Tobacco control policies and socio-economic inequalities in smoking cessation

*Evaluating natural experiments*

Bosdriesz, J.R.

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The effect of tobacco tax and price increases on smoking cessation or reduction – a scoping realist review

Jizzo Bosdriesz
Anton Kunst
Carles Muntaner
Marc Willemsen
Patricia O’Campo

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Chapter 10

ABSTRACT

Background
Raising taxes on tobacco products is the most effective way to decrease the consumption of tobacco and the prevalence of smoking, especially among low socioeconomic status (SES) groups. Most studies so far assessed whether tobacco use is responsive to price, but did not assess through which mechanisms these effects were established. The overall aim of this review is to understand how, among whom, and under which circumstances increases in the tax or price of tobacco can influence individual smoking behaviour of adult smokers. We particularly focus on the role of SES.

Methods
Based on a scoping search of the literature, and consultations with experts, we have proposed a theoretical framework that specifies the different strategies, mechanisms, and outcomes, and the contextual factors potentially affecting these processes. Then we performed a systematic literature search to identify empirical evidence (1980-2015) to support and/or adjust this framework.

Results
Of the 4,107 papers identified after the primary search, we identified only 9 studies that contained evidence on the mechanisms of the effect of tax/price increases on smoking behaviour. From these studies, all from the US, we found evidence for three distinct mechanisms. The main mechanism seems to be the cost/utility balance effect (a rational maximization of utility, because of increases in tax, the cost of smoking may outweigh the utility gained). To a lesser extent, we found support for increased societal anti-smoking norms, and the substitution effect (the inability to cover basic expenses as a result of increased spending on smoking). The role of SES in these mechanisms is mixed: the substitution effect is mainly found among low income groups.

Conclusions
Our review of literature identified three distinct mechanisms that explain how an increase in tobacco taxes can lead to smoking cessation. These results can be used to embed future tax increases in a more comprehensive tobacco control effort that addresses these behavioural drivers.
INTRODUCTION

Raising taxes on tobacco products is generally the most effective way to decrease the consumption of tobacco and the prevalence of smoking.\(^1\)\(^,\)\(^2\) Increasing taxes can increase smoking cessation among current smokers, prevent smoking uptake among youth, prevent relapse among former smokers, and reduce the amount of cigarettes smoked by current smokers.\(^3\) A price increase of 10% will lead to a drop in consumption of around 4% (although there might be considerable variance around this estimate).\(^4\) In addition to its effect on the population level, tobacco taxes are credited to have the potential to decrease inequalities in smoking between low and high socio-economic status (SES) groups.\(^5\)\(^,\)\(^6\) However, the body of evidence on the ‘positive equity impact’, i.e. the ability to increase equity in smoking and smoking-related disease, of tobacco taxation is not clear-cut. Recently, Brown at al. reviewed studies that looked at the impact of tobacco control policies on inequalities in smoking.\(^7\) They concluded that only about half of the studies on the impact of raising taxes clearly showed that this would decrease inequalities in smoking.

Most studies to assess the effects of tobacco taxes are quantitative and focus on effect sizes, usually in terms of price elasticity. While they can assess whether tobacco use among low SES groups is more responsive to price than among high SES groups,\(^4\) they rarely can provide clues on how taxation would affect individual smokers. It seems that most researchers assume a tax-price-demand mechanism that is modified by the level of disposable income. Smokers from lower socioeconomic groups may be more likely to respond to higher prices because their lower disposable income makes cigarettes less affordable. They can do so by trying to quit, cutting down; or switching to a cheaper brand, roll-your-own cigarettes, or alternative (cheaper) products such as e-cigarettes; or by obtaining cigarettes from illicit/untaxed sources.\(^8\)

However, since the evidence is not quite unanimous regarding the positive equity impact,\(^7\) more varied or complex mechanisms might play a role in the real world. The role of these mechanisms might well vary between different social groups stratified by e.g. economic resources. Additionally, studies from different countries sometimes seem to yield different results, which suggest that the national or local context might modify the way in which tobacco taxes affect tobacco consumption. More detailed knowledge about the role of these mechanisms and the contexts in which effects are or are not substantial could be important for policymakers. They
could use this information to take into account the contextual settings when implementing a tax increase in such a way as to maximize its potential impact.

To answer these complex issues, the realist approach seems especially applicable, as this focuses on the question of how, among whom, and under which circumstances a policy could have the expected effects. Realist reviews have often been applied in the social sciences to the study of complex interventions, and are increasingly being used in the field of public health, especially for policy evaluations. The advantage of using a realist review approach is that it can uncover causative mechanisms that intervention-outcome association studies cannot. Such an understanding of mechanisms is necessary to establish causality and subsequently to inform future interventions on how to increase their effectiveness.

The overall aim of this review is to search for confirmatory evidence for mechanisms that will be proposed in a theoretical framework, to reveal additional mechanisms through which the taxation and price of tobacco products can affect individual-level smoking behaviour, and to identify personal characteristics or circumstances that may modify their effect. We explicitly focus on smoking cessation, and not on initiating smoking by youth, as this is a distinct process which is likely to work through a different set of mechanisms. We focus particularly on SES, to understand why the effects of tobacco taxation on smoking behaviour could differ between low and high SES groups. We thus aim to assess how taxation of tobacco products effects smoking behaviour of adult smokers, and socio-economic differences therein.

**METHODS**

**Theoretical framework development**
We have first performed a targeted literature search in which we identified key publications. On the basis of this literature, we have formulated an initial theoretical framework of how tax increases would engender a series of mechanisms that affect smoking behaviours of adults, and circumstances that may affect the occurrence and outcome of these mechanisms (see Appendix Table 1). From the key publications in the field, we have also identified a list of experts, four of whom have commented on our initial framework at different stages of development. Their suggestions have been incorporated in the initial theoretical framework.
As outcomes for this systematic realist review, we have focused on smoking cessation and cutting down. Smoking cessation is often not a single action, but a process of behavioural change with different routes.\textsuperscript{16,17} Quit attempts can succeed or fail; if quit success is maintained, one becomes a former smoker, if quit success is not maintained, one relapses into current smoking with or without reduction in smoking levels, with the possibility of new quit attempts. We include quit attempts, quit success, and former smoking as part of the concept of smoking cessation behaviour. In addition to smoking cessation, we also include cutting down (a deliberate reduction in the amount of cigarettes smoked per day) as a main outcome. The framework recognises that there are a number of alternative behaviours that can be part of cutting down, lead to cessation over time, or prevent cessation by providing alternatives. Examples are switching to a cheaper brand, switching to a higher nicotine-yielding cigarette, use of illicit tobacco, or use of electronic cigarettes. We will label these different responses as price minimizing behaviour.

In our initial framework, we included three mechanisms that could lead from a tax/price increase to a quitting or cutting down on smoking. The first is the opportunity cost, i.e. the amount of basic necessities that are forgone in order to purchase tobacco. If the price of tobacco increases and it becomes less affordable, the same smoking behaviour can only be maintained at the expense of other spending. To avoid this, smokers may attempt to quit or cut down on smoking. The second is the social norm, when tobacco taxes are increased, this might be interpreted by smokers and non-smokers alike as an indication of the decreased social acceptability of smoking. The more society and the social surroundings of the smoker display a negative social norm towards smoking, the higher the odds that the smoker will attempt to quit. The third is the substitution effect, where a smoker is faced with the decision to spend money on tobacco or on other goods/services. If tobacco becomes more expensive, but the smoker continues to smoke, the resulting financial difficulties or lack of food/money to pay rent can be a motivation to quit or cut down on smoking.

Out of a wide range of factors on the individual level (age, sex, SES, etc.), we focus here on one: SES. The proposed mechanisms may depend on disposable income and the individual financial situation. The opportunity cost and substitution effect mechanisms are likely to be stronger among low SES smokers, because these mechanisms function through a limited amount of disposable income.\textsuperscript{1,2} Any spending on tobacco will displace spending on other products, possibly on basic necessities. While for higher income smokers, an increase in expenditure on tobacco...
can be more easily overcome without having to cut down on other expenditures. Budgeting decisions among the very poor might differ substantially from the higher income groups\textsuperscript{18,19} due to the fact that tobacco for them might have a different use value, as (their only) coping mechanism\textsuperscript{20}. Moreover, low SES smokers are often more heavily addicted, which can impair rational decision making\textsuperscript{21}. Social norms on the societal level could be expected to affect low and high SES smokers to a similar extent. However, it is known that low SES smokers often have many other smokers in their social networks\textsuperscript{6}, and thus most likely a pro-smoking social norm.

There are also many factors that can play a role at the societal level, such as the level of economic development of a country or state. The effects of tax increases are likely to be different in lower and middle income countries, compared to high income countries, although both stronger and weaker effects are reported\textsuperscript{22–24}. Moreover, the presence of other tobacco control policies is likely to impact the relation between tax increases and smoking cessation\textsuperscript{4}. This is most clear for smoking cessation support, which can be a great benefit in helping smokers go from quit intention to sustained successful quitting. Advertising restrictions are likely to help as well, as without these, the tobacco industry can freely promote their products and encourage consumers to shift to discount brands in response to tax increases. Lastly, the impact of raising tobacco taxes might be reduced if accompanied by increases in smuggled/illicit tobacco. The evidence for this is fairly mixed\textsuperscript{25–28}, but in some countries it might be a genuine concern.

**Search strategy**

We have conducted a systematic literature review through the searching of electronic databases in different fields of research (behavioural economics/medicine/social psychology). Moreover, we have searched the Legacy Tobacco Documents Library, a collection of tobacco industry documents, released following litigation. This database includes internal strategy documents, but also a large amount of original research, most of which has not been published in mainstream scientific journals. Our search terms were chosen to capture tax/price increases and smoking outcomes or price minimizing behaviour. We used these broad outcome-related search terms, without adding terms regarding mechanisms, in order to decrease the chances of missing studies. More details on the databases searched and the search terms used can be found in Appendix Table 2.

The documents identified in the systematic literature search were carefully screened to determine whether or not they could be used in our study.
To be included a document needed to meet two main inclusion criteria:
1. The document contains data on at least one of these smoking outcomes:
   - Smoking cessation/quit attempts/quit success/quit rates
   - Cutting down/intensity of smoking/number of cigarettes smoked per day
   - Switching to cheaper/discount cigarettes/e-cigarettes.
   (This means that we excluded documents that only report smoking prevalence, participation or initiation.)
2. The document should contain data on any measure of an increase or decrease in the tax and/or price of tobacco. (This means that we excluded documents that include only cross-sectional comparisons between countries/states with different price levels.)

Next in the screening of abstracts or full texts, documents had to meet these additional criteria to be included:
- Data should (at least partly) be collected after 1980.
- Data are analysed/presented at the individual level. Documents with only national-level data, e.g. smoking prevalence, tobacco sales, or price elasticity were not included, because these analyses cannot provide information on mechanisms of change at individual level.
- Price increases are real (proposed or hypothesized price increases were excluded).

**Data extraction**
To extract the data from the identified studies, we used a systematic data extraction form to allow for transparent and consistent treatment of each document. Extraction was performed by the first author, with other authors reviewing random selections of documents to test and improve the inter-rater consistency of the results. The data extraction form also contains judgements on both the methodological quality of the study (design, sample size, statistical analyses, etc.) and the richness of the evidence (e.g. whether the mechanism was experimentally derived and tested, or only included as covariate and only briefly mentioned in the discussion). The data extraction form also included information on the study population and study design, and allowed for grouping of results by mechanism, outcome, or contextual variables included. Following this initial systematic gathering of evidence, the sources of evidence were combined to synthesize the evidence on each mechanism. This synthesis also included a description of evidence, if any, on the role of contextual variables for each specific mechanism.
RESULTS

Selection of papers
The flowchart in figure 1 shows that, as a result of the broad search terms and lenient initial inclusion criteria, we identified a large number of studies: 4,107 after duplicates were removed. Of these, 3,817 were excluded based on screening of title and/or abstract. Of the remaining 290 full-texts screened, 78 were included for full review. Of these 78 studies, only 9 were found to contain direct evidence on mechanisms, including mechanisms that were not yet specified in our initial theoretical framework. The other studies only contain ‘thin’ evidence: they focussed on the
Tax increases and smoking cessation

effect size only, and did not contain any empirical evidence for possible mechanisms to explain this effect. Some studies did speculate or hypothesize explanations for the (lack of) found effect, but this was not considered as evidence of a mechanism. Characteristics of the 9 included studies can be found in Table 1.

General results

The revised theoretical framework is shown in Figure 2. Compared to the initial framework, there was no evidence to support the opportunity costs as a separate mechanism, so this mechanism was excluded. Additionally, we included a slightly different mechanism mentioned in some studies, regarding the cost/utility balance. The included mechanisms will be discussed in more detail below.

In the initial framework, price-minimizing behaviour was conceived as an alternative outcome, based on the assumption found in the literature that smokers try to minimize the impact of a tax increase on their financial situation by either quitting/cutting down on smoking, or engaging in price minimizing behaviour. However, we found two studies that observed that price minimizing behaviour might co-occur with cutting down or quitting, or lead to future cutting down or quitting.29,30 We adopted the framework to account for this concurrence.

Mechanism 1: Societal antismoking norms

An increase in the tax and price of tobacco can influence the behaviour of adult smokers by shifting the societal norms regarding smoking towards more negative norms. Moreover, the fact that tobacco taxes are regulated by the government can be interpreted as an act by an authority to reinforce antismoking norms. The combined influence of societal norms and the government authority might result in changes in the use value of smoking, which might strengthen the intention to quit smoking.

We found four studies showing some evidence to support this mechanism. A US cohort study, following youths from age 13-14 (1988) to age 25-26 (2000), showed that the effect of tobacco tax on smoking cessation became weaker, but remained significant, after adjusting for state-level antismoking norms, indicating the latter was a moderating factor.31 Another US study, using repeated cross sectional data from 1992 to 2003, showed that the effect of tobacco price effect was significant for adult smokers (aged 25 or older). When controlled for anti-smoking norms, the effect size of the price effect decreases in all groups. The individual effect of anti-smoking norms on smoking cessation was significant, except for the group aged 65 or older.32
<table>
<thead>
<tr>
<th>Author(s), Year, Journal</th>
<th>Study design</th>
<th>Study population</th>
<th>Context</th>
<th>Mechanism</th>
<th>Strength of evidence</th>
<th>Outcome</th>
<th>Cost / utility balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choi et al., 2011, American Journal of Health Promotion</td>
<td>Prospective cohort (interview)</td>
<td>Minnesota (USA), Age 12-20, N=3,167</td>
<td>Lower education, working class, pro-smoking social environment</td>
<td>Quit attempts, cutting down</td>
<td>Quality: +, Evidence: thin</td>
<td>Cessation</td>
<td>Cost / utility balance</td>
</tr>
<tr>
<td>DeCicca et al., 2008, Journal of Health Economics</td>
<td>Prospective cohort (survey)</td>
<td>USA, Age ~17-26, N=10,706</td>
<td>Current taxes vs. past taxes, heaviness of smoking</td>
<td>Societal antismoking norms</td>
<td>Quality: +, Evidence: thin</td>
<td>Cessation</td>
<td>Cost / utility balance</td>
</tr>
<tr>
<td>Harris &amp; Harris, 1996, Journal of Socio-Economics</td>
<td>Cross-sectional (survey)</td>
<td>Maryland (USA), Age 18-94, N=1,723</td>
<td>Income, education, age, risk taking behaviour</td>
<td></td>
<td>Quality: +, Evidence: thin</td>
<td>Cessation</td>
<td>Cost / utility balance</td>
</tr>
<tr>
<td>Author(s), Year, Journal</td>
<td>Study population</td>
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<tr>
<td>Okechukwu et al., 2012, Social Science &amp; Medicine</td>
<td>USA Construction workers Age ≥15 N=52,418</td>
<td>Repeated cross-sectional (survey)</td>
<td>Quality: +/- Evidence: thin</td>
<td>Labour market shock</td>
<td>Societal antismoking norms</td>
<td>Cigarettes per day</td>
<td></td>
</tr>
<tr>
<td>Shelley et al., 2007, American Journal of Public Health</td>
<td>New York City African-Americans Age ≥18 N=104</td>
<td>Qualitative (focus groups)</td>
<td>Quality: +/- Evidence: moderate</td>
<td>Illicit trade, addiction</td>
<td>Substitution effect, Societal antismoking norms</td>
<td>Quit attempts, cutting down, price minimizing behaviour</td>
<td></td>
</tr>
</tbody>
</table>
Figure 2 The revised theoretical framework
The identified studies also provide some evidence on differences in the effectiveness of tax increases between high and SES groups. US data showed that the effect of tax increases on smoking cessation, with adjustment for antismoking norms, was strongest in the higher education and income groups. Adjustment for anti-smoking norms had similar effects across SES groups.32 A US study on construction workers (i.e. blue-collar workers), using the same repeated cross sectional data from 1992 to 2007, found that antismoking norms were an important predictor of smoking intensity. So much so, that after controlling for antismoking norms, the effect of the tax increase itself was no longer significant.33 A New York City based focus group study among smokers in a disadvantaged community found that the prevailing prosmoking norm was one of the factors contributing to the fact that a tax increase had very little effect on quit rates.34 So these studies suggest that the impact of price increases on quit rates among low SES groups may strongly depend on whether or not these price changes affect pro-smoking norms.

**Mechanism 2: Substitution effect**

If an increase in tobacco taxes is not offset by a concurrent increase in income, the affordability of tobacco will decrease. Especially large increases in taxes will result in sudden budget constraints for the smoker and in noticeable increases in the opportunity cost of smoking (i.e. the amount of other expenditures that are forgone in order to purchase tobacco). If smoking becomes less affordable and smoking behaviour is not changed, spending on tobacco would displace expenditures on basic needs such as housing and food. The resultant situation, where basic needs might not be met, could be a motivation to quit or cut down on smoking, or it may reinforce pre-existing intentions to quit smoking. Alternatively, to maintain the same level of expenditure on tobacco, smokers might want to reduce consumption, or switch to a cheaper brand, alternative products or illicit tobacco.

We found two studies showing some evidence for mechanism 2. A qualitative study among Minnesota (US) tobacco users showed that smokers were unable to pay the rent or meet other essential expenses, because of the increased cost of their smoking behaviour. This led to a desire to quit smoking, and actual quit attempts, in order to be able to spend money on other goods.35 A New York City based focus group study among smokers in a disadvantaged community reported that smokers would cut back on necessary expenses, even exchanging food stamps, in order to still get their cigarettes. However, the hardship and guilt associated with these behaviours reinforced pre-existing quit intentions (but not actual quitting).34
Mechanism 3: Cost / utility balance

Becker and Murphy developed the rational addiction model, wherein they state that smokers do recognize that smoking is addictive, but they choose to remain smoking so long as the perceived utility (benefit) of smoking outweigh the costs. In this model, it is assumed that smokers are aware not only of the current cost of smoking in terms of money spent, but also the future cost in terms of addiction and health effects. The rational addiction model states that decisions regarding smoking are based on such balancing of costs and utilities.

We found five studies providing some evidence for this mechanism. Studies from the US showed that those who were aware of price changes before the actual tax increase were more likely to quit smoking than smokers who were not aware of announced price increases. This hints to the fact that this was a forward-looking rational decision. A US study among pregnant women found that more than the presence of a tax increase, the future increase in price was associated with the likelihood of smoking cessation. The authors argue that knowledge of future increases in costs affected the current balance between cost and utility. This is supported by a Maryland (US) cross-sectional survey study, which found that when smokers judge the long-term benefits of quitting smoking to be greater than the short-term costs of behaviour change, they will intend to quit smoking.

One study did not focus on the aspect of future price increases and forward looking behaviour, but did consider a cost/utility balance. This qualitative study among Minnesota (US) tobacco users showed that smokers would quit smoking, only if they found an alternative that offered them greater utility. In addition, another study reported that being more informed about the negative health effects of smoking was associated with higher odds of quitting.

There is some evidence to suggest that rational balancing of utility and costs might more often occur among the higher educated. Higher educational level and higher family income were found to be associated with more forward-looking, rational decision making, and with higher odds of smoking cessation. However, a Minnesota (US) cohort study of adolescents and young adults showed that the effect of the tax increase (on quit attempts and cutting down) for those who were aware of price changes before the actual tax increase were stronger among those with less educated parents.
Additional results
Alongside the evidence for these mechanisms, we found some evidence to support that actual price increases may not be important for changing smoking behaviour, but only perceived price increases. This would be an important part of the causal pathway from tax increase to smoking cessation, but it is not a mechanism in its own right. It does however seem to fit with the mechanism of cost/utility balance, where the effect of future price increases seemed to be dependent on whether or not smokers were aware of them.

DISCUSSION

Summary of findings
We found supporting evidence for three different mechanisms that can lead from tobacco tax/price increases to smoking cessation or cutting down. Firstly, no longer being able to meet essential household expenditures (rent, food, etc.) as a result of increased spending on tobacco can lead to quitting smoking. This mechanism applies mostly to low income smokers. Secondly, following a tobacco tax increase, the presence of stronger societal antismoking norms are predictive of quitting smoking. This effect was found both for high and low educated smokers. Lastly, most evidence was found that faced with increasing costs of tobacco, the rational balancing of the cost versus the utility of tobacco is likely to change. As long as the utility of smoking is higher than the cost, a smoker will remain smoking. Following tax/price increases, this balance is likely to shift, so that the cost outweighs the utility derived from smoking, and cessation becomes the more attractive alternative.

Limitations
There are some issues which might affect the evidence acquired in this review. Although we have tried to be as inclusive as possible, we might have missed relevant evidence in the literature. For instance, we chose to focus on smoking cessation outcomes, therefore studies on smoking prevalence or smoking participation (of which there are many) were excluded. However, for these studies that do not focus on smoking cessation, it is unlikely that they would contain evidence on mechanisms that are (also) valid for smoking cessation. Moreover, we did not find any grey literature containing evidence on mechanisms, but again, this is not really unexpected. We did extensively search tobacco industry documents (grey literature), but this yielded no results after applying all inclusion criteria.
Moreover, every single study we identified as containing evidence to support the mechanisms relied solely on US-based data. Although it might seem reasonable to assume that their findings would hold true for other high-income Western countries, this is probably much less applicable to lower income countries. As the sociocultural context might differ from country to country, particularly in terms of disadvantaged communities and socio-economic inequalities, our conclusions regarding socioeconomic inequalities might not be readily transferable to other countries.

One of the most obvious findings is the disappointingly low number of studies that contain any evidence on the mechanisms of tax effects on smoking cessation. Although there is a vast body of evidence regarding other aspects of tax increases, most studies are restricted to measuring effects on various smoking-related outcomes, estimating precise effect sizes, and assessing these effects for different SES groups or different policy alternatives (e.g. tax structures). Moreover, from the limited number of studies that we did identify, the strength of the evidence for the various mechanisms is fairly low. This means that in all fairness, the ‘black box’ of the mechanisms in play here has hardly been opened, and our theoretical framework will need testing and further refinement when new evidence accumulates.

**Interpretation of results**

Although many studies state that the effects of tax/price increases are greater among the lower income groups, it is worth noting that most of these studies looked at smoking participation or tobacco consumption, not at cessation. Therefore it stands to reason that we found only a few studies that provided some clues on the mechanisms and how these would influence differences between SES groups. For instance, it may seem obvious that the substitution effect is specific to lower income groups, but there are only very few studies documenting whether and how this mechanism operates among the poor. For anti-smoking norms, we found a bit more evidence, but none of it showing a greater effect among low SES groups. The mechanism with the most supporting evidence, the cost/utility balance, seemed to be more or less equal between SES groups, possibly slightly stronger among higher educated smokers.

The mixed evidence we found across and within the separate mechanisms might have important implications for the equity impact of tobacco tax increases in general. Which of these mechanisms is dominant might determine whether the effect of the tax increase is greatest among high or low SES smokers, or both. In turn, which
mechanism is dominant is likely to be dependent on a number of contextual factors, including the availability of cessation support services.

An expert panel directed by the International Agency for Research on Cancer (IARC) stated that there was *strong but not sufficient evidence* to support that effects of tax/price increases in low SES smokers are stronger than in high SES smokers.\(^4\) This fact may be explained in part by the chosen outcome measure. Most of the studies reporting an equity positive effect used price elasticity as the outcome, which is a fairly abstract and aggregated measure, and may not be indicative of actual smoking cessation. Another explanation could be that the effect of price increases might have diminished over time. A US study covering three decades, showed the price elasticity of smoking among low SES smokers in 1997-2004 decreased by 0.31, compared to 1984-1996, while among high SES smokers, it only decreased by 0.15.\(^4\) In addition, a recent review study identified 27 studies that assessed the equity impact of tobacco taxes, and only about half of these (14) showed a greater effect among low SES smokers than among high SES smokers.\(^7\)

**Future research**

The very small number of studies containing evidence on mechanisms of how tobacco tax increases can lead to smoking cessation identified in this study highlights a clear need for more research focused on unravelling mechanisms. It is important for policymakers to have evidence to support not only whether a tax increase can be effective in general, but also how it can achieve the strongest effects, and how it can achieve an effect among the low SES groups. Knowledge on the specific mechanisms of this effect can help set up the policy in such a way that the effect is maximized. For instance, the effects of a tax increase might be strengthened if it coincides with mass media campaigns that focus on specific mechanisms. Moreover, we found some indications that the dominant mechanisms might vary in different contexts. With this information, policymakers can be more aware of the contextual factors relevant to their situation and adapt their strategy accordingly. In this regard, it would also be important to generate evidence from studies outside the US, as the societal level context is quite different in Europe or elsewhere.

Even though we found very little evidence on mechanisms, providing more such evidence should be feasible with current widespread study designs. Combining price data with individual level survey data, especially longitudinal cohort data, remains a good method to provide evidence on the mechanisms of tax and other policy effects. However, a major requirement would be that they provide detailed data on quitting...
smoking, such as when and why the respondent quit smoking, where most studies just include smoking status. In addition, we found in this study that alongside the actual price it might be important to study perceived price. The mechanisms we identified can be measured by including moderating factors in survey data, such as perceived social norms, willingness to pay more for tobacco, difficulties in meeting other essential expenses, and other factors mentioned in the IARC evaluation framework.³

Qualitative studies can also provide thick evidence on the mechanisms, but in practice we found most qualitative studies were not aimed specifically at the effects of price/tax increases. They tended to focus on motivations, facilitators and barriers of smoking cessation in general. Although cost of tobacco was often mentioned as a motivator to quit, this does not provide evidence on mechanisms specific to tax/price increases. Future studies could assess in depth what the smokers did as a direct result of the price increase. For instance, did they perceive a change in the norms regarding smoking, in broader society or in their own social network? To what extent do smokers rationally judge the utility they gain from smoking, and when would this be outweighed by the cost being too high?

Conclusions
On the basis of a limited number of studies, we were able to develop a theoretical framework that will need to be further tested and refined. According to this framework, the rational balancing of costs and utility of smoking is the main driver of smoking cessation following price increases. An increase in expenditure on smoking displacing spending on essential household goods, and societal antismoking norms can also contribute to the effect of tax increases, but the evidence for these mechanisms was thin. Moreover, we found little evidence to support differential effects by SES, the substitution effect seems most valid for low SES smokers, but the other two mechanisms were fairly evenly supported for low and high SES smokers.

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We would like to thank Carolyn Ziegler, medical librarian at St. Michael's Hospital, Toronto, Canada for her invaluable assistance with building keyword search terms, searching electronic databases, and sorting the results.
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**Author contributions**

JRB and AEK conceived and designed the study, with critical feedback on the study design by CM and PO. JRB performed the screening of titles, abstracts and full texts, with random samples being screened for consistency by AEK, CM, MCW, and PO. Data extraction was led by JRB, with review by AEK and PO. JRB led the writing, and is the guarantor. AEK, CM, MCW, and PO interpreted the data and provided critical revisions. All authors have read and approved the final version of this paper.

**Conflicts of interest**

None declared.

**REFERENCES**


# Appendix Table 1: Proposed initial theoretical framework for the effect of tobacco taxes on smoking behaviour.

<table>
<thead>
<tr>
<th>Societal Context</th>
<th>Individual Context</th>
<th>Mechanism set in motion by tax increase</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic development</td>
<td>SES</td>
<td>Increased (perceived) price of tobacco, as a result of increased taxes, will change the opportunity cost for tobacco use, which means smokers might be unwilling or unable to pay this higher price.</td>
<td>Attempt to quit or cut down*</td>
</tr>
<tr>
<td>- Societal norms</td>
<td>- Age</td>
<td>2. Increased (perceived) price of tobacco, as a result of increased taxes, can change the use value of tobacco, as the social norm becomes more disapproving of smoking.</td>
<td>-- OR --</td>
</tr>
<tr>
<td>- Marketing and pricing</td>
<td>- Smoking attitudes and beliefs</td>
<td>3. Decreased affordability of tobacco, as a result of increased taxes, under unchanged smoking behaviour will lead to a substitution effect, where spending on tobacco displaces spending on other (essential) goods.</td>
<td>Successfully quit or cut down</td>
</tr>
<tr>
<td>- Illicit trade</td>
<td>- Level of addiction</td>
<td></td>
<td>-- OR --</td>
</tr>
<tr>
<td>- Tobacco control policies</td>
<td>- Self-efficacy</td>
<td></td>
<td>Switching</td>
</tr>
<tr>
<td>- Cessation support</td>
<td>- Social support</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: cutting down = the intentional reduction of the number of cigarettes smoked per day. SES = socio-economic status
Appendix Table 2 Search strategy: electronic databases searched and keywords used

<table>
<thead>
<tr>
<th>Database</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovid MEDLINE</td>
<td>1 exp Tobacco Products. 2 exp Tobacco. 3 1 or 2. 4 Taxes. 5 Commerce. 6 4 or 5. 7 3 and 6. 8 exp Tobacco Products/ec [Economics]. 9 Tobacco Industry/ec, li [Economics, Legislation &amp; Jurisprudence]. 10 ((price* or pricing or tax*) adj3 (tobacco or cigarette*)).mp. 11 8 or 9 or 10. 12 7 or 11. 13 exp &quot;Tobacco Use Cessation&quot;. 14 exp &quot;Tobacco Use&quot;/ec, ep, px, td [Economics, Epidemiology, Psychology, Trends]. 15 smoking onset.tw. 16 (stop* adj2 smok*).tw. 17 (quit* adj2 smok*).tw. 18 (cess* adj2 smok*).tw. 19 (cessat* adj2 smok*).tw. 20 (giv* up adj2 smok*).tw. 21 (reduce* adj2 smok*).tw. 22 (gave up adj2 smok*).tw. 23 (discontinue* adj2 smok*).tw. 24 (tobacco adj2 cessation).tw. 25 (smoking adj2 decline*).tw. 26 (smoking adj2 decrease*).tw. 27 smok* behavior*.tw. 28 smok* behavior*.tw. 29 smoke less.tw. 30 less smoking.tw. 31 cigarette demand.tw. 32 demand for cigarettes.tw. 33 smoking prevalence.tw. 34 cigarette consumption.tw. 35 tobacco consumption.tw. 36 ((Behavior* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 37 ((Behaviour* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 38 consumption of tobacco.tw. 39 (inequalit* adj2 smoking).tw. 40 (cut* down adj2 (smoking or cigarettes or tobacco)).tw. 41 smoking outcome*.tw. 42 smoking pattern*.tw. 43 smoking practice*.tw. 44 smoking intensity.tw. 45 smoking initiation.tw. 46 readiness to quit.tw. 47 intention to quit.tw. 48 ((illegal or illicit) adj2 (cigarette* or tobacco)).tw. 49 roll your own.tw. 50 ((substitut* or switch*) adj2 (cigarette* or tobacco)).tw. 51 or/1 - 50. 52 12 and 51. 53 limit 52 to yr=&quot;1980 -Current&quot;. 54 remove duplicates from 53.</td>
</tr>
<tr>
<td>Review databases</td>
<td>1 exp Tobacco Products. 2 exp Tobacco. 3 exp &quot;Tobacco Use Cessation&quot;. 4 exp &quot;Tobacco Use&quot;. 5 (tobacco or cigarette* or smoking or smoker*).ti. 6 or/1-5. 7 Taxes. 8 (price* or tax*).ti. 9 7 or 8. 10 6 and 9. 11 ((price* or pricing or tax*) adj3 (tobacco or cigarette* or smoking or smoker*)).ti,ab. 12 10 or 11. 13 remove duplicates from 12. 14 limit 13 to yr=&quot;1980 -Current&quot; [Limit not valid in DARE; records were retained].</td>
</tr>
<tr>
<td>CINAHL</td>
<td>S1 (MH &quot;Tobacco Products+/EC&quot;). S2 (MH &quot;Tobacco&quot;). S3 (MH &quot;Smoking&quot;). S4 (MH &quot;Smoking Cessation&quot;). S5 S1 OR S2 OR S3 OR S4. S6 (MH &quot;Taxes&quot;). S7 price or prices or pricing or tax or taxes or taxation. S8 S6 OR S7. S9 S5 AND S8. S10 (MH &quot;Tobacco Products+/EC&quot;). S11 S9 OR S10. Limiters - Published Date: 19800101-20151231. Exclude magazines.</td>
</tr>
</tbody>
</table>
### Appendix Table 2 Continued

<table>
<thead>
<tr>
<th>Database</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embase</td>
<td>1 exp tobacco. 2 tobacco industry. 3 1 or 2. 4 tax. 5 (price or prices or pricing).ti. 6 affordability.ti. 7 (cost or costs).ti. 8 tax*.ti. 9 or/4-8. 10 3 and 9. 11 economic aspect. 12 cost. 13 1 and (11 or 12). 14 10 or 13. 15 ((price* or pricing or tax*) adj3 (tobacco or cigarette* or smoking)).tw. 16 14 or 15. 17 exp &quot;tobacco use&quot;, 18 exp tobacco dependence. 19 exp smoking cessation. 20 smoking onset.tw. 21 (stop* adj2 smok*).tw. 22 (quit* adj2 smok*).tw. 23 (cess* adj2 smok*).tw. 24 (cessat* adj2 smok*).tw. 25 (giv* up adj2 smok*).tw. 26 (reduc* adj2 smok*).tw. 27 (gave up adj2 smok*).tw. 28 (discontinue* adj2 smok*).tw. 29 (tobacco adj2 cessation).tw. 30 (smoking adj2 decline*).tw. 31 (smoking adj2 decrease*).tw. 32 smok* behavior*.tw. 33 smok* behaviour*.tw. 34 smoke less.tw. 35 less smoking.tw. 36 cigarette demand.tw. 37 demand for cigarettes.tw. 38 smoking prevalence.tw. 39 cigarette consumption.tw. 40 tobacco consumption.tw. 41 ((Behavior* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 42 ((Behaviour* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 43 consumption of tobacco.tw. 44 (inequalit* adj2 smoking).tw. 45 (cut* down adj2 smoking or cigarettes or tobacco).tw. 46 smoking outcome*.tw. 47 smoking pattern*.tw. 48 smoking practice*.tw. 49 smoking intensity.tw. 50 smoking initiation.tw. 51 readiness to quit.tw. 52 intention to quit.tw. 53 (illegal or illicit) adj2 (cigarette* or tobacco).tw. 54 roll your own.tw. 55 ((substitut* or switch*) adj2 cigarette* or tobacco).tw. 56 or/17-55. 57 16 and 58 17-55. 58 57 to yr=&quot;1980 -Current&quot;. 59 remove duplicates from 58. 60 limit 59 to embase.</td>
</tr>
<tr>
<td>ProQuest Databases^2</td>
<td>Searched for: all(((price* OR pricing OR tax*) NEAR/3 (tobacco OR cigarette* OR smoking OR smoker*)) AND pd.</td>
</tr>
<tr>
<td>Web of Science Databases^3</td>
<td>TITLE: ((((price* OR pricing OR tax*) NEAR/3 (tobacco OR cigarette* OR smoking OR smoker*))))) Indexes=SSCI, CPCI-S, CPCI-SSH Timespan=1980-2015</td>
</tr>
<tr>
<td>Legacy Tobacco Documents Library</td>
<td>Limited to research. (title:(price* or tax*) AND type:(Report)) AND title:(smoking)</td>
</tr>
<tr>
<td>The Campbell Collaboration of Systematic Reviews</td>
<td>Title and keyword searches:Smoking or smoke* or cigarette* or tobacco</td>
</tr>
</tbody>
</table>
Appendix Table 2 Continued

<table>
<thead>
<tr>
<th>Database</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>PsycINFO</td>
<td>1 tobacco smoking. 2 smoking cessation. 3 1 or 2. 4 exp' Taxation. 5 &quot;costs and cost analysis&quot;/ or money. 6 (price or prices or pricing).ti. 7 affordability.ti. 8 tax*.ti. 9 or/4-8. 10 3 and 9. 11 ((price* or pricing or tax* or cost or costs) adj3 (tobacco or cigarette*)).tw. 12 smoking onset.tw. 13 (stop* adj2 smok*).tw. 14 (quit* adj2 smok*).tw. 15 (ceas* adj2 smok*).tw. 16 (cessat* adj2 smok*).tw. 17 (giv* up adj2 smok*).tw. 18 (reduce* adj2 smok*).tw. 19 (gave up adj2 smok*).tw. 20 (discontinue* adj2 smok*).tw. 21 (tobacco adj2 cessation).tw. 22 (smoking adj2 decline*).tw. 23 (smoking adj2 decrease*).tw. 24 smok* behavior*.tw. 25 smok* behaviour*.tw. 26 smoke less.tw. 27 less smoking.tw. 28 cigarette demand.tw. 29 demand for cigarettes.tw. 30 smoking prevalence.tw. 31 cigarette consumption.tw. 32 tobacco consumption.tw. 33 ((Behavior* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 34 ((Behaviour* adj3 chang*) and (smoking or smoker* or cigarette* or tobacco)).tw. 35 consumption of tobacco.tw. 36 (inequalit* adj2 smoking).tw. 37 (cut* down adj2 (smoking or cigarettes or tobacco)).tw. 38 smoking outcome*.tw. 39 smoking pattern*.tw. 40 smoking practice*.tw. 41 smoking intensity.tw. 42 smoking initiation.tw. 43 readiness to quit.tw. 44 intention to quit.tw. 45 ((illegal or illicit) adj2 (cigarette* or tobacco)).tw. 46 roll your own.tw. 47 ((substitut* or switch*) adj2 (cigarette* or tobacco)).tw. 48 or/12-47. 49 11 and 48. 50 10 or 49. 51 limit 50 to yr=&quot;1980 -Current&quot;.</td>
</tr>
</tbody>
</table>

1 Review databases included: EBM Reviews - Cochrane Database of Systematic Reviews; ACP Journal Club; EBM Reviews - Database of Abstracts of Reviews of Effects; EBM Reviews - Cochrane Central Register of Controlled Trials; EBM Reviews - Cochrane Methodology Register; EBM Reviews - Health Technology Assessment; EBM Reviews - NHS Economic Evaluation Database. 2 ProQuest databases included: Applied Social Sciences Index and Abstracts (ASSIA), EconLit, International Bibliography of the Social Sciences (IBSS), PAIS International, ProQuest Dissertations & Theses Global, Sociological Abstracts, Worldwide Political Science Abstracts. 3 Web of Science databases included: Social Sciences Citation Index (SSCI), Conference Proceedings Citation Index- Science (CPCI-S), Conference Proceedings Citation Index- Social Science & Humanities.