008 and 2012 with the aim of addressing diabetes and oral health. Harmonised codes are used to categorise traded goods and are frequently used in tax administration. On 1 July 2008, a 40 % tariff in place since 1979⁽¹⁴⁾ was replaced with

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a 60 % tariff⁽¹⁵⁾. At the end of July 2012, the tariff was increased to 75 %⁽¹⁶⁾, and in July 2013 this was increased to 77 %⁽¹⁷⁾. This two-percentage point change was unlikely to cause a detectable signal on study outcomes and therefore was not evaluated. On 1 July 2014, after a review of the tax structure in Cook Islands⁽¹⁷⁾, the sweetened beverage tariff was replaced with a nutrient-specific excise of NZ \$9.37 per 1 kg of sugar⁽¹⁸⁾, equivalent to NZ\$0.94/l (2018 US\$0.64/l) (using the 106 g/l sugar content of Coca-Cola). The aim of the excise was to remain revenue neutral and align the SSB tax more closely with its rationale to reduce sugar consumption; however, this tax was an eleven percentage point decrease compared with the existing tariff (see the 'Results' section). For the first time, locally manufactured beverages were included, although implementation of this was incomplete and delayed. The excise applied to all sugar-sweetened waters (carbonated or not, HS 2202) but excluded juice, sachet drinks, fountain drinks and flavoured milk⁽¹⁸⁾. The excise removed SSB tax on beverages without sugar, such as artificially sweetened beverages (ASB).

Given this background, the current study aimed to examine the 1-year and 2-year impact of SSB tax changes in the Cook Islands on: (i) the shelf price of a selected indicator soft drink (can of Coca-Cola as a common and high profile brand); (ii) import volumes of taxed and untaxed beverages and (iii) sales of taxed and untaxed beverages (2014 only).

Methods

The study was an interrupted time series design comparing trends before and after tax changes.

Data sets

Cook Island Statistics Division, Ministry of Finance and Economic Development provided quarterly average price data (NZ\$) for a 355 ml can of Coca-Cola from 2001 to 2017. This product is of sufficient popularity to be included in the consumer price index. These data were collected mid-quarter for calculating the consumer price index and the average prices across ninety retail outlets on the main island of Rarotonga. Coca-Cola range cans comprised 40 % of soft drink and energy drink sales volumes (below) at a major supermarket from 2012 to 2017.

Monthly export volumes from New Zealand (the main trading partner) to the Cook Islands were obtained online from Statistics New Zealand (2001–2017). Beverage categories were sweetened beverages including full-sugar and zero-sugar soft drinks (HS 2202), juice (2009), milk (0401.00 and 0401.29) and water (2201, i.e. bottled water). The majority of imported sweetened beverages (98 % during the study period (UN Comtrade)⁽¹⁹⁾, milk (98 %), juice (72 %) and bottled water (67 %) were from New Zealand. New Zealand contributions to the total exports to the Cook Islands were extracted from the World Bank

UN Comtrade trade database for each year and product⁽¹⁹⁾. They were also applied as inverse weights to New Zealand export volumes to adjust for any shifts in country of origin that might have affected import trends. Missing data were approximated as the average of the earlier and later adjacent years. The usefulness of trade data as a measure of consumption depends on the market share of imported beverages compared with local manufacturing (for which there were no public data available) and locally made SSB, for example, sugar-sweetened fruit juices. Litter survey information from 2018 suggests approximately three-quarters of sweetened beverages were imported and the rest were locally manufactured (see the online Supplementary Material). Changes in production of local soft drinks could have an important influence on overall consumption but could not be measured here.

Annual sales volumes (litres) were provided by Cook Islands Trading Company from 2012 to 2017 for full-sugar beverages (carbonated full-sugar soft drinks, energy drinks full-sugar), low-sugar beverages (carbonated low-sugar soft drinks, low-sugar energy drink, flavoured water, e.g., ASB) and bottled water (imported and locally manufactured) (see online Supplementary Material for product details).

The Statistics Division also provided quarterly population projections, quarterly gross domestic product and monthly international visitor numbers (see online Supplementary Material for further information). Quarterly data were transformed into monthly figures for the trade analyses using the moving averages of the quarterly figures. Information from meetings with Cook Island expert stakeholders contributed to the contextual information in the interpretation of study results.

Statistical analysis

The size of the three major SSB tax changes was estimated and compared. The 2014 nutrient-specific excise tax (NZ\$/kg sugar) was transformed to an ad valorem equivalent (% , 2014) using the sugar concentration of the indicator soft drink (Coca-Cola; kg/l), UN Comtrade imported beverage values (US\$/l)⁽¹⁹⁾ and IMF exchange rates (NZ\$/US\$),⁽²⁰⁾ similar to what has been done elsewhere to estimate tax rates from trade databases.^(21,22)

Interrupted time series with segmented regression was used to examine trends in taxed and untaxed beverages (where possible) for three key outcomes: (i) average price NZ\$, (ii) import volume (l/person per year) and (iii) sales volume (l/person per year). Generalised least squares regression was used to model time series data and to allow for errors to be correlated and/or have unequal variances. Autocorrelation and moving averages were tested and adjusted for wherever this made a significant improvement in the model fit (lower AIC and $P < 0.05$ from log-likelihood ratio test). Potential confounding by gross domestic product per capita (in 2016 NZ\$), monthly international visitor numbers and season/month was adjusted for, except for in

the sales analysis where numbers were limited. Both absolute change and trend changes after each tax were modelled with all three taxes in the same statistical model. The absolute and relative difference (% change) in outcomes in the first and second year after the tax change compared with the counterfactual were reported. The counterfactual was the expected model outcome based on existing pre-tax trends in the Cook Islands. Monte Carlo simulation was used to calculate 95 % CI (see online Supplementary Material). Tax elasticities were calculated, that is, the percentage change in import volumes for a 1 % change in the absolute tax level. All analyses were performed using R (version 3.4.3) in 2019.

Trends in sweetened beverage import volumes were also modelled compared with trends in a control group of sugary snack imports (kg), selected due to their similarity as discretionary products, likely high sugar content, and because they were generally not subject to any increases in tariffs during the study period. Sugary snacks comprised a combination of sweets and chewing gum (1704), chocolate (1806.20–1806.90), biscuits and crackers (1905.20, 1905.30, 1905.31, 1905.32), cake (1905.90-0909) and ice cream (2105). A 12.5 % import tariff on ice cream was removed on 1 April 2014, but this was not accounted for in the analysis. Sensitivity analyses were also used to test different model specifications (see online Supplementary Material for more information).

Results

Tax changes

The 2008 and 2012 tariff changes were both absolute increases of 20 and 15 % percentage points in the tariff level, respectively (Table 1). However, the 2014 replacement of a tariff with an excise tax equated to an absolute

11 % percentage point decrease in the overall applied tax level on full-sugar soft drinks and for zero-sugar soft drinks there was an even larger decline.

Price changes

In the first year after the 2008 tariff increase, the price of an indicator soft drink (can of Coca-Cola) increased by 7.3 % (95 % CI 6.3, 8.3) compared with the counterfactual (Fig. 1 and see online supplementary material, Supplemental Table S4). However, after the 2012 tariff the price of the indicator beverage decreased by 13.9 % (95 % CI –14.9, –12.8). After the 2014 excise replacement, there was a larger decrease in the price of 23.6 % (95 % CI –26.0, –21.1). The average prices in the second year after each tax change were in the same direction but with different magnitudes (see online supplementary material, Supplemental Table S4).

Imports

In the first year after the 2008 tariff increase, there was a 13.2 % (95 % CI –38.1, 17.8) decline in imported volumes of sweetened beverages compared with the counterfactual and for the 2012 increase this figure was smaller at 2.9 % (95 % CI –41.6, 72.5) (Fig. 2 and see online supplementary material, Supplemental Table S5). After the smaller 2014 excise was introduced, the imported volumes of sweetened beverages increased by 4.5 % (95 % CI –39.5, 156.0). The tax elasticities for these three figures were –0.66 (95 % CI –1.91, 0.89), –0.19 (95 % CI –2.77, 4.83) and –0.42 (95 % CI –14.58, 3.69), respectively, all with wide CI. In the second year after the 2008 tariff increase, there was an even greater decline in import volumes of 21.3 % (95 % CI –40.4, 3.6); however, in the second year after the 2012 and 2014 tax changes, the observed first year changes in

Table 1 Sweetened beverage tax changes in the Cook Islands by year and beverage type

Year	Tax changes	Beverage category	Import unit value in year of change (NZ\$/l)	Size of the previous tax (%/AVE)	Size of the new tax (%/AVE)	Tax change (AVE, percentage points)
13 August 2008	Tariff 40 % → 60 %	Sweetened beverages, including flavoured milk HS 2202	\$0.50/l	40 % tariff	60 % tariff	20 %
End Jul 2012	Tariff 60 % → 75 %	Sweetened beverages, including flavoured milk HS 2202	\$0.82/l	60 % tariff	75 % tariff	15 %
1 Jul 2014	Tariff 77 % → excise NZ \$9.37/kg of sugar	Sweetened beverages, with sugar HS 2202	\$1.24/l	77 % tariff	66 % AVE*	–11 %
	Tariff 77 % → 0 %	Sweetened beverages with no sugar (e.g., ASB) HS 2202	\$1.24/l	77 % tariff	0 % tariff	–77 %

AVE, ad valorem equivalent; ASB, artificially sweetened beverage.

*The AVE is calculated as the ratio between the excise tax and the import unit value. The size of the excise is calculated by calculating the excise tax for the indicator soft drink (Coca-Cola) with 10.6 g sugar/100 ml as sold in the main island of Rarotonga. The unit value is from UN Comtrade exports to the Cook Islands, measured in US\$/l and transformed to NZ\$/l using the IMF exchange rate. The AVE tax change is simply the difference between the size of the old tax and the new tax, measured in percentage points and as a relative change.

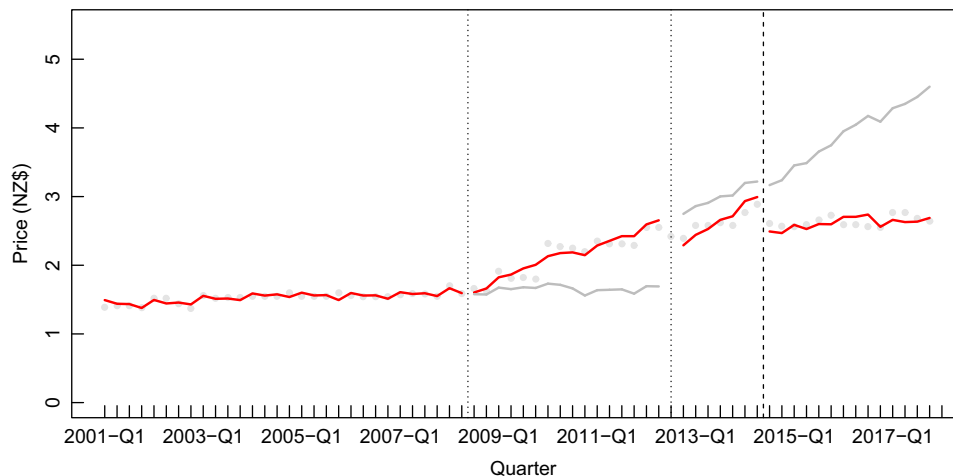


Fig. 1 (colour online) Impact of import tariff increases in the Cook Islands for 2008 (20 %) and 2012 (15 %) and decreased tax level in 2014 (by 11 %) on the average price of an indicator soft drink (355 ml can of Coca-Cola), 2001–2017. Data are from the Statistics Division, Ministry of Finance and Economic Management, Cook Islands. Analysis was adjusted for existing time trends, autocorrelation, GDP per capita, international visitor numbers and seasonality. Vertical dotted lines indicate tariff increases of 20 and 15 % points in 2008 and 2012, respectively. The vertical dashed line was the introduction of the excise tax with a decrease of 11 % points in the tariff/tax level. —, Price of a can of Coco-Cola; —, expected price per can with no tax change

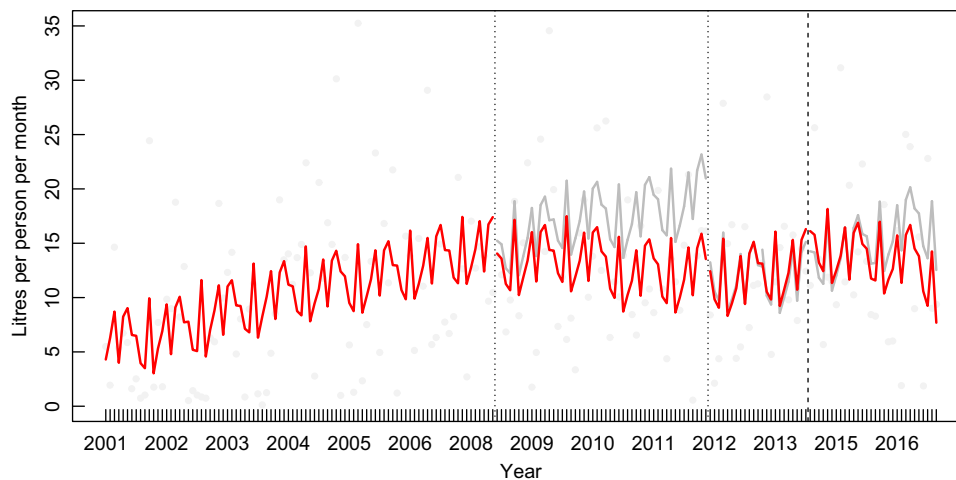


Fig. 2 (colour online) Impact of import tariff increases in the Cook Islands in 2008 (20 %), 2012 (15 %) and decrease in tax level in 2014 (by 11 %), on taxed sweetened beverage exports to Cook Islands, 2001–2017. Data are publicly available from Statistics New Zealand. Analysis was adjusted for existing time trends, autocorrelation, GDP per capita, international visitor numbers (Statistics Division, MFEM) and seasonality. New Zealand (NZ) exports were weighted to represent all UN Comtrade partner reported exports to the Cook Islands (0–2 % excluding 2005 which was 8 %). These figures do not include local soft drink production, considered to be a small part of the sweetened drink market, but it may have changed over time. —, Sweetened beverage imports; —, expected sweetened beverage imports if there was no SSB tax change

the import trends reversed (see online supplementary material, Supplemental Table S5).

There was little evidence of any substitution to milk or juice (see online supplementary material, Supplemental Figure S3 and Table S6), although we could not rule out some substitution to bottled water or local soft drink products. Instead, there were declines in import volumes of milk and juice after the 2008 tariff increase and of juice after the 2012 tariff increase (not statistically significant). Although not formally studied given the low market share (44 %),

there was a suggestion that imported bottle water volumes increased after the 2008 and 2012 tariffs (see online supplementary material, Supplemental Figure S4).

In the controlled analysis, the declines in sweetened beverages after each tariff were larger and more precise: -24.8% (95 % CI $-36.9, -9.8$) in 2008 and -10.2% (95 % CI $-37.1, 37.5$) in 2012 (see online supplementary material, Supplemental Table S7 and Figure S5). Lead-in period and population change had important impacts on the model.

Sales volumes

There were 31.0 % (95 % CI -20.7, 242.5) and 32.3 % (95 % CI -39.5, 625.8) increases in sales volumes of full-sugar beverages (soft drinks and energy drinks) in the first and second year after the 2014 excise, respectively (Table 2 and see online supplementary material, Supplemental Figure S6), although results were imprecise. The figures for low-sugar beverages were a 6.2 % (95 % CI -791.2, 648.9) decline in the first year and a 21.7 % (95 % CI -862.1, 696.4) increase in the second year.

Discussion

Tariff increase findings

There was a significant 7 % increase in price in the year after the 2008 import tariff increase, whereas after the 2012 tariff increase there was a significant 14 % decrease in price and no pass-through of the tax increase. Opposite trends suggest that contextual factors may have been important. For example, the 2012 result may have been affected by ‘split invoicing’. That is, the legal practice of recording soft drink packaging and liquid on separate invoices was used since the 1980s to reduce the amount of tax paid on SSB; however, it was revoked in September 2009 (Audit Office investigation, 2011)⁽²³⁾, with likely substantially increased tariffs paid by the major importer and sole supplier of Coca-Cola. In 2010, there was a stepwise increase in the price of Coca-Cola (Fig. 1), a trend which subsequently contributed to a higher counterfactual price and lower detected price impact after the 2012 tariff increase.

The low impact of the 2012 tariff change was also reflected in taxed beverage import trends. The decrease was greater (13 % decrease) after the 2008 tariff than after the 2012 tariff (3 % decrease), although both had wide CI and decreases were two-fold and three-fold greater in controlled analyses. This may have been influenced by the revoking of split invoicing, increased availability of 50+ community water stations since 2010 with freely available UV light treated and tested drinking water and possible increases in local soft drink production after the 2009 sale of the local soft drink manufacturing business, although we had no data to assess this. The corresponding tax elasticities (change in import volume for every 1 % change in SSB tax) were -0.66 and -0.19. These are less than many other SSB tax elasticities⁽²²⁾, but similar to those seen in Barbados (elasticity -0.43, with a 4.3 % reduction in grocery sales after a 10 % tax) and Berkeley, USA (average elasticity -0.49). Barbados, like the Cook Islands, relied on an ad valorem tax increase, which may have resulted in a smaller impact on volume (elasticity) than volumetric or nutrient-specific taxes. Low awareness of the tariff increases by the public may also have limited their signalling effect⁽²⁴⁾.

Second year import trends were similar to the first year after the 2008 tariff increase but after the 2012 and 2014 tax

Table 2 Annual sales volumes per population in the major Cook Islands supermarket after the 2014 excise introduction compared with what was expected based on existing trends, 2012–2017*

Beverage	Tax change	Time period	Observed l/person per year	Counterfactual l/person per year	Absolute difference l/person per year	95 % CI	Percentage change, %	95 % CI
Full-sugar beverages, taxed	Tariff 77 % → excise NZ\$9.37/kg of sugar	First year	85.8	65.5	20.3	-21.5, 62.2	31.0	-20.7, 242.5
		Second year	79.6	60.2	19.4	-36.8, 76.1	32.3	-39.5, 625.8
		Both years	82.7	62.9	19.9	-29.0, 69.0	31.6	-27.9, 401.2
Low-sugar beverages, untaxed or very low tax	Tariff 77 % → no tax	First year	10.5	11.2	-0.7	-42.7, 41.1	-6.2	-791.2, 648.9
		Second year	15.3	12.5	2.7	-53.9, 59.3	21.7	-862.1, 696.4
		Both years	12.9	11.9	1.0	-48.1, 50.0	8.5	-843.2, 657.2
Bottled water (local and imported)	No change	First year	32.4	40.8	-8.4	-21.6, 4.8	-20.6	-41.7, 26.8
		Second year	32.5	46.4	-13.9	-31.6, 4.0	-29.9	-50.2, 21.5
		Both years	32.5	43.6	-11.1	-26.6, 4.3	-25.6	-46.1, 24.0

*No adjustment for confounding was possible due to low numbers. The measure of sales is litres (l) per population (p) per annum. Data provided by the Cook Islands Trading Company.



changes the first year changes reversed. Although imprecision affects these estimates, it is possible that changes in context factors over time can influence tax effects.

Fruit juice and milk import volume changes were mixed in response to SSB tariff changes and decreases suggest they were not important substitutes in the Cook Islands.

Excise level decrease findings

The changes related to the excise introduction were expected to be similar to tax subsidy studies reported elsewhere⁽²⁵⁾. Indeed, the price of the indicator beverage decreased significantly; there was an increase in sweetened beverage import volumes and in sales volumes of full-sugar beverages. Low-sugar beverage sales decreased slightly in the first year despite a large tax decrease but they increased in the second year. ASB may be less hazardous than SSB⁽²⁶⁾; however, water is considered preferable for protecting health, particularly oral health. ASB substitution could be avoided by including ASB in the sweetened beverage tax regimen. The increases in imports and sales after the 2014 excise may have also been influenced by wider tax review changes in 2014 such as a decrease in income tax, an increase in social welfare payment levels, an increase in the minimum wage and an increase in consumption tax⁽¹⁷⁾. Overall, households were likely to have had more money available to spend on SSB, ASB and potential substitutes.

Study strengths and limitations

The current study is one of few SSB tax in evaluations conducted in a Pacific Island jurisdiction⁽⁴⁾ and Small Island Developing State^(4,27). The interrupted time series design allowed adjustment for existing trends and potential confounding. The study included up to 2 years of follow-up, compared three different tax changes (with both increased and decreased levels), used a within-country control and was interpreted in the light of contextual information from Cook Island-based experts. However, there was limited study power in the import and sales analyses given the large variation in month-to-month import volumes and the low number of sales data points. The sugary snack control was useful because these products were exposed to similar policies (except for SSB tax increases), availability and economic or environmental shocks; however, differences in marketing, popularity or shelf-life may also have affected trends and comparison with sweetened beverages. Price trends on a can of Coca-Cola are unlikely to fully represent the price changes of all beverages affected by the tax. Also, import and sales volumes do not fully equate to consumption in the short term, given potential waste and stockpiling. Sales in other grocery stores may have been affected differently compared with the major supermarket measured in the current study, for example, if they do not differentiate in price between low-sugar and full-sugar soft drinks. There were

no data to examine trends in some potential substitute products such as locally manufactured soft drinks, tap water, flavoured milk, powdered drink sachets, soft drinks made from syrups, and local juice or bottled water. We could not distinguish differences in response between local residents and tourists with results representing both groups.

Potential implications

SSB taxes appear to have been a valuable tool for the Cook Islands in addressing increasing volumes of SSB imports, particularly the 2008 tariff increase. However, earlier decreases in expected import volumes were somewhat reversed after the 2014 excise change and SSB import volumes remained relatively high. SSB tax policies in the Cook Islands and elsewhere could be further strengthened for improved nutrition and health gains. SSB tax of at least 20% of shelf price is recommended for positive behavioural change⁽³⁾; however, further increases are likely to be needed for additional declines in SSB consumption and to maintain the level of tax with inflation for volumetric or nutrition-specific taxes. To avoid substitution to other unhealthy products, a SSB tax should ideally encompass a broad range of SSB⁽⁴⁾, including effective implementation of a SSB tax on locally produced beverages, while at the same time ensuring the availability of healthier alternatives such as bottled water and coconut water. Drinking water fountains and water-only policies in schools and the public provision of safe, tested and treated reticulated drinking water, are likely to be beneficial. For greater equity and public acceptance, SSB tax revenue could be hypothecated and invested into obesity prevention measures; health system capacity building and other interventions that benefit low-income households. Also, when a SSB tax increase is proposed, the change can be used as an opportunity to improve public awareness about the harms of SSB consumption, for example, via the mass media or even with a regulation requiring health warning labels on the beverages themselves⁽²⁸⁾. Ongoing monitoring of SSB tax can help inform further changes that could strengthen implementation and enhance health benefits. Context and additional policy changes are important to consider because they can influence on SSB consumption and tax impact, for example, revoking of split invoicing in the Cook Islands. Involvement of health experts in SSB tax design⁽²⁹⁾ and a multi-sectoral non-communicable disease (NCD) taskforce may strengthen the sustainability and implementation of obesity prevention policies^(30,31).

Conclusions

Although there was uncertainty in effect sizes, SSB tariffs appeared to have been a valuable tool for the Cook Islands in constraining SSB imports, particularly in 2008.

The decline in SSB tax after the switch to SSB excise in 2014 appeared to reverse earlier gains and the existing policy could be strengthened for greater potential health gains.

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Supplementary material

For supplementary material accompanying this paper visit <https://doi.org/10.1017/S1368980021000185>

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