Tobacco Control

Was the implementation of standardised tobacco packaging legislation in England associated with changes in smoking prevalence? A segmented regression analysis between 2006 and 2019

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Dear Editor,

Thank you for the comments we have received on our manuscript. Below we have prepared our response to the reviewers' comments.

Best wishes,
Ilze Bogdanovica

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
Looking at the form of the questions asked to establish smoking presented here, I have a query about the STP survey on which this analysis is based.
'I smoke cigarettes (including hand-rolled) every day', 'I smoke cigarettes (including hand-rolled), but not every day', or 'I do not smoke cigarettes at all, but I do smoke tobacco of some kind (e.g. Pipe, cigar or shisha)'; and as a non-smoker (with the value '0') if they responded affirmatively to any of the statements 'I stopped smoking completely in the last year', 'I stopped smoking completely more than a year ago', or 'I have never been a smoker'.
(Apologies, I couldn't quickly find the information I was looking for on the Smoking Toolkit Project site, but) If this is not the exact wording of the questions, then it should be replaced with the exact wording. If it is the exact wording, then I wonder if some (even a small) proportion of cigarette smokers who smoke factory-made cigarettes but no hand-rolled tobacco (or who did use hand-rolled tobacco but not every day) may have misunderstood the intention of this question (which does appear to be ambiguously worded) and answered 'no'. Or, alternatively, dropped out of the survey not knowing how best to answer this question. We know from sales data that use of hand-rolled tobacco is increasing over time. If there *was* a problem of misunderstanding, then the proportion of cigarette smokers who mistakenly answered 'no' might be expected therefore to have declined over time, thus resulting in an artificial reduction in the magnitude of any downward trend in detected prevalence of 'any cigarette smoking'.
This may not be a concern for the overall validity of the Smoking Toolkit project, except perhaps in a period of particularly rapid change in use of handrolled tobacco. But in a study such as the one under review, small changes in prevalence month to month are critical and may be affected. Particularly so during a period when pouch and pack sizes simultaneously changed (with many brands becoming less affordable up front).

Thank you for your comment. We agree that any reporting errors arising from the possible misunderstanding described by the reviewer is likely to be very small. However, our previous analysis demonstrates that smoking prevalence estimates from the Smoking Toolkit Study (STS) tend to be slightly higher than those derived from other national surveys (please see comparison supplementary material provided to this manuscript), so it is unlikely that any misunderstanding of this questions leads to appreciable under-reporting. A validation study of the STS (Fidler et al, 2011) also clearly demonstrated that STS findings on smoking prevalence are generalisable to the adult population in England. We therefore have

no reason to suspect that the questions asked (as reported in the manuscript) do not adequately measure smoking prevalence among those smoking factory made or roll-your-own cigarettes.

Specific suggestions
INTRODUCTION
Page 4
Line 7, Please specify whether you are talking about daily, regular or current smoking and in what age range.

We have clarified that we are referring to current tobacco smoking:
"Over the past decade the prevalence of current tobacco smoking in England has been in sustained decline, falling from 19.8% in 2011 to 13.9%, or approximately 5.7 million smokers, in 2019 [1]."

Line 16
Close gap in 'one-year'
This has now been corrected

Line 17
Dark green? I thought the required colour was better described as 'drab dark brown'.
The colour is Pantone 448C. We have now described this as 'drab dark brown'

Line 26
Ref 5, In preference to the ASH UK information sheet, a more robust reference for the primary aim of the legislation is the Explanatory Memorandum associated with the regulations.
This is at
https://www.legislation.gov.uk/uksi/2015/829/pdfs/uksiem_20150829_en.pdf and states…
"A key aspect in deciding to introduce standardised packaging is the potential benefit for the health and wellbeing of young people."
It goes on to say…
"The objectives of a policy for standardised packaging include:
• discouraging people from starting to use tobacco products
• encouraging people to give up using tobacco products
• reducing the appeal or attractiveness of tobacco products, the misleading elements of packaging and the potential for packaging to detract from the effectiveness of health warnings
• having an effect on attitudes, beliefs, intentions and behaviours relating to the reduction in use of tobacco products"
Thank you- we have updated this reference as suggested

Page 5
Endo of Line 29 … to carry out 'a' not 'an'
This has now been corrected

Pages 6 to 8
The regression analysis is clearly described.
Thank you.
Page 13
The authors could reiterate that longer-term and more gradually evident effects of the policy on uptake and cessation might be expected in an environment of reduced attractiveness of packaging, clearer space for health warnings, and reduced capacity to mislead consumers about relative harm of different products. But that nevertheless this study – which was able to focus only on relatively immediate changes-- provides evidence of an appreciable drop in the prevalence of adult smoking as well.

As suggested we have made the following changes:
"In the long run, more pronounced effects on uptake of smoking and smoking cessation might be observed related to reduced appeal of packaging and more prominent health warnings. However, our analysis focusing on short to medium term effects provides clear evidence that these marked changes in packaging policy have had an appreciable beneficial effect on smoking prevalence in England."

Page 17
It would helpful to bold the terms May 2017 and May 2016 in the title of Table 1 (and July 2017 and July 2016) in Table 2 to help readers distinguish between the two sets of analysis.
We have made these changes as suggested

Reviewer: 2

Comments to the Author
First, I would like to congratulate the authors for the initiative to bring important results and analysis on the implementation of standardized packaging and its impact on the prevalence of smokers in England. The study presented is of paramount importance both for its findings and to counter the skewed results presented by the tobacco industry.
The limitation is so clear, and I think it does not interfere in the main results of this manuscript.
I have just two mainly comments:
1) The authors reinforce that these results refer only to England, however, it would be important to bring similar studies from other countries and their findings into the discussion. Or point that there are no publications on that in the world. In the final of discussion section, the authors present some studies, anyway from UK.

To our knowledge this is the first study investigating the effects of standardised packaging on the odds of being a smoker in England and the UK. We are aware of a study in Australia looking at the effects of standardised packaging on smoking which we have referenced. We have now clarified the limitation that we had explained in the discussion:

"Therefore, generalisability of the findings to other UK countries and elsewhere in the world is limited and further research exploring differences in the UK countries and globally is warranted. To our knowledge studies similar to this have not been carried out elsewhere."

2) On page 12 line 19 the authors say: "changes in the tobacco control market introduced by the tobacco industry in advance of plain packaging".

the tobacco industry in preparation to standardized packs".
It is not clear for me whether the industry has "prepared".
The introduction of a measure such as standardized tobacco packaging is commonly accompanied by a disclosure by the Government in printed and television media. Did this happen in England?
Did the tobacco industry or the Government run campaigns to publicize the adoption of the measure?
Did the industry use any mechanism, as has been seen in other countries to communicate changes in cigarette packaging through inserts or onserts?
Are the authors referring to the possibility of interference with other measures adopted concurrently, as minimum pack sizes and updated health warnings?
Or when the authors say that the tobacco industry has prepared, they mean that the plain packs began to appear on the UK market, and it could be the reason?
Anyway, I consider it important to clarify what kind of facts may have interfered, even if we are not completely sure. These are hypotheses that need to be raised in my opinion.
I totally agree that a "preparation" can really have an impact and generate a reflection for smokers, really motivating them to stop smoking. It just was not clear to me what took part of that preparation.

Thank you for your comment. We think it is difficult to say what specific measures used by the industry or otherwise contributed to the decision by smokers to quit or not start smoking. Our previous evidence suggests that when the discussion about Standardised Packaging and minimum pack size started the industry made major changes in the market by focusing on 11-19 cigarette packs and introducing new products (primarily from 2014 onwards) and thus minimised the reduction in smoking that would potentially have happened if such strategies wouldn't have been used (Opazo Breton, M., et al., *Cigarette brand diversity and price changes during the implementation of plain packaging in the United Kingdom.* Addiction, 2018. **113**(10): p. 1883-1894). However, once the ban on small packs and other measures included in Standardised packaging legislation and TPD were implemented, opportunities for industry to keep smokers into smoking were reduced. Also, there was considerable media coverage and discussion about the new legislative measures, which might have had an effect on smokers' decision to stop or not take up smoking. However, these are just our hypotheses. We have therefore clarified our statement in the discussion as much as possible:
"Within this study we were unable to investigate what the underlying reasons were though we hypothesize that smokers might have been aware of the policy due to media coverage and had consider what effect this specific policy might have on their smoking behaviour (costs, no brand loyalty, lack of appealing packaging)."

Besides that, I have just minor points to add. In the Section Methods on page 5 line 13 until 18, I consider that the sentences should be in the past (used, selected and were). I would like to suggest completing the sentence on page 9 line 53 "Hence, our results indicate that the level decrease in the odds of being a smoker was associated with the onset of standardized packaging in May 2016", just to be clearer.

Thank you for your suggestions. We have made these changes as advised.

Reviewer: 3

Comments to the Author
Abstract: Very well written, one point below is confusing. Is the analysis about quitting or a reduction in prevalence (quitting plus reduced uptake).
The findings section refers to a reduction in the odds of being a smoker, while the conclusions refer to quitting. From just having read the abstract, it is unclear if any reduced odds of being a smoker could also be due to prevention (reduction in smoking uptake). Please clarify in abstract whether design was to look at odds of being a smoker (cessation, or also any possible effect of reduction in uptake).

We have rephrased our conclusions in the abstract as follows and hope it is clearer now:

"This is the first independent study demonstrating that implementation of standardised packaging was associated with a reduction in smoking in England which occurred in anticipation of, rather than after, full policy implementation. It appears that the odds of being a smoker was affected by the prospect of the move to standardised packs and accompanying legislation."

Introduction: Very will written, clear and consie. One minor correction.
Standardised packaging only applies to cigarettes and roll your own in UK, unlike other countires. Clarify introduction statements which confuse this, e.g, at line 15-17 which state that tobacco products could only be sold. Tobacco products such as cigars, cigarillos, and waterpipe tobacco do not have to sold in standardised packaging in UK.

Thank you for noting this. We have now rephrased the sentence as follows:

"This legislation determined that after a one-year transition period to May 2017, manufactured cigarettes and roll-your-own tobacco products could be sold in England only if packaged in generic drab dark brown packs with brand names and a single descriptor presented in a standard font."

Methods: Problematic.

The methods section switches to using the term plain packaging, other parts of the paper use standardised tobacco packaging, and the abstract STP. Choose one term and use consistently.

We have now used the term 'standardised packaging' throughout the manuscript

The defintion of smoking in this analysis includes pipe, cigar, shisha. These products do not have to sold in standardised packaging in England. A sensitivity analysis should be run with this group removed.

We have now run the sensitivity analysis and explain the process in the methods:
"This question differs from the question used in other nationally representative surveys. Hence, two actions were taken as a precautionary measure. First, we compared quarterly trends in smoking prevalence from STS data to Annual Population Survey (APS), and second, we compared general monthly smoking prevalence in STS to that of different tobacco product users, such as manufactured cigarettes only, hand-rolled tobacco only, combined manufactured cigarettes and hand-rolled tobacco users, and other tobacco product users, which would include those using pipe cigar or cigarillos among others. These two comparisons can be found in Figure S1 and Figure S2 in the Online Supplementary Material and show that trends in STS were fairly similar for most quarters when compared to APS data and that most of the smoking prevalence figures refer to only manufactured cigarette and only hand-rolled tobacco users, which were the most affected by standardised packaging legislation."

Tobacco manufacturers upped their packaging design and the novelty of products such as cigarillos, adding flavour capsules etc. after standardised packaging was implemented. These produces are also excluded from several other regs, flavours, and pack size. Cigarillos in branded packs, with flavour capsules sold at sainsburys, https://www.sainsburys.co.uk/gol-ui/product/cigarettes/sterling-dual-capsule-leaf-wrapped
I would still included an analysis with cigar, pipe smokers included, as they are still smoking, and it is still a relevant test of the legislation, i.e., depsite the exception for these products, was the legislation effective.

Smoking Toolkit Data suggest that in England the prevalence of cigar smoking is less than 1% hence we have neither performed a separate analysis of this group of tobacco users nor included them in the current analysis due to the way the question we use to determine smoking status is phrased.

Everything else looks good, congratulations to the authors, well written, clear, concise.
Thank you

Discussion

Perhaps offer some clarification here on the point in the abstract, cessation, uptake, reduced odds of smoking etc.

As in this study we used Smoking Toolkit Study data, which is a repeated cross sectional and not a panel dataset, we were unable to measure exact quitting. In the discussion we have tried to provide possible explanations for our findings and suggested some hypotheses, and

that includes potential changes in quitting behaviour and maybe uptake. We propose to do further work to understand details of changes in quitting and uptake and such work is currently underway:

"In this study we were unable to determine whether the reduction in odds of smoking occurred due to changes in quitting or smoking uptake though detailed analysis of each of these aspects is necessary in further research."

Was the implementation of standardised tobacco packaging legislation in England associated with changes in smoking prevalence? A segmented regression analysis between 2006 and 2019

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Running head: Standardised packaging and smoking prevalence

Word count: 3,420 words

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Keywords: smoking, prevalence, standardized packaging

ABSTRACT

Background and aim: In 2016 England initiated the implementation of standardised tobacco packaging, introduced in conjunction with minimum pack sizes and other measures included in the 2014 European Tobacco Products Directive, over the course of a one-year sell-off period ending in May 2017. These measures have been shown to have been associated with increases in tobacco prices and product diversity. We now investigate the association between implementation of the new legislation and smoking status in England.

Design: Segmented regression analysis of repeated cross-sectional surveys using a GLM model with individual-level data to test for a change in trend and immediate step change.

Setting: England.

Participants: Participants in the Smoking Toolkit Study, which involves repeated, cross-sectional household surveys of individuals aged 16 years and older in England. The sample included 278,219 individual observations collected between November 2006 and December 2019.

Intervention: Implementation of standardised packaging legislation (May 2016 and May 2017).

Measurements: Individual level current smoking status adjusted for implementation of tobacco control policies, cigarette price, seasonality and autocorrelation.

Findings: The implementation of standardised packaging was associated with a significant step reduction in the odds of being a smoker after May 2017 (Odds Ratio (OR) 0.93; 95% Confidence Interval (CI) 0.87 to 0.99). The magnitude of the association was similar when modelling the step change in May 2016 at the start of the one-year policy implementation period (OR 0.90; 95% CI: 0.83 to 0.97).

Conclusions: This is the first independent study demonstrating that implementation of standardised packaging was associated with a reduction in smoking in England which occurred in anticipation of, rather than after, full policy implementation. It appears that the odds of being a smoker was affected by the prospect of the move to standardised packs and accompanying legislation.

INTRODUCTION

Over the past decade the prevalence of current tobacco smoking in England has been in sustained decline, falling from 19.8% in 2011 to 13.9%, or approximately 5.7 million smokers, in 2019 [1]. This reduction in prevalence has been particularly marked among children and young adults [1, 2] and those in higher socio-economic groups [1], and has been achieved by a range of tobacco control policies implemented by the UK government over the past two decades, the most recent of which was the introduction of standardised packaging legislation in May 2016 [3]. This legislation determined that after a one-year transition period to May 2017, manufactured cigarettes and roll-your-own tobacco products could be sold in England only if packaged in generic drab dark brown packs with brand names and a single descriptor presented in a standard font. These requirements were implemented alongside the 2014 European Tobacco Products Directive, which among other measures mandated minimum pack sizes and larger pictorial health warnings [4].

The primary aim of the standardised packaging legislation was to make smoking less appealing to and discourage smoking uptake among young people [5], but there is evidence that standardised packaging legislation might also reduce the prevalence of smoking among adults [6, 7]. Evidence from Australia, which in 2012 became the first country to introduce standardised packaging, suggests that implementation led to an increase in quitline calls [8] and increased the rate of decline in smoking prevalence [9]. Research on the introduction of standardised packaging in England has demonstrated that implementation has been associated with considerable increases in the price of tobacco products, switching to less expensive tobacco products and increased use of e-cigarettes among smokers [10-13]. However, the effect of standardised packaging on smoking prevalence in England has not yet been explored by researchers independent of the tobacco industry's funding. In 2018 Tobacco Manufacturers' Association published analysis using Smoking Toolkit Study (STS) data suggesting that implementation of standardised packaging was associated with an increase in smoking prevalence [14]. However, the data analysis was based on a very basic comparison of three months rolling average with the data from the same time period in the previous year. The analysis was considerably underpowered and did not consider any potential confounders. The aim of this study was therefore 1) to investigate the effect of the introduction of standardised packaging on smoking prevalence by estimating step and trend changes in individual current smoking status after the policy was implemented in England, and aggregating these results to estimate changes in smoking prevalence; 2) to explore whether differences in step and trend

changes were observed in different population subgroups defined by age, sex and socio-economic status.

METHODS

Data sources and research design

We used data from Smoking Toolkit Study (STS), a monthly interview-based household survey of smoking status in representative samples of ~1,700 adults aged 16 and over in England that has collected data since 2006 [15]. The survey used a random location sampling design to select grouped output areas (~300 households) stratified by socio-demographic characteristics, while interviewers selected households within areas based on quotas targeted to the characteristics of the output area. Face-to-face computer-assisted interviews were then carried out with one household member. More details about the methods and the data can be found elsewhere [16-19]. Comparisons to other national surveys suggests the design produces a sample of the population in England representative of key demographic variables, smoking prevalence, and cigarette consumption [15].

We used individual-level data from November 2006 to December 2019 to carry out a segmented regression analysis to study level and post-slope changes [20, 21] in current smoking status after the implementation of the standardised packaging policy in England, using a before and after approach [21, 22]. Our analysis first explored effects before and after May 2017, the end of the one-year implementation period, as the main implementation point, and then before and after May 2016 and explored effects after the start of that implementation period. To check the robustness of our results, we performed a sensitivity analysis using implementation dates based on the proportion of tobacco sales in standardised packs, derived from Nielsen sales data, as a marker of the extent to which standardised packaging had been implemented during the implantation period [11]. These indicated that standardised packs began to appear on the UK market in July 2016 [11], and that sales of branded packs probably did not end until July 2017 [11, 13].

Measures

Outcome variable

The outcome variable was current smoking status. All participants from STS were classified as current smokers (with the value '1') if they responded affirmatively to any of the statements

‘I smoke cigarettes (including hand-rolled) every day’, ‘I smoke cigarettes (including hand-rolled), but not every day’, or ‘I do not smoke cigarettes at all, but I do smoke tobacco of some kind (e.g. Pipe, cigar or shisha)’; and as a non-smoker (with the value ‘0’) if they responded affirmatively to any of the statements ‘I stopped smoking completely in the last year’, ‘I stopped smoking completely more than a year ago’, or ‘I have never been a smoker’. This question differs from the question used in other nationally representative surveys. Hence, two actions were taken as a precautionary measure. First, we compared quarterly trends in smoking prevalence from STS data to Annual Population Survey (APS), and second, we compared general monthly smoking prevalence in STS to that of different tobacco product users, such as manufactured cigarettes only, hand-rolled tobacco only, combined manufactured cigarettes and hand-rolled tobacco users, and other tobacco product users, which would include those using pipe cigar or cigarillos among others. These two comparisons can be found in Figure S1 and Figure S2 in the Online Supplementary Material and show that trends in STS were fairly similar for most quarters when compared to APS data and that most of the smoking prevalence figures refer to only manufactured cigarette and only hand-rolled tobacco users, which were the most affected by standardised packaging legislation.

Segmented regression analysis variables

For our analysis after full implementation of the policy we created a level variable that took the value ‘0’ for all observations from months up to and including May 2017 (before), and the value ‘1’ for all observations after May 2017 (after). For our analysis after the policy start date we added a before and after variable for May 2016, while our sensitivity analysis studied level changes using July 2016 and July 2017 as the start and full implementation dates. We also created a slope variable (post intervention) with values between zero and one that increases in equal amounts each month after full implementation up to eighteen months to study changes in smoking status trend after full policy implementation (post-slope after May 2017 and post-slope after July 2017 in our sensitivity analysis). An equivalent slope variable was created for the implementation period (between May 2016 and May 2017) as well as for the period between July 2016 and July 2017. In addition to the level and post intervention slope variables, the model included a linear time-trend variable with equally increasing values starting in the first month of the data until the last month of our study period [23].

Subgroup analysis by age and socio-economic status

We studied changes in the likelihood of being a current smoker among six population subgroups defined by sex (males and females), age (individuals aged 16-25 and those above 25 years of age) and socioeconomic status (routine and manual occupations vs non-routine occupations).

Control for the effects of other tobacco control policies

During our study data period the following tobacco control policies were implemented: smoke-free public places legislation in July 2007, an increase in the minimum age of sale from 16 to 18 years in October 2007, and a ban on point of sale displays which applied to large shops from April 2012 and small shops from April 2015. We created a dummy variable for each of these policies which assigned the value '0' for all months up to and including the implementation month, and the value '1' for all subsequent months. To adjust for the effects of tobacco tax and other price rises [24-28] we used the average monthly price for a 20 cigarette pack [29], adjusted for inflation using the Consumer Price Index (CPI) [30].

Seasonality and autocorrelation

Two additional variables were included to adjust our models: seasonality and autocorrelation. Regarding the first, evidence suggests that smoking has a seasonal pattern [31, 32]. Hence, we used a categorical 'month of the year variable' to account for possible differences in smoking status specific to the month of the year in which the survey took place. For autocorrelation, as we were using individual level data to estimate grouped policy effects we used robust standard errors and created a variable with lagged values (one lag) of smoking prevalence (general population smoking prevalence and subgroup smoking prevalence to use accordingly) [33].

Statistical analysis

We initially plotted aggregated monthly trends in current smoking prevalence in the general population and in the subgroups defined by sex, age and socioeconomic status using weighted STS data from November 2006 to December 2019 to illustrate overall prevalence trends for the population in England [15]. We compared smoking prevalence during the year the policy was implemented to the year before using a t-test to have a simple estimate of difference in prevalence before and after policy implementation.

We then used a generalized linear model (GLM) to estimate changes in level and slope of the likelihood of being a smoker after implementation of the standardised packaging policy using individual level data on a binary smoking status variable. We did not use survey weights for this analysis, but we performed the same analysis using quarterly data from Annual Population Survey (2010-2019) and run the general population analysis for different types of tobacco users in order to check the robustness of our results. The results from these two analyses can be found in Table S1 and Table S2 in the Supplementary Material. Our GLM models were defined using binomial family and logit link to estimate odds ratio (OR) and 95% confidence intervals for each of the variables included in the regression. Only results for level (before/after) and slope (implementation period and 18 months after implementation) were reported here, while full list of results for the main analyses can be found in the Online Supplementary Material (Table S4 to Table S11). We used robust standard errors, and adjustments by seasonality and autocorrelation since we estimated aggregate before/after and slope effects.

We estimated unadjusted models, which only included seasonality and autocorrelation, and adjusted models, which added other tobacco control policies implemented during the period 2006-2019 (smoking ban, change in minimum age of sale, and tobacco display ban in small and large shops), as well as our monthly average retail price variable. We first estimated the model exploring changes after May 2017, the full implementation date (level and post intervention slope). We then added May 2016, the start of policy implementation period, and explored level changes for before/after May 2016, the slope for the implementation period (slope May 2016-May 2017), level changes before/after May 2017, and post intervention slope 18 months after May 2017.

We estimated changes in level and slope among population subgroups by running the same models described for each population subgroup (the four model specifications six times), in order to study each group's smoking status separately. Interaction effects by subgroup were also investigated for the main analysis. These results can be found in the Online Supplementary Material (Table S3).

We performed a sensitivity analysis using the same models described above but exploring level and slope changes before/after July 2017, and before/after July 2016. Using July 2017 instead of May 2017 also allowed us to disentangle policy effects from any tax effect that were not

captured in our price variable, since in 2017 there were changes in tobacco taxes in March, May and November.

Finally, we plotted the linear predictions of our model for the whole sample of England against a counterfactual prediction reflecting the hypothetical situation 'if the policy was not in place' to visually compare smoking prevalence trends with and without (counterfactual) standardised packaging policy. To obtain the standardised packaging policy predicted trends we ran our unadjusted models, removing adjustments by seasonality to compute linear trends. To obtain the counterfactual predicted trend we estimated our GLM model only including a time-trend variable and limited the regression to the period before full implementation (May 2017), and to the period before implementation start date (May 2016). Then, we aggregated individual level predicted values from the unadjusted models, and from the counterfactual model to generate scatter plots of smoking prevalence combined with line graphs for the linear predictions. We performed all analyses in Stata 16.0, and the confidence level was set to 95%.

RESULTS

Our sample included 278,219 individual observations collected between November 2006 and December 2019, of which 48.6% were from males and 51.5% from females, 15.8% from persons aged up to 25 years and 84.2% above 25 years old, while 40.3% were classified as manual workers and 59.7% as non-manual workers.

Figure 1 here

There was a secular downward trend in smoking prevalence throughout the study period for the general population of England (Figure 1a). During the standardised packaging policy implementation period (May 2016 to May 2017) the prevalence of smoking was on average 17.9% (95% CI: 17.2 to 18.6%), while it was 19.2% (95% CI: 18.6 to 19.9%) in the year before the policy was implemented. Trends within age, sex and socioeconomic subgroups were similar to those in the total population, though among those aged 16-25, the prevalence of smoking declined rapidly from November 2006 until May 2012, then remained at around 24.9% (95% CI: 24.2% to 25.7%) until May 2016, declined to an average of 22.5% (95% CI: 21.1% to 23.8%) between May 2016 and May 2017, and then after a brief increase again assumed a decreasing trend (Figure 1c).

Regression results

Our model before and after full implementation demonstrated a statistically significant level decrease in the odds of being a smoker after May 2017 (adjusted OR 0.93; 95% CI: 0.87 to 0.99) with no statistically significant change in post intervention slope. However, when May 2016 was included in the model (before/after policy start date), the observed level decrease in the odds of being a smoker was similar to the analysis after full implementation in both the unadjusted (OR 0.91; 95% CI: 0.85 to 0.98) and adjusted models (OR 0.90; 95% CI: 0.83 to 0.97), again with no significant change in post intervention slope. Hence, our results indicate that the level decrease in the odds of being a smoker was associated with the onset of standardized packaging in May 2016, and not the full implementation of, standardised packaging and other TPD measures.

Table 1 here

Our subgroup analyses explored each population subgroup's smoking status and showed statistically significant step changes for females, males, those aged over 25 years old and manual occupations. For females there was a significant level decrease after May 2016 (adjusted OR: 0.89; 95% CI: 0.79 to 1.00), which was also observed among males (unadjusted OR 0.89; 95% CI: 0.80 to 0.98). Males also showed a statistically significant level decrease in our model exploring effects before/after May 2017 (unadjusted OR: 0.92; 95% CI: 0.85 to 1.00; adjusted OR: 0.90; 95% CI: 0.83 to 0.98). For population aged over 25 years old there was a significant level decrease after May 2017 in our model exploring effects before/after full implementation (unadjusted OR 0.92; 95% CI: 0.87 to 0.98; and adjusted OR 0.90; 95% CI: 0.84 to 0.96) and after May 2016 (unadjusted OR 0.90; 95% CI: 0.83 to 0.98; and adjusted OR 0.90; 95% CI: 0.82 to 0.98) in our model exploring effects before/after the policy start date. Finally, there was a significant decrease after May 2016 for manual occupations in our model exploring effects after the policy start date (adjusted OR: OR 0.85; 95% CI: 0.75 to 0.96). The only increase in the odds of being a smoker was observed among population aged 25 years old or younger after May 2017 in our model exploring effects before/after the policy start date (adjusted OR: 1.29; 95% CI: 1.03 to 1.62).

Sensitivity analysis

Our sensitivity analysis of step and trend changes between July 2016 and July 2017 (Table 2) was consistent with our two models for the general population of England with similar step changes observed at both the beginning and end of the policy implementation period, though only statistically significant after May 2016 (unadjusted OR: 0.93; 95% CI: 0.86 to 1.00; adjusted OR: 0.92; 95% CI: 0.85 to 0.99).

Subgroup results in our sensitivity analyses differed in that the only step decreases observed were among males after May 2016 in our model exploring effects after the policy start date (unadjusted OR: 0.89; 95% CI: 0.80 to 0.98), among population aged over 25 years old after May 2016 in our model exploring effects after full implementation (adjusted OR: 0.93; 95% CI: 0.87 to 0.99) and among manual occupations after May 2016 in our model exploring effects after the policy start date (adjusted OR: 0.85; 95% CI: 0.75 to 0.96), and in that there was a decreasing trend observed between July 2016 and July 2017 among non-manual occupations (adjusted OR 0.79; 95% CI: 0.64 to 0.97).

Table 2 here

Model predictions

Figure 2 shows predictions of smoking prevalence obtained from the unadjusted model, excluding autocorrelation and seasonality, allowing us to explore linear changes before and after the implementation of standardised packaging. The two models show that there was a step decrease in prevalence and no significant change in trends eighteen months after full implementation –in line with our regression results. Moreover, both the predictions from our models after full implementation and after the policy start date show no complete return to the pre-policy level of smoking prevalence, and a larger difference between the counterfactual trend and the predicted trend when the model accounts for the start of the implementation date (May 2016) in Figure 2b.

DISCUSSION

To our knowledge, this is the first study evaluating the possible impact of standardised packaging on smoking prevalence in England. Our individual level findings found that the implementation of standardised packaging legislation was associated with a step decrease in the odds of being a smoker which was associated with the onset of standardised packaging after May 2016, when the transition to the new policy officially began, rather than May 2017 when the policy was fully implemented. Insofar that the association reflected a causal impact, the suggestion is that smokers were influenced more by the prospect of standardised packs, and possibly also of minimum pack sizes and other TPD measures, or of changes in the tobacco market introduced by the tobacco industry in advance of standardised packaging, than the actual adoption of standardised packaging. Within this study we were unable to investigate what the underlying reasons were though we hypothesize that smokers might have been aware of the policy due to media coverage and had consider what effect this specific policy might have on their smoking behaviour (costs, no brand loyalty, lack of appealing packaging). We found no strong evidence in our subgroup analyses that this effect differed markedly between the sexes, between older and younger smokers, or those of high or low occupational socioeconomic status.

The main limitation of our study was that we were only able to include policy implementation as May 2016 and May 2017 though the policy was gradually implemented over nine months of the one-year transition period [11], and our model did not account for that. The standardised packaging policy was actually implemented across the UK but the results of this study were based on individual level data from a large sample representative to population in England only. Therefore, generalisability of the findings to other UK countries and elsewhere in the world is limited and further research exploring differences in the UK countries and globally is warranted. To our knowledge studies similar to this have not been carried out elsewhere. Also, time series analysis using ARIMA models at the aggregated level would be more suitable for assessing the effect of policy on smoking prevalence though at the time of analysis the power was too low to produce such analysis. Therefore, we will use aggregated level data to evaluate longer term effects.

Although UK law did not require tobacco manufacturers to adopt standardised packaging simultaneously with minimum pack sizes, updated health warnings and other measures, in practice the changes were introduced simultaneously within individual cigarette brands. Consequently, we were unable to determine the effect of each of these policy elements

separately. However the findings of our study, which used individual level data and estimated odds of being a smokers in various population groups instead of measuring the effect of policy on aggregated prevalence data, are consistent with previous research [7-9] and provide further evidence that standardised packaging, or at least the prospect of standardised packaging, influences smoking status. In this study we were unable to determine whether the reduction in odds of smoking occurred due to changes in quitting or smoking uptake though detailed analysis of each of these aspects is necessary in further research.

A possible explanation for this is that prospect of standardised packs proved to be a stimulus for smokers intending to quit smoking to act on that intention, rather than a direct visual effect of the pack itself. We have previously described substantive changes in the diversity of products available on the market both in advance of and after standard packs appeared in the UK [11] and described substantial price increases with the adoption of standardised packaging [11, 13]. These included the introduction of, and widespread consumption of, low price cigarettes in packs of less than 20 in advance of the change to standardised packaging [11]. Whether any of these changes, introduced by the tobacco industry in preparation to standardised packs and the loss of distinctive branding and brand descriptors contributed to the step change in smoking prevalence when the law mandating the change to standardised packs came into force is not known and will be difficult to determine. The fact remains however that standardised packaging occurred in the UK in conjunction with a wide range of other legislative and market changes, so the precise contribution of standardised packs *per se* to the reduction in smoking prevalence we observed is impossible to determine.

In the long run, more pronounced effects on uptake of smoking and smoking cessation might be observed related to reduced appeal of packaging and more prominent health warnings. However, our analysis focusing on short to medium term effects provides clear evidence that these marked changes in packaging policy have had an appreciable beneficial effect on smoking prevalence in England.

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Table 1: Regression results for level and slope changes in the odds of being a smoker after full implementation of standardised packaging in **May 2017** (before/after full implementation) and accounting for standardised packaging start date in **May 2016** (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	Before/after full implementation		**Before/after policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
a. General population				
Level after May 2016			**0.91**	**0.90**
			(0.018)	(0.009)
			0.85 - 0.98	0.83 - 0.97
Slope May 2016-May 2017			1.02	0.96
			(0.728)	(0.578)
			0.90 - 1.17	0.84 - 1.10
Level after May 2017	0.95	**0.93**	0.99	1.00
	(0.073)	(0.015)	(0.813)	(0.975)
	0.90 - 1.00	0.87 - 0.99	0.90 - 1.09	0.91 - 1.10
Post-slope 18 months after May 2017	1.02	1.00	1.02	1.00
	(0.474)	(0.892)	(0.591)	(0.940)
	0.96 - 1.10	0.94 - 1.08	0.95 - 1.09	0.93 - 1.07
Observations	276,416	276,416	276,416	276,416
b. Females only subgroup				
Level after May 2016			0.95	**0.89**
			(0.342)	(0.046)
			0.85 - 1.06	0.79 - 1.00
Slope May 2016-May 2017			1.08	1.08
			(0.438)	(0.430)
			0.89 - 1.30	0.89 - 1.32
Level after May 2017	0.99	0.97	0.96	0.97
	(0.802)	(0.480)	(0.572)	(0.617)
	0.91 - 1.07	0.89 - 1.06	0.84 - 1.10	0.84 - 1.11
Post-slope 18 months after May 2017	0.98	0.97	0.98	0.96
	(0.640)	(0.522)	(0.636)	(0.459)
	0.89 - 1.08	0.87 - 1.07	0.89 - 1.08	0.87 - 1.07
Observations	142,107	142,107	142,107	142,107
c. Males only subgroup				
Level after May 2016			**0.89**	0.91
			(0.022)	(0.083)
			0.80 - 0.98	0.81 - 1.01
Slope May 2016-May 2017			1.00	0.88
			(0.969)	(0.204)
			0.83 - 1.20	0.73 - 1.07
Level after May 2017	**0.92**	**0.90**	1.01	1.03
	(0.046)	(0.013)	(0.932)	(0.706)
	0.85 - 1.00	0.83 - 0.98	0.88 - 1.15	0.90 - 1.18
Post-slope 18 months after May 2017	1.07	1.04	1.05	1.03
	(0.176)	(0.444)	(0.262)	(0.556)
	0.97 - 1.17	0.94 - 1.15	0.96 - 1.16	0.93 - 1.14
Observations	134,254	134,254	134,254	134,254
d. Population aged 18 to 25 years old only subgroup				
Level after May 2016			1.02	0.95
			(0.842)	(0.541)
			0.86 - 1.21	0.79 - 1.13

Slope May 2016-May 2017			0.87	0.84
			(0.377)	(0.277)
			0.64 - 1.18	0.61 - 1.15
Level after May 2017	1.12	1.10	1.25	**1.29**
	(0.078)	(0.183)	(0.052)	(0.028)
	0.99 - 1.28	0.96 - 1.27	1.00 - 1.57	1.03 - 1.62
Post-slope 18 months after May 2017	0.87	0.87	0.87	0.86
	(0.088)	(0.088)	(0.074)	(0.068)
	0.75 - 1.02	0.73 - 1.02	0.74 - 1.01	0.72 - 1.01
Observations	43,729	43,729	43,729	43,729
e. Population over 25 years old only subgroup				
Level after May 2016			**0.90**	**0.90**
			(0.014)	(0.016)
			0.83 - 0.98	0.82 - 0.98
Slope May 2016-May 2017			1.07	1.00
			(0.386)	(0.976)
			0.92 - 1.23	0.86 - 1.17
Level after May 2017	**0.92**	**0.90**	0.94	0.94
	(0.013)	(0.002)	(0.228)	(0.283)
	0.87 - 0.98	0.84 - 0.96	0.84 - 1.04	0.85 - 1.05
Post-slope 18 months after May 2017	1.06	1.04	1.06	1.04
	(0.109)	(0.304)	(0.147)	(0.382)
	0.99 - 1.15	0.96 - 1.13	0.98 - 1.14	0.96 - 1.12
Observations	232,687	232,687	232,687	232,687
f. Routine and manual occupations only subgroup				
Level after May 2016			0.89	**0.83**
			(0.065)	(0.004)
			0.79 - 1.01	0.73 - 0.94
Slope May 2016-May 2017			1.08	1.11
			(0.499)	(0.361)
			0.87 - 1.33	0.89 - 1.38
Level after May 2017	1.07	1.07	1.08	1.09
	(0.149)	(0.171)	(0.315)	(0.289)
	0.98 - 1.17	0.97 - 1.18	0.93 - 1.27	0.93 - 1.27
Post-slope 18 months after May 2017	1.02	1.00	1.01	1.00
	(0.721)	(0.939)	(0.798)	(0.948)
	0.91 - 1.14	0.89 - 1.13	0.91 - 1.13	0.89 - 1.12
Observations	95,770	95,770	95,770	95,770
g. Non-routine occupations only subgroup				
Level after May 2016			1.03	1.00
			(0.578)	(0.961)
			0.92 - 1.16	0.89 - 1.13
Slope May 2016-May 2017			0.99	0.93
			(0.942)	(0.457)
			0.82 - 1.21	0.75 - 1.13
Level after May 2017	0.98	0.94	0.97	0.99
	(0.669)	(0.149)	(0.666)	(0.846)
	0.90 - 1.07	0.85 - 1.02	0.84 - 1.12	0.85 - 1.14
Post-slope 18 months after May 2017	1.00	0.96	1.00	0.96
	(0.999)	(0.453)	(0.973)	(0.435)
	0.91 - 1.10	0.86 - 1.07	0.91 - 1.11	0.86 - 1.07
Observations	141,844	141,844	141,844	141,844

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05). Unadjusted model includes adjustment by seasonality and serial correlation, while the adjusted model incudes other tobacco control policies implemented during the period studied and monthly average real retail price, in addition to seasonality and serial correlation.

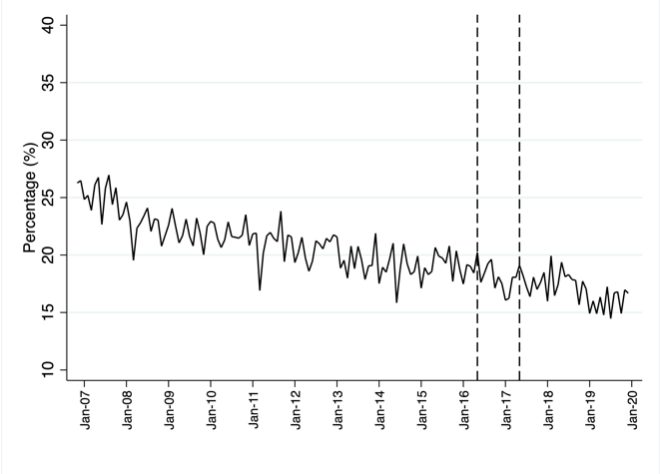
Table 2: Regression results for level and slope changes in the odds of being a smoker after full implementation of standardised packaging using **July 2017** (before/after full implementation) and accounting for standardised packaging start date using **July 2016** (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	Before/after full implementation		**Before/after policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
a. General Population				
Level after July 2016			**0.93**	**0.92**
			(0.042)	(0.027)
			0.86 - 1.00	0.85 - 0.99
Slope July 2016-July 2017			1.01	0.95
			(0.878)	(0.445)
			0.89 - 1.15	0.82 - 1.09
Level after July 2017	0.96	0.94	1.00	1.02
	(0.165)	(0.054)	(0.956)	(0.664)
	0.91 - 1.02	0.89 - 1.00	0.91 - 1.10	0.93 - 1.13
Post-slope 18 months after July 2017	1.01	0.99	1.01	0.99
	(0.679)	(0.836)	(0.793)	(0.738)
	0.95 - 1.09	0.92 - 1.07	0.94 - 1.08	0.92 - 1.06
Observations	276,416	276,416	276,416	276,416
b. Females only subgroup				
Level after July 2016			0.98	0.93
			(0.768)	(0.239)
			0.89 - 1.09	0.83 - 1.05
Slope July 2016-July 2017			1.05	1.06
			(0.645)	(0.598)
			0.87 - 1.26	0.86 - 1.29
Level after July 2017	0.97	0.95	0.95	0.94
	(0.511)	(0.242)	(0.443)	(0.408)
	0.90 - 1.06	0.87 - 1.04	0.82 - 1.09	0.82 - 1.08
Post-slope 18 months after July 2017	0.99	0.98	0.99	0.98
	(0.854)	(0.748)	(0.866)	(0.719)
	0.90 - 1.09	0.88 - 1.09	0.90 - 1.10	0.88 - 1.09
Observations	142,107	142,107	142,107	142,107
c. Males only subgroup				
Level after July 2016			**0.89**	0.90
			(0.020)	(0.070)
			0.80 - 0.98	0.81 - 1.01
Slope July 2016-July 2017			0.99	0.87
			(0.917)	(0.152)
			0.82 - 1.19	0.71 - 1.05
Level after July 2017	0.96	0.94	1.05	1.10
	(0.264)	(0.155)	(0.490)	(0.197)
	0.88 - 1.03	0.87 - 1.02	0.92 - 1.20	0.95 - 1.26
Post-slope 18 months after July 2017	1.04	1.00	1.02	0.99
	(0.479)	(0.957)	(0.628)	(0.903)
	0.94 - 1.14	0.91 - 1.11	0.93 - 1.13	0.90 - 1.10
Observations	134,254	134,254	134,254	134,254
d. Population aged 18 to 25 years old only subgroup				
Level after July 2016			0.93	0.85
			(0.393)	(0.084)
			0.78 - 1.10	0.71 - 1.02

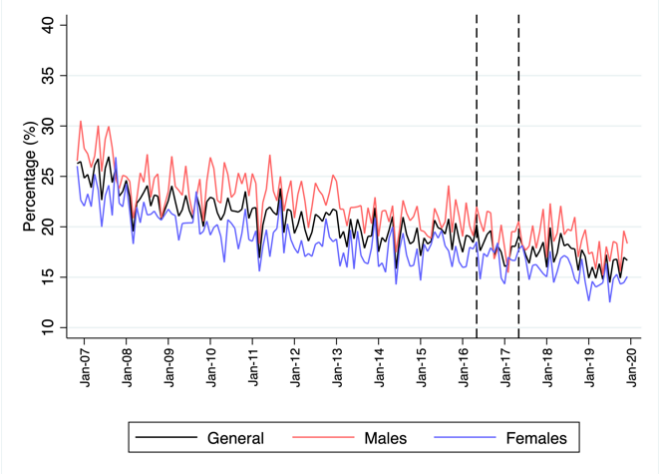
Slope July 2016-July 2017			1.10	1.11
			(0.553)	(0.533)
			0.81 - 1.50	0.80 - 1.54
Level after July 2017	1.09	1.06	1.06	1.06
	(0.211)	(0.441)	(0.639)	(0.614)
	0.95 - 1.24	0.92 - 1.21	0.84 - 1.32	0.85 - 1.33
Post-slope 18 months after July 2017	0.89	0.89	0.89	0.88
	(0.169)	(0.171)	(0.162)	(0.140)
	0.76 - 1.05	0.75 - 1.05	0.76 - 1.05	0.74 - 1.04
Observations	43,729	43,729	43,729	43,729
e. Population over 25 years old only subgroup				
Level after July 2016			0.94	0.94
			(0.124)	(0.174)
			0.86 - 1.02	0.86 - 1.03
Slope July 2016-July 2017			0.99	0.92
			(0.919)	(0.277)
			0.86 - 1.15	0.79 - 1.07
Level after July 2017	0.94	**0.93**	0.99	1.01
	(0.071)	(0.025)	(0.886)	(0.809)
	0.89 - 1.00	0.87 - 0.99	0.89 - 1.10	0.91 - 1.13
Post-slope 18 months after July 2017	1.04	1.02	1.04	1.02
	(0.269)	(0.630)	(0.338)	(0.687)
	0.97 - 1.13	0.94 - 1.11	0.96 - 1.12	0.94 - 1.10
Observations	232,687	232,687	232,687	232,687
f. Routine and manual occupations only subgroup				
Level after July 2016			0.91	**0.85**
			(0.106)	(0.011)
			0.80 - 1.02	0.75 - 0.96
Slope July 2016-July 2017			1.14	1.19
			(0.243)	(0.129)
			0.92 - 1.41	0.95 - 1.49
Level after July 2017	1.07	1.07	1.03	1.02
	(0.146)	(0.185)	(0.747)	(0.818)
	0.98 - 1.17	0.97 - 1.18	0.88 - 1.20	0.87 - 1.19
Post-slope 18 months after July 2017	1.01	1.00	1.01	0.99
	(0.832)	(0.953)	(0.854)	(0.887)
	0.90 - 1.13	0.89 - 1.12	0.90 - 1.13	0.88 - 1.12
Observations	95,770	95,770	95,770	95,770
g. Non-routine occupations only subgroup				
Level after July 2016			1.09	1.07
			(0.147)	(0.265)
			0.97 - 1.22	0.95 - 1.21
Slope July 2016-July 2017			0.87	**0.79**
			(0.159)	(0.026)
			0.71 - 1.06	0.64 - 0.97
Level after July 2017	1.01	0.97	1.08	1.12
	(0.783)	(0.507)	(0.281)	(0.140)
	0.93 - 1.10	0.89 - 1.06	0.94 - 1.25	0.96 - 1.29
Post-slope 18 months after July 2017	0.97	0.93	0.97	0.93
	(0.556)	(0.187)	(0.534)	(0.178)
	0.88 - 1.07	0.83 - 1.04	0.87 - 1.07	0.83 - 1.03
Observations	141,844	141,844	141,844	141,844

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05). Unadjusted model includes adjustment by seasonality and serial correlation, while the adjusted model incudes other tobacco control policies implemented during the period studied and monthly average real retail price, in addition to seasonality and serial correlation.

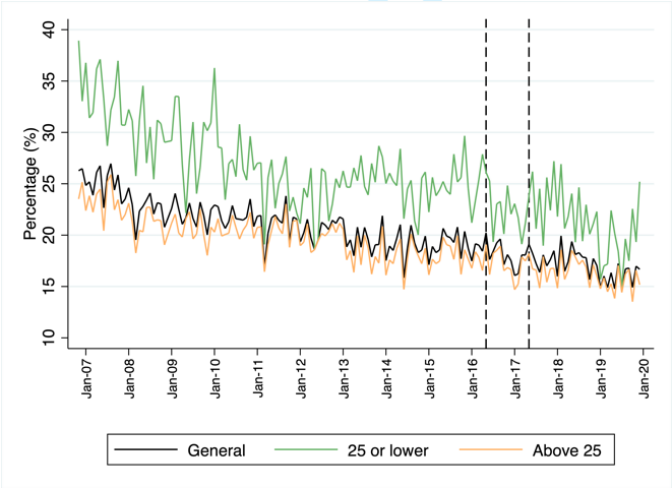
a. General Population



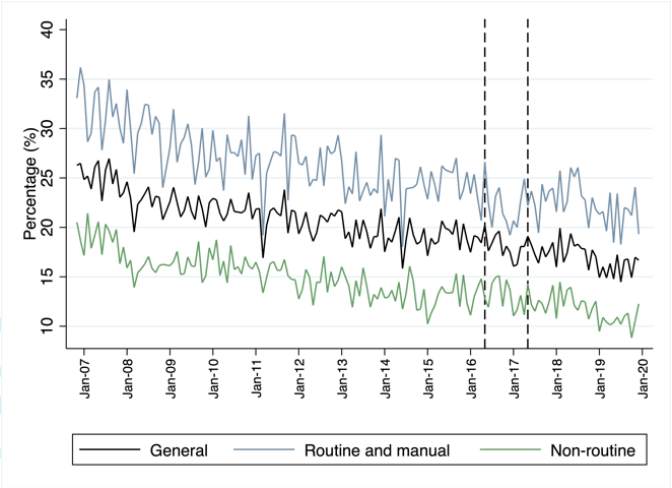
b. By sex



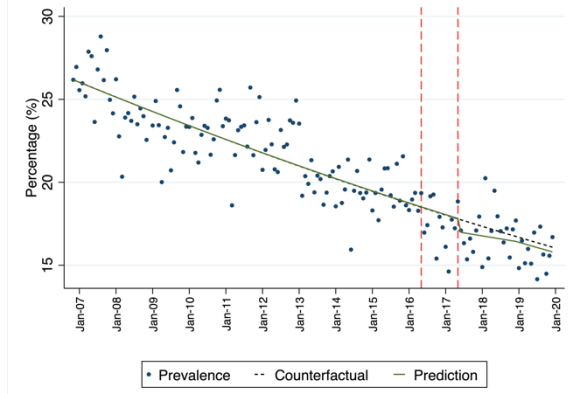
c. By age

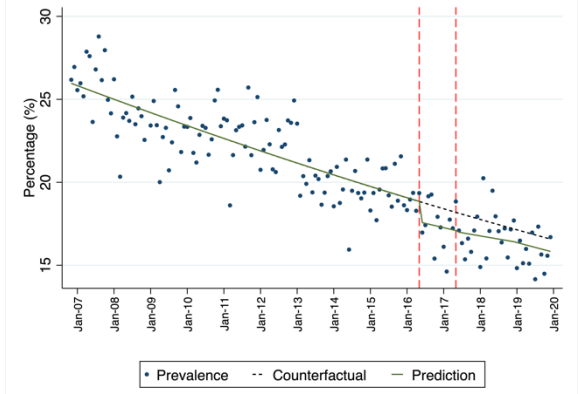


d. By socioeconomic status



a. Before/after full implementation	b. Before/after policy start date





Note: Predicted and counterfactual data was obtained using unadjusted primary and secondary model removing seasonality and the lagged prevalence variable in order to obtain a linear prediction.

Figure S1: Percentage of current regular cigarette smokers in England (2007-2019) using Smoking Toolkit Study (STS) and Annual Population Survey (APS) quarterly data (2007q1-2019q4).

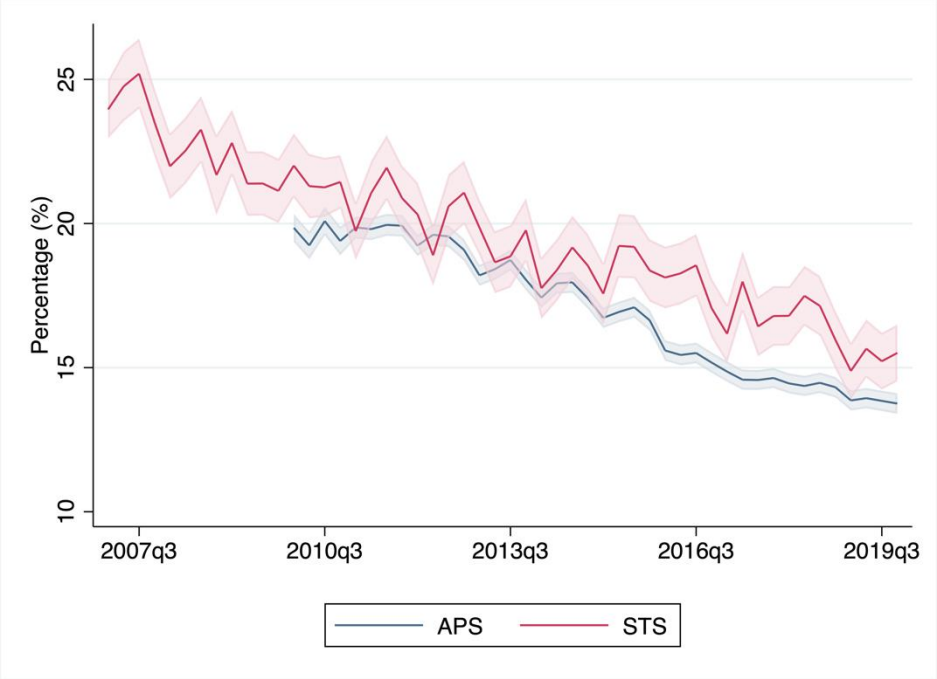
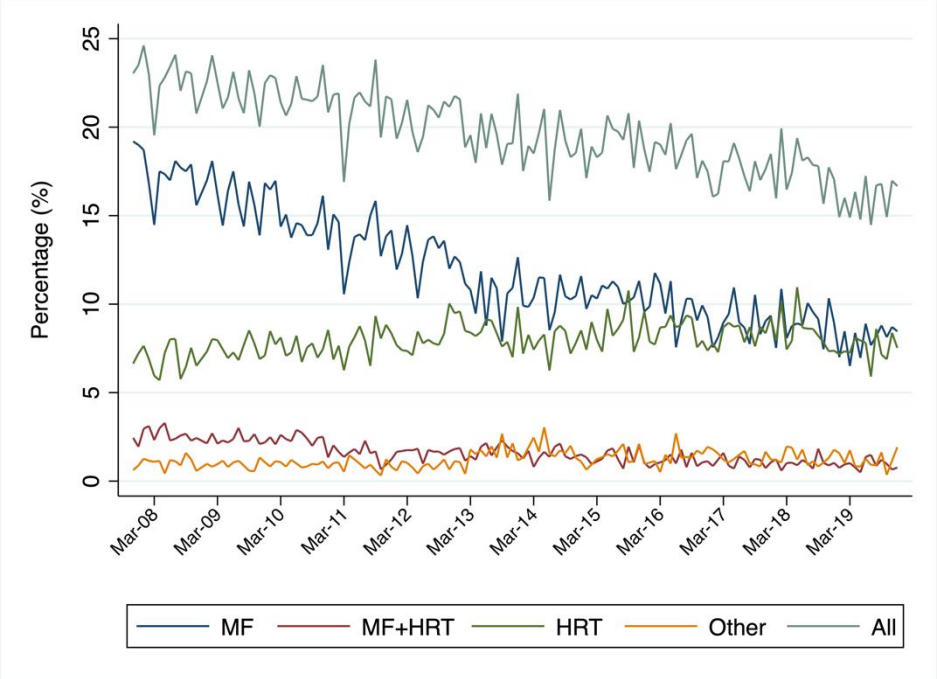


Figure S2: Percentage of smokers by type of tobacco product used: manufactured cigarettes (MF), hand-rolled tobacco (HRT), other (including pipe, cigar, cigarillos and other) and all tobacco products (Smoking Toolkit Study data November 2007* to December 2019)



* The variable 'type of cigarette smoked' was only available from November 2007. This implies that the smoke-free in public spaces legislation or the increase in minimum age of sale.

Table S1: Regression results for level and slope changes in the odds of being a smoker after full implementation of plain packaging in **May 2017** (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Annual Population Survey, 2010q1 to 2019q4)

	Primary analysis		**Secondary analysis**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
a. General population				
Level after May 2016			**0.96**	**0.97**
			(0.007)	(0.036)
			0.93 - 0.99	0.94 - 1.00
Slope May 2016-May 2017			1.02	1.00
			(0.563)	(0.935)
			0.96 - 1.07	0.94 - 1.06
Level after May 2017	0.98	0.98	0.98	0.97
	(0.051)	(0.125)	(0.231)	(0.213)
	0.96 - 1.00	0.95 - 1.01	0.94 - 1.02	0.93 - 1.02
Post-slope 18 months after May 2017	1.02	1.01	1.02	1.01
	(0.125)	(0.500)	(0.090)	(0.586)
	0.99 - 1.05	0.98 - 1.04	1.00 - 1.05	0.98 - 1.04
Observations	1,555,452	1,555,452	1,555,452	1,555,452
b. Females only subgroup				
Level after May 2016			**0.95**	0.96
			(0.015)	(0.076)
			0.92 - 0.99	0.92 - 1.00
Slope May 2016-May 2017			1.01	1.01
			(0.831)	(0.841)
			0.94 - 1.09	0.93 - 1.09
Level after May 2017	**0.97**	0.99	0.98	0.98
	(0.043)	(0.617)	(0.410)	(0.539)
	0.94 - 1.00	0.95 - 1.03	0.92 - 1.03	0.92 - 1.04
Post-slope 18 months after May 2017	1.03	1.02	1.03	1.01
	(0.187)	(0.477)	(0.186)	(0.549)
	0.99 - 1.06	0.97 - 1.06	0.99 - 1.06	0.97 - 1.06
Observations	818,331	818,331	818,331	818,331
c. Males only subgroup				
Level after May 2016			**0.95**	0.96
			(0.030)	(0.062)
			0.91 - 1.00	0.92 - 1.00
Slope May 2016-May 2017			1.02	0.98
			(0.622)	(0.638)
			0.95 - 1.10	0.91 - 1.06
Level after May 2017	0.98	**0.96**	0.97	0.96
	(0.111)	(0.047)	(0.329)	(0.203)
	0.95 - 1.01	0.92 - 1.00	0.92 - 1.03	0.91 - 1.02
Post-slope 18 months after May 2017	1.03	1.02	1.03	1.01
	(0.128)	(0.405)	(0.108)	(0.586)
	0.99 - 1.06	0.98 - 1.06	0.99 - 1.07	0.97 - 1.05
Observations	737,121	737,121	737,121	737,121
d. Population aged 18 to 25 years old only subgroup				
Level after May 2016			0.93	0.97
			(0.100)	(0.427)
			0.86 - 1.01	0.89 - 1.05
Slope			0.95	0.92

May 2016-May 2017			(0.546)	(0.325)
			0.82 - 1.11	0.78 - 1.09
Level after May 2017	0.98	0.99	1.03	1.03
	(0.529)	(0.818)	(0.602)	(0.634)
	0.92 - 1.05	0.90 - 1.08	0.92 - 1.16	0.91 - 1.16
Post-slope 18 months after May 2017	1.01	0.99	1.00	0.98
	(0.868)	(0.885)	(0.963)	(0.587)
	0.93 - 1.09	0.91 - 1.08	0.93 - 1.08	0.89 - 1.07
Observations	154,924	154,924	154,924	154,924
e. Population over 25 years old only subgroup				
Level after May 2016			**0.96**	**0.97**
			(0.012)	(0.041)
			0.93 - 0.99	0.94 - 1.00
Slope May 2016-May 2017			1.03	1.01
			(0.366)	(0.654)
			0.97 - 1.08	0.95 - 1.08
Level after May 2017	**0.97**	0.98	0.97	0.97
	(0.036)	(0.152)	(0.122)	(0.126)
	0.95 - 1.00	0.94 - 1.01	0.93 - 1.01	0.92 - 1.01
Post-slope 18 months after May 2017	1.02	1.01	1.03	1.01
	(0.088)	(0.358)	(0.070)	(0.377)
	1.00 - 1.05	0.98 - 1.05	1.00 - 1.05	0.98 - 1.05
Observations	1,400,528	1,400,528	1,400,528	1,400,528
f. Manual and routine occupations only subgroup				
Level after May 2016			0.97	0.98
			(0.153)	(0.470)
			0.92 - 1.01	0.93 - 1.03
Slope May 2016-May 2017			1.04	1.02
			(0.382)	(0.730)
			0.95 - 1.14	0.92 - 1.12
Level after May 2017	0.97	0.97	0.96	0.96
	(0.179)	(0.217)	(0.221)	(0.249)
	0.94 - 1.01	0.92 - 1.02	0.89 - 1.03	0.89 - 1.03
Post-slope 18 months after May 2017	1.02	0.99	1.03	0.99
	(0.287)	(0.819)	(0.273)	(0.834)
	0.98 - 1.07	0.94 - 1.05	0.98 - 1.07	0.94 - 1.05
Observations	368,993	368,993	368,993	368,993
g. Non-routine occupations only subgroup				
Level after May 2016			0.96	0.96
			(0.112)	(0.079)
			0.92 - 1.01	0.91 - 1.01
Slope May 2016-May 2017			1.02	0.99
			(0.589)	(0.880)
			0.94 - 1.11	0.91 - 1.09
Level after May 2017	0.99	0.98	0.99	0.98
	(0.786)	(0.442)	(0.652)	(0.491)
	0.96 - 1.03	0.93 - 1.03	0.92 - 1.05	0.91 - 1.04
Post-slope 18 months after May 2017	**1.06**	1.04	**1.05**	1.03
	(0.007)	(0.075)	(0.008)	(0.146)
	1.02 - 1.10	1.00 - 1.09	1.01 - 1.10	0.99 - 1.08
Observations	735,612	735,612	735,612	735,612

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05). Unadjusted model includes adjustment by seasonality and serial correlation, while the adjusted model incudes other tobacco control policies implemented during the period studied and monthly average real retail price, in addition to seasonality and serial correlation.

Table S2: Regression results for level and slope changes in the odds of being a smoker after full implementation of plain packaging in **May 2017** (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England by type of smoking product (Smoking Toolkit Study data November 2007* to December 2019)

	Primary analysis		**Secondary analysis**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
a. Smokers of manufactured cigarettes				
Level after May 2016			**0.73**	**0.83**
			(0.000)	(0.001)
			0.65 - 0.81	0.74 - 0.93
Slope May 2016-May 2017			1.04	1.18
			(0.683)	(0.088)
			0.86 - 1.26	0.98 - 1.43
Level after May 2017	**0.81**	0.92	0.97	0.89
	(0.000)	(0.067)	(0.652)	(0.104)
	0.75 - 0.88	0.85 - 1.01	0.84 - 1.11	0.78 - 1.02
Post-slope 18 months after May 2017	0.94	**1.13**	0.92	**1.12**
	(0.209)	(0.019)	(0.074)	(0.028)
	0.86 - 1.03	1.02 - 1.25	0.84 - 1.01	1.01 - 1.24
Observations	240,251	225,270	240,251	225,270
b. Smokers of hand-rolled tobacco				
Level after May 2016			**0.68**	0.82
			(0.009)	(0.193)
			0.51 - 0.91	0.60 - 1.11
Slope May 2016-May 2017			0.98	1.12
			(0.929)	(0.681)
			0.57 - 1.67	0.66 - 1.89
Level after May 2017	**0.73**	0.87	0.97	0.89
	(0.005)	(0.268)	(0.889)	(0.546)
	0.59 - 0.91	0.68 - 1.11	0.66 - 1.44	0.61 - 1.30
Post-slope 18 months after May 2017	0.96	1.22	0.93	1.21
	(0.747)	(0.185)	(0.581)	(0.205)
	0.73 - 1.25	0.91 - 1.63	0.71 - 1.21	0.90 - 1.61
Observations	221,890	206,909	221,890	206,909
a. Smokers of manufactured cigarettes and hand-rolled tobacco				
Level after May 2016			**0.68**	0.82
			(0.009)	(0.193)
			0.51 - 0.91	0.60 - 1.11
Slope May 2016-May 2017			0.98	1.12
			(0.929)	(0.681)
			0.57 - 1.67	0.66 - 1.89
Level after May 2017	**0.73**	0.87	0.97	0.89
	(0.005)	(0.268)	(0.889)	(0.546)
	0.59 - 0.91	0.68 - 1.11	0.66 - 1.44	0.61 - 1.30
Post-slope 18 months after May 2017	0.96	1.22	0.93	1.21
	(0.747)	(0.185)	(0.581)	(0.205)
	0.73 - 1.25	0.91 - 1.63	0.71 - 1.21	0.90 - 1.61
Observations	221,890	206,909	221,890	206,909
h. Smokers of other tobacco products (including pipe, cigar, cigarillos, etc.)				
Level after May 2016			**6.47**	**1.36**
			(0.000)	(0.020)
			5.08 - 8.24	1.05 - 1.77

Slope May 2016-May 2017			1.28	**0.59**
			(0.212)	(0.031)
			0.87 - 1.87	0.37 - 0.95
Level after May 2017	**3.29**	1.00	0.72	1.27
	(0.000)	(0.978)	(0.050)	(0.175)
	2.56 - 4.23	0.80 - 1.25	0.51 - 1.00	0.90 - 1.79
Post-slope 18 months after May 2017	**2.65**	0.82	**2.95**	0.83
	(0.000)	(0.122)	(0.000)	(0.143)
	1.98 - 3.54	0.63 - 1.06	2.21 - 3.94	0.64 - 1.07
Observations	226,983	226,983	226,983	226,983

* The variable 'type of cigarette smoked' was only available from November 2007. This implies that the smoke-free in public spaces legislation or the increase in minimum age of sale.

Table S3: Regression results step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England using interaction effect (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
a. Interaction with female gender (reference: male)				
Step change after May 2016			0.91	**0.89**
			(0.056)	(0.031)
			0.82 - 1.00	0.80 - 0.99
Female's step change after May 2016			1.02	1.02
			(0.758)	(0.762)
			0.89 - 1.17	0.89 - 1.17
Trend May 2016-May 2017			0.98	0.92
			(0.806)	(0.358)
			0.81 - 1.17	0.76 - 1.10
Female's trend May 2016-May 2017			1.00 - 1.00	1.00 - 1.00
			1.11	1.11
			(0.435)	(0.431)
Step change after May 2017	0.93	**0.91**	1.02	1.04
	(0.068)	(0.017)	(0.740)	(0.594)
	0.86 - 1.01	0.84 - 0.98	0.90 - 1.17	0.91 - 1.19
Female's step change after May 2017	1.05	1.05	0.93	0.93
	(0.358)	(0.358)	(0.468)	(0.463)
	0.95 - 1.17	0.95 - 1.17	0.77 - 1.12	0.77 - 1.12
Trend 18 months after May 2017	1.07	1.05	1.06	1.04
	(0.175)	(0.356)	(0.218)	(0.443)
	0.97 - 1.17	0.95 - 1.15	0.97 - 1.16	0.94 - 1.14
Female's trend 18 months after May 2017	0.92	0.92	0.92	0.92
	(0.224)	(0.226)	(0.224)	(0.227)
	0.81 - 1.05	0.81 - 1.05	0.81 - 1.05	0.81 - 1.05
Observations	276,361	276,361	276,361	276,361
b. Interaction with population aged 18 to 25 years old (reference: population > 25 years old)				
Step change after May 2016			0.93	**0.91**
			(0.075)	(0.033)
			0.86 - 1.01	0.84 - 0.99
18-25's step change after May 2016			0.97	0.97
			(0.714)	(0.708)
			0.81 - 1.15	0.81 - 1.15

Trend May 2016-May 2017			1.04	0.98
			(0.557)	(0.804)
			0.90 - 1.21	0.84 - 1.14
18-25's trend May 2016-May 2017			0.93	0.93
			(0.641)	(0.649)
			0.67 - 1.28	0.67 - 1.28
Step change after May 2017	0.94	**0.92**	0.95	0.96
	(0.066)	(0.010)	(0.366)	(0.510)
	0.89 - 1.00	0.86 - 0.98	0.86 - 1.06	0.87 - 1.07
18-25's step change after May 2017	1.08	1.08	1.20	1.20
	(0.238)	(0.238)	(0.128)	(0.131)
	0.95 - 1.24	0.95 - 1.24	0.95 - 1.53	0.95 - 1.53
Trend 18 months after May 2017	1.07*	1.05	1.06	1.04
	(0.099)	(0.266)	(0.129)	(0.350)
	0.99 - 1.15	0.97 - 1.13	0.98 - 1.14	0.96 - 1.12
18-25's trend 18 months after May 2017	**0.82**	**0.82**	**0.82**	**0.82**
	(0.024)	(0.024)	(0.024)	(0.024)
	0.69 - 0.97	0.70 - 0.97	0.69 - 0.97	0.70 - 0.97
Observations	276,416	276,416	276,416	276,416
c. Interaction with manual and routine occupations (reference: non-routine occupations)				
Step change after May 2016			1.04	0.98
			(0.503)	(0.743)
			0.93 - 1.15	0.88 - 1.10
Manual's step change after May 2016			0.86	0.86
			(0.051)	(0.052)
			0.74 - 1.00	0.74 - 1.00
Trend May 2016-May 2017			0.99	0.96
			(0.881)	(0.716)
			0.81 - 1.19	0.79 - 1.17
Manual's trend May 2016-May 2017			1.10	1.10
			(0.492)	(0.496)
			0.83 - 1.46	0.83 - 1.46
Step change after May 2017	1.00	0.97	0.97	0.99
	(0.969)	(0.543)	(0.713)	(0.855)
	0.92 - 1.08	0.90 - 1.06	0.85 - 1.12	0.86 - 1.14
Manual's step change after May 2017	1.06	1.06	1.11	1.10
	(0.344)	(0.349)	(0.336)	(0.339)
	0.94 - 1.18	0.94 - 1.18	0.90 - 1.36	0.90 - 1.36
Trend 18 months after May 2017	1.00	0.97	1.00	0.97
	(0.955)	(0.573)	(0.937)	(0.495)
	0.90 - 1.10	0.88 - 1.08	0.90 - 1.10	0.87 - 1.07
Manual's trend 18 months after May 2017	1.02	1.02	1.02	1.02
	(0.771)	(0.772)	(0.771)	(0.771)
	0.88 - 1.18	0.88 - 1.18	0.88 - 1.18	0.88 - 1.18
Observations	237,614	237,614	237,614	237,614

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05). Unadjusted model includes adjustment by seasonality and serial correlation, while the adjusted model incudes other tobacco control policies implemented during the period studied and monthly average real retail price, in addition to seasonality and serial correlation.

Table S4: General population regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		After policy start date	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
General population				
Level after May 2016			**0.91**	**0.90**
			(0.018)	(0.009)
			0.85 - 0.98	0.83 - 0.97
Slope May 2016-May 2017			1.02	0.96
			(0.728)	(0.578)
			0.90 - 1.17	0.84 - 1.10
Level after May 2017	0.95	**0.93**	0.99	1.00
	(0.073)	(0.015)	(0.813)	(0.975)
	0.90 - 1.00	0.87 - 0.99	0.90 - 1.09	0.91 - 1.10
Post-slope 18 months after May 2017	1.02	1.00	1.02	1.00
	(0.474)	(0.892)	(0.591)	(0.940)
	0.96 - 1.10	0.94 - 1.08	0.95 - 1.09	0.93 - 1.07
Smoke free ban		1.08		1.07
		(0.056)		(0.062)
		1.00 - 1.16		1.00 - 1.16
Minimum age of sale		**0.84**		**0.82**
		(0.000)		(0.000)
		0.78 - 0.90		0.76 - 0.88
Display ban in small shops		0.98		0.97
		(0.407)		(0.205)
		0.93 - 1.03		0.92 - 1.02
Display ban in large shops		0.98		1.03
		(0.372)		(0.242)
		0.93 - 1.03		0.98 - 1.09
Price per cigarette		1.00		**1.00**
		(0.090)		(0.031)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	276,416	276,416	276,416	276,416

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S5: Females only subgroup regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		After policy start date	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Females only subgroup				
Level after May 2016			0.95	**0.89**
			(0.342)	(0.046)
			0.85 - 1.06	0.79 - 1.00

Slope May 2016-May 2017			1.08	1.08
			(0.438)	(0.430)
			0.89 - 1.30	0.89 - 1.32
Level after May 2017	0.99	0.97	0.96	0.97
	(0.802)	(0.480)	(0.572)	(0.617)
	0.91 - 1.07	0.89 - 1.06	0.84 - 1.10	0.84 - 1.11
Post-slope 18 months after May 2017	0.98	0.97	0.98	0.96
	(0.640)	(0.522)	(0.636)	(0.459)
	0.89 - 1.08	0.87 - 1.07	0.89 - 1.08	0.87 - 1.07
Smoke free ban		1.10		1.09
		(0.076)		(0.088)
		0.99 - 1.22		0.99 - 1.21
Minimum age of sale		**0.87**		**0.86**
		(0.005)		(0.005)
		0.78 - 0.96		0.78 - 0.95
Display ban in small shops		0.99		0.98
		(0.856)		(0.640)
		0.92 - 1.07		0.91 - 1.06
Display ban in large shops		1.04		1.08
		(0.215)		(0.053)
		0.97 - 1.12		1.00 - 1.16
Price per cigarette		1.00		1.00
		(0.765)		(0.744)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	142,107	142,107	142,107	142,107

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S6: Males only subgroup regression results for level and slope changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Males only subgroup				
Level after May 2016			**0.89**	0.91
			(0.022)	(0.083)
			0.80 - 0.98	0.81 - 1.01
Slope May 2016-May 2017			1.00	0.88
			(0.969)	(0.204)
			0.83 - 1.20	0.73 - 1.07
Level after May 2017	**0.92**	**0.90**	1.01	1.03
	(0.046)	(0.013)	(0.932)	(0.706)
	0.85 - 1.00	0.83 - 0.98	0.88 - 1.15	0.90 - 1.18
Post-slope 18 months after May 2017	1.07	1.04	1.05	1.03
	(0.176)	(0.444)	(0.262)	(0.556)
	0.97 - 1.17	0.94 - 1.15	0.96 - 1.16	0.93 - 1.14

Smoke free ban		1.04		1.04
		(0.541)		(0.515)
		0.93 - 1.16		0.93 - 1.16
Minimum age of sale		**0.84**		**0.80**
		(0.003)		(0.000)
		0.75 - 0.94		0.72 - 0.90
Display ban in small shops		0.97		0.95
		(0.362)		(0.211)
		0.90 - 1.04		0.88 - 1.03
Display ban in large shops		**0.93**		1.00
		(0.036)		(0.902)
		0.88 - 1.00		0.93 - 1.07
Price per cigarette		**1.00**		**1.00**
		(0.010)		(0.001)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	134,254	134,254	134,254	134,254

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S7: Population aged 18 to 25 years old only regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Population aged 18-25 years old only				
Level after May 2016			1.02	0.95
			(0.842)	(0.541)
			0.86 - 1.21	0.79 - 1.13
Slope May 2016-May 2017			0.87	0.84
			(0.377)	(0.277)
			0.64 - 1.18	0.61 - 1.15
Level after May 2017	1.12	1.10	1.25	**1.29**
	(0.078)	(0.183)	(0.052)	(0.028)
	0.99 - 1.28	0.96 - 1.27	1.00 - 1.57	1.03 - 1.62
Post-slope 18 months after May 2017	0.87	0.87	0.87	0.86
	(0.088)	(0.088)	(0.074)	(0.068)
	0.75 - 1.02	0.73 - 1.02	0.74 - 1.01	0.72 - 1.01
Smoke free ban		1.09		1.09
		(0.347)		(0.366)
		0.91 - 1.31		0.91 - 1.30
Minimum age of sale		0.85		**0.82**
		(0.070)		(0.031)
		0.71 - 1.01		0.69 - 0.98
Display ban in small shops		1.02		1.01
		(0.725)		(0.818)
		0.90 - 1.16		0.90 - 1.15

Display ban in large shops		1.07		**1.13**
		(0.211)		(0.033)
		0.96 - 1.19		1.01 - 1.28
Price per cigarette		1.00		1.00
		(0.936)		(0.705)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	43,729	43,729	43,729	43,729

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S9: Population over 25 years old only regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Population over 25 years old only				
Level after May 2016			**0.90**	**0.90**
			(0.014)	(0.016)
			0.83 - 0.98	0.82 - 0.98
Slope May 2016-May 2017			1.07	1.00
			(0.386)	(0.976)
			0.92 - 1.23	0.86 - 1.17
Level after May 2017	**0.92**	**0.90**	0.94	0.94
	(0.013)	(0.002)	(0.228)	(0.283)
	0.87 - 0.98	0.84 - 0.96	0.84 - 1.04	0.85 - 1.05
Post-slope 18 months after May 2017	1.06	1.04	1.06	1.04
	(0.109)	(0.304)	(0.147)	(0.382)
	0.99 - 1.15	0.96 - 1.13	0.98 - 1.14	0.96 - 1.12
Smoke free ban		1.07		1.06
		(0.139)		(0.151)
		0.98 - 1.16		0.98 - 1.16
Minimum age of sale		**0.85**		**0.83**
		(0.000)		(0.000)
		0.78 - 0.92		0.77 - 0.91
Display ban in small shops		0.97		0.96
		(0.296)		(0.153)
		0.91 - 1.03		0.90 - 1.02
Display ban in large shops		0.97		1.01
		(0.242)		(0.659)
		0.92 - 1.02		0.96 - 1.07
Price per cigarette		1.00		**1.00**
		(0.060)		(0.035)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes

Seasonality	Yes	Yes	Yes	Yes
Observations	232,687	232,687	232,687	232,687

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S10: Manual and routine occupations only regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017 (before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Manual and routine occupations only				
Level after May 2016			0.89	**0.83**
			(0.065)	(0.004)
			0.79 - 1.01	0.73 - 0.94
Slope May 2016-May 2017			1.08	1.11
			(0.499)	(0.361)
			0.87 - 1.33	0.89 - 1.38
Level after May 2017	1.07	1.07	1.08	1.09
	(0.149)	(0.171)	(0.315)	(0.289)
	0.98 - 1.17	0.97 - 1.18	0.93 - 1.27	0.93 - 1.27
Post-slope 18 months after May 2017	1.02	1.00	1.01	1.00
	(0.721)	(0.939)	(0.798)	(0.948)
	0.91 - 1.14	0.89 - 1.13	0.91 - 1.13	0.89 - 1.12
Smoke free ban		1.09		1.09
		(0.149)		(0.173)
		0.97 - 1.23		0.96 - 1.22
Minimum age of sale		**0.89**		**0.88**
		(0.045)		(0.027)
		0.79 - 1.00		0.78 - 0.99
Display ban in small shops		0.99		0.97
		(0.729)		(0.423)
		0.91 - 1.07		0.89 - 1.05
Display ban in large shops		1.00		1.06
		(0.945)		(0.179)
		0.93 - 1.08		0.98 - 1.14
Price per cigarette		1.00		1.00
		(0.215)		(0.234)
		1.00 - 1.00		1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	95,770	95,770	95,770	95,770

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)

Table S11: Non-routine occupations only regression results for step and trend changes in the odds of being a smoker after full implementation of plain packaging in May 2017

(before/after full implementation) and accounting for plain packaging start date in May 2016 (before/after policy start date) in England (Smoking Toolkit Study data January 2007 to December 2019)

	After full implementation		**After policy start date**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (p-value) [95% CI]	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**	**OR (p-value) [95% CI]**
Non-routine occupations only				
Level after May 2016			1.03 (0.578) 0.92 - 1.16	1.00 (0.961) 0.89 - 1.13
Slope May 2016-May 2017			0.99 (0.942) 0.82 - 1.21	0.93 (0.457) 0.75 - 1.13
Level after May 2017	0.98 (0.669) 0.90 - 1.07	0.94 (0.149) 0.85 - 1.02	0.97 (0.666) 0.84 - 1.12	0.99 (0.846) 0.85 - 1.14
Post-slope 18 months after May 2017	1.00 (0.999) 0.91 - 1.10	0.96 (0.453) 0.86 - 1.07	1.00 (0.973) 0.91 - 1.11	0.96 (0.435) 0.86 - 1.07
Smoke free ban		1.04 (0.573) 0.91 - 1.17		1.04 (0.567) 0.92 - 1.18
Minimum age of sale		**0.79** (0.000) 0.70 - 0.90		**0.78** (0.000) 0.69 - 0.89
Display ban in small shops		0.94 (0.206) 0.86 - 1.03		0.94 (0.203) 0.86 - 1.03
Display ban in large shops		1.02 (0.544) 0.95 - 1.11		1.04 (0.344) 0.96 - 1.13
Price per cigarette		1.00 (0.311) 1.00 - 1.00		1.00 (0.211) 1.00 - 1.00
Lagged smoking prevalence	Yes	Yes	Yes	Yes
Seasonality	Yes	Yes	Yes	Yes
Observations	141,844	141,844	141,844	141,844

Note: Values in **bold** refer to statistically significant OR (p-value < 0.05)