US consumer interest in non-cigarette tobacco products spikes around the 2009 federal tobacco tax increase

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ABSTRACT

Objectives This quasi-experimental longitudinal study monitored aggregate Google search queries as a proxy for consumer interest in non-cigarette tobacco products (NTP) around the time of the 2009 US federal tobacco tax increase.

Methods Query trends for searches mentioning common NTP were downloaded from Google's public archives. The mean relative increase was estimated by comparing the *observed* with *expected* query volume for the 16 weeks around the tax.

Results After the tax was announced, queries spiked for chewing tobacco, cigarillos, electronic cigarettes ('e-cigarettes'), roll-your-own (RYO) tobacco, snuff, and snus. E-cigarette queries were 75% (95% CI 70% to 80%) higher than expected 8 weeks before and after the tax, followed by RYO 59% (95% CI 53% to 65%), snus 34% (95% CI 31% to 37%), chewing tobacco 17% (95% CI 15% to 20%), cigarillos 14% (95% CI 11% to 17%), and snuff 13% (95% CI 10% to 14%). Unique queries increasing the most were 'ryo cigarettes' 427% (95% CI 308% to 534%), 'ryo tobacco' 348% (95% CI 300% to 391%), 'best electronic cigarette' 221% (95% CI 185% to 257%), and 'e-cigarette' 205% (95% CI 163% to 245%).

Conclusions The 2009 tobacco tax increase triggered large increases in consumer interest for some NTP, particularly e-cigarettes and RYO tobacco.

Increasing the price of cigarettes by raising excise taxes is one of the most effective tobacco control strategies because it reduces consumption among people who continue to smoke,[1] encourages quitting,[2 3] reduces relapse[4] and discourages initiation.[1] Despite these aggregate public health benefits, some smokers may respond to cigarette tax increases by stockpiling prior to implementation of the tax[5]; switching to discount brands[6] or non-cigarette tobacco products (NTP) (eg, smokeless or pipe tobacco)[7 8]; or buying cigarettes in bulk, in lower-tax jurisdictions, or from discount outlets.[6] Since these price minimisation strategies undermine the public health benefits of cigarette tax increases, assessing unintended consequences, particularly around tobacco tax increases, is a priority for policymakers and researchers.

In April 2009, the US Children's Health Insurance Program Reauthorisation Act (CHIPRA) increased the federal excise tax on tobacco products, but the increases were not uniform.[9] The tax on cigarettes increased 158%, from US$19.50 to US$50.33 per 1000. The increases for roll-your-own (RYO) tobacco and small cigars were significantly higher (2159% and 2653%, respectively), making the rates equivalent to the rate per unit dose of cigarettes. By contrast, tax increases for large cigars, pipe tobacco and smokeless tobacco were much smaller than for cigarettes.[9] The new tax rates led to a disparity in relative tobacco product prices that may have led some smokers to consider switching to NTP. The purpose of the present study is to use aggregate Google search queries to analyse US consumer interest in NTP around the time of the CHIPRA tax increase. We hypothesised that queries for common NTP would increase and remain elevated following the implementation of the tax.

METHODS

Query selection

Query trends were systematically gathered from Google Trends (google.com/trends/), a public database of geographically aggregated Google search queries. We identified eight NTPs to be monitored, based on the tobacco products included in the Internal Revenue Code (IRC),[10] consultation with other experts, and data availability. For each product, we began with a single root term: "cigars", "cigarillos", "chewing tobacco", "electronic cigarettes", "pipe tobacco", "roll your own tobacco", "snuff", and "snus". Using a built-in feature on Trends, we used the eight root terms to identify the next 10 related terms, which were then used to find 10 additional related terms for each related term, yielding 800 terms (8×10×10). All duplicate terms were deleted, yielding 504 unique terms. Two investigators (JWA and BMA) then independently purged terms unrelated to NTP (eg, 'cigarettes') or with alternative meanings that were potentially unrelated to NTP (eg, 'Copenhagen'). We conducted additional tests on this latter class of terms to verify that the majority of queries they generated were unrelated to tobacco. For example, we estimated the ratio of queries that included Copenhagen in combination with 'tobacco,' 'snuff,' or 'chew,' relative to all queries that included Copenhagen was 5%. Thus, we concluded the inclusion of the term Copenhagen alone would induce a great deal of queries not related to tobacco products. Term classification was discussed to achieve 100% agreement between the investigators, and the final listing included 296 terms, with a minimum of 26 for cigarillos and a maximum of 63 for cigars.

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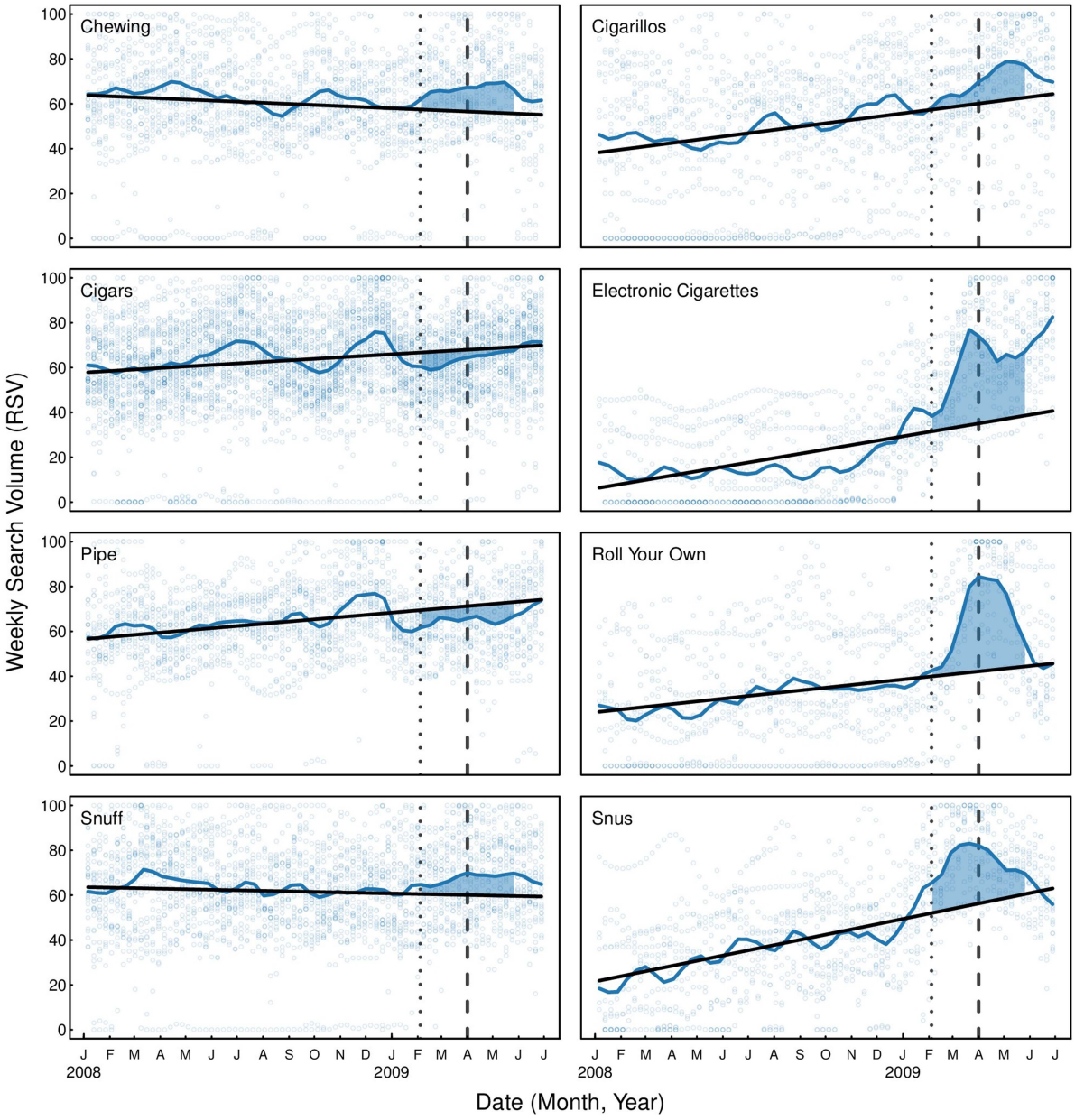

Figure 1 Google Search Query Trends for Categories of Non-cigarette Tobacco Products Around the 2009 Federal Tobacco Excise Tax Increase, 80 weeks, January 2008 to July 2009, USA. Note: Circles indicate an observed weekly search volume estimate for a specific query term. The curved line represents the weekly observed mean trend lines for all specific queries in a category of products. The straight line is the linear projection for January 2008 through January 2009, or expected query volume. The difference in these trends is shaded to highlight potential increases or decreases with reference lines indicating when Children's Health Insurance Program Reauthorisation Act (CHIPRA) was signed into law and when CHIPRA took effect.

Query volume

We analysed weekly query trends in the USA from January 2008 to April 2010 on a relative search volume (RSV) scale, with each category of specific queries normalised to their highest search proportion week, for example, RSV=100 is the highest search proportion week and RSV=50 is 50% of the highest search proportion week. This normalisation corrects for increases in absolute search volume, which occur for most queries over time due to greater internet use. Because rare queries would always have the largest increases (eg, a few additional queries could produce a large increase in RSV), we excluded queries with a mean RSV<1 for 2008. As a result, our rankings of specific queries are indicative of increases for more common queries or practical consequence.

Query analysis

We estimated excess search volume for NTP that may be temporally linked to the CHIPRA tax, comparing observed RSV to a counterfactual that CHIPRA had not occurred. The observed outcome was the weekly RSV for February 4 (when the tax was signed into law) through May 31. The counterfactual outcome was the weekly RSV for February 1 through May 31, derived from a linear projection of the best fitting line for January 2008 through January 2009. Model fits for the linear projection were

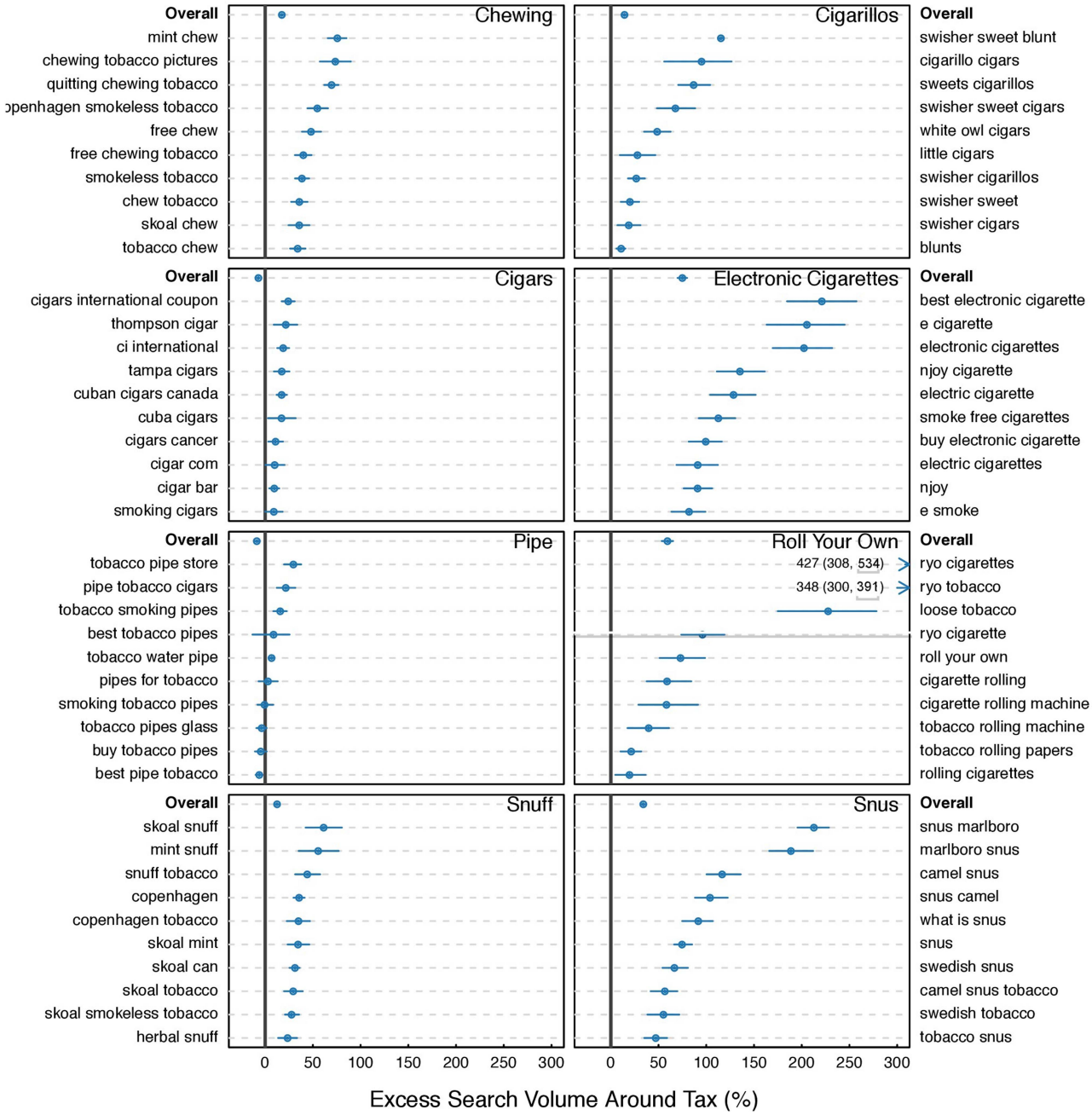

Figure 2 Internet Search Query Volume for Specific Non-cigarette Tobacco Products Changed Around the 2009 Federal Tobacco Excise Tax Increase, 1 week, 29 March 2009 to 4 April 2009, USA. Note: Each dot plot corresponds to an estimated effect size representing the relative difference in observed versus expected search volume for the 16 weeks around Children's Health Insurance Program Reauthorisation Act (CHIPRA). Lines represent the 95% CIs for these estimates.

assessed using Akaike Information Criterion[11 12] and deemed superior or equivalent to alternatives, for example, quadratic fits. The impact of CHIPRA was then represented by the pooled mean difference in RSV (observed minus counterfactual, divided by counterfactual) for each of the 16 weeks for individual queries and pools of similar queries (ie, 'electronic cigarettes' vs all electronic cigarette-like queries). These ratios were bootstrapped to provide 95% CIs.[13]

This modified interrupted time series[14] has been successfully implemented by others for similar research questions.[15] This approach is immune to cyclical trends that bias pure pre-/post-comparisons. Queries that had been increasing would need to increase even more around CHIPRA to produce positive effect estimates.

RESULTS

The mean weekly trend of queries grouped by NTP was higher than the projected trend for chewing tobacco (17%; 95% CI 15% to 20%), cigarillos (14%; 95% CI 11% to 17%), electronic cigarettes ('e-cigarettes') (75%; 95% CI 70% to 80%), RYO tobacco (59%; 95% CI 53% to 65%), snuff (12%; 95% CI 10% to 14%), and snus (34%; 95% CI 31% to 37%) (figure 1). The mean query trend for RYO began increasing immediately after the tax was announced, peaking when the

tax took effect, and remaining higher for eight more weeks. The trend for e-cigarettes followed a similar pattern but, 8 weeks following the implementation of the tax, continued to rise.

E-cigarette queries as a group rose the most around CHIPRA, being 75% (95% CI 70% to 80%) higher than expected and including 'best electronic cigarette,' 'e cigarette,' and 'electronic cigarettes' queries (figure 2). Many of the specific e-cigarette queries with the largest increase around CHIPRA were related to sales. For example, 'buy electronic cigarette' (99%; 95% CI 82% to 116%) and 'njoy cigarette' (135%; 95% CI 111% to 161%) were among the e-cigarette queries with the largest increases around CHIPRA.

RYO 59% (95% CI 53% to 65%), snus 34% (95% CI 31% to 37%), chewing tobacco 17% (95% CI 15% to 20%), cigarillos 14% (95% CI 11% to 17%), and snuff 13% (95% CI 10% to 14%) were searched significantly more than expected around CHIPRA. The unique queries increasing the most were 'ryo cigarettes' 427% (95% CI 308% to 534%), 'ryo tobacco' 348% (95% CI 300% to 391%), 'best electronic cigarette' 221% (95% CI 185% to 257%), and 'e cigarette' 205% (95% CI 163% to 245%).

Queries for cigars (−7%; 95% CI −6% to −8%) and pipe tobacco (−9%; 95% CI −7% to −11%) were searched significantly *less* than expected around CHIPRA. However, some of the unique queries contributing to this mean trend did have significantly more searches around CHIPRA, such as 'tobacco pipe store' 30% (95% CI 20% to 38%), 'pipe tobacco cigars' 22% (95% CI 12% to 32%), and 'tobacco smoking pipes' 16% (95% CI 9% to 23%).

DISCUSSION

This study is the first to analyse information-seeking about NTP at the population level after the 2009 CHIPRA tax increase.[16] Our hypothesis was partially supported. The tax increase was associated with a rise in relative internet search queries for cigarillos, e-cigarettes, RYO tobacco, chewing tobacco, snuff and snus, but not for cigars or pipe tobacco. Of these products, RYO tobacco and e-cigarettes experienced the greatest increases in search query volumes.

For some cigarette smokers, the tax increase may have stimulated interest in RYO tobacco. Although CHIPRA equalised the tax rates, RYO tobacco still costs less than manufactured cigarettes. Nevertheless, the fact that the increase in RYO tobacco queries dissipated 8 weeks after the tax was implemented suggests this interest in RYO tobacco was temporary.

For e-cigarettes, the increase in search queries persisted for the remainder of the study period. Other studies[17 18] suggest a secular trend toward e-cigarette interest and use, which may explain the sustained rise in e-cigarette queries. Consumer awareness of e-cigarettes has been growing, reaching 75% in 2012,[19] and continued expansion of the market is predicted.[20] Reasons for the trend toward e-cigarette use may include their low price relative to cigarettes and aggressive advertising. E-cigarettes are currently exempt from federal and most state excise taxes,[21] thus providing a cheaper source of nicotine for cigarette smokers.

The continued upward trend in the interest and use of e-cigarettes is disturbing given the limited and conflicting data on their health effects and lack of quality control and product standards.[22] However, the US Food and Drug Administration (FDA) has the authority to regulate e-cigarettes and their marketing, and we hope this authority, combined with continued research on the health impact of e-cigarettes, will influence these trends in a way that improves public health.

What this paper adds

Internet search query surveillance can be used to monitor consumer interest in NTP around major tobacco control policy developments, such as tobacco tax increases. The CHIPRA tax increase was associated with a rise in relative internet search queries for cigarillos, e-cigarettes, RYO tobacco, chewing tobacco, snuff and snus, but not for cigars or pipe tobacco. Of these products, RYO tobacco and e-cigarettes experienced the greatest increases in search query volumes, but this rise was sustained only for e-cigarettes.

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Competing interests JWA and BMA share an equity stake in a consulting group, Directing Medicine, that helps other clinician-scientists implement some of the ideas embodied in this work. The data generation procedures, however, are not proprietary and rely on public archives. There are no other conflicts of interest relevant to this study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement All data used in this study are publicly available from Google Trends (google.com/trends/).

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