



Examining the influence of tobacco control mass media campaign expenditure on the association between motivation to stop smoking and quit attempts: A prospective study in England

Sarah E. Jackson^{*}, Lion Shahab, Jamie Brown

Department of Behavioural Science and Health, University College London, London, UK
SPECTRUM Consortium, UK

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ABSTRACT

Objective: To explore whether expenditure on national tobacco control mass media campaigns moderates the association between motivation to stop smoking and future quit attempts.

Method: Data were from 2601 people who smoke participating in a population survey with 12-month follow-up between April 2015 and February 2021. We used logistic regression to test associations of (i) baseline level of motivation to stop smoking, (ii) mean monthly tobacco control mass media campaign expenditure in England between baseline and follow-up, and (iii) their interaction, on past-year quit attempts assessed at 12-month follow-up. Covariates included age, sex, occupational social grade, and region.

Results: Between baseline and follow-up, 38.6% of participants made a quit attempt. Each one-point increase in baseline motivation to stop smoking was associated with 1.37 times greater odds (95%CI = 1.31–1.43) of making a quit attempt over 12-month follow-up. Each one standard deviation increase in tobacco control mass media expenditure between baseline and 12-month follow-up was associated with 13% greater odds of making a quit attempt (95%CI = 1.05–1.23). There was no significant interaction between mass media expenditure and motivation to stop on quit attempts (OR = 1.01, 95%CI = 0.97–1.05); the data provided strong evidence for the null (Bayes factors = 0.07 and 0.04 based on expected effect sizes of OR = 1.5 and OR = 0.67, respectively).

Conclusions: Among people who smoke, self-reported level of motivation to stop strongly predicted whether they made a quit attempt in the subsequent year. Increased expenditure on tobacco control mass media campaigns was associated with increased quit attempts. The association between motivation and quit attempts did not differ according to tobacco control mass media expenditure over this period.

1. Introduction

Reducing smoking prevalence remains a priority for governments worldwide. In 2005, a global tobacco control treaty, the World Health Organisation's Framework Convention on Tobacco Control (WHO FCTC), came into force containing provisions aimed at reducing tobacco consumption and toxicity. Under the WHO FCTC, countries are required to promote "public awareness about the health risks of tobacco consumption and exposure to tobacco smoke, and about the benefits of the cessation of tobacco use and tobacco-free lifestyles" (World Health Organization, 2003). Tobacco control mass media campaigns are designed to increase the salience of the negative health consequences of smoking, promote quitting, and increasingly enable the use of evidence-based

support (Langley et al., 2013). In this study, we consider the impact of mass media campaign expenditure in England on quit attempts among people who smoke with differing levels of motivation to stop smoking.

While there is substantial evidence linking mass media campaigns with increased rates of success among people trying to quit smoking (Durkin et al., 2012; Kuipers et al., 2018; Bala et al., 2017; Beard et al., 2020), their impact on generating quit attempts is less consistent. Several studies have reported increases in quit attempts related to mass media campaigns. For example, in the United States, evaluations of the national 'Tips From Former Smokers (Tips)' campaign have consistently reported associations with increased quit attempts among people who smoke (McAfee et al., 2013; Davis et al., 2019; Murphy-Hoefer et al., 2020; Davis et al., 2018). Similarly, when England's national 'Stoptober'

^{*} Corresponding author at: Department of Behavioural Science and Health, University College London, 1-19 Torrington Place, London WC1E 7HB, UK.
E-mail address: s.e.jackson@ucl.ac.uk (S.E. Jackson).

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campaign (which encourages quitting for the month of October) was launched in 2012, a significant increase in quit attempts was seen in October vs. other months compared with previous years (Brown et al., 2014), which was inconsistently sustained in subsequent years as a function of campaign expenditure (Kuipers, West, Beard, & Brown, 2020). On an individual level, exposure to tobacco control advertising has been shown to be associated with greater odds of making a quit attempt, at least in the short-term (~3 months) (Davis et al., 2018; McAfee et al., 2017; Wakefield et al., 2011; Terry-McElrath et al., 2013; Durkin et al., 2018). However, two representative time series studies in England have failed to identify any significant association between tobacco control mass media campaign expenditure and the rate of quit attempts among people who smoke at the population level (Kuipers et al., 2018; Beard et al., 2020).

Several prominent theories identify motivation as a key driver of behaviour change (Davis et al., 2015; West and Michie, 2020; Michie et al., 2005). Consistent with this, studies have shown strong links between motivation to stop smoking and subsequent quit attempts (Beard et al., 2020; Kotz et al., 2013; Borland et al., 2010; Smit et al., 2011). If tobacco control mass media campaigns increase quit attempts to differing extents according to people's level of motivation to stop smoking, this could potentially account for the mixed evidence linking mass media campaigns and quit attempts. On the one hand, mass media campaigns may have comparatively more success in generating quit attempts among those with low or no motivation to stop. Increasing motivation is one of the pathways through which tobacco control mass media campaigns may work to increase quitting (Durkin et al., 2012; Wakefield et al., 2010). These campaigns can offer people who smoke new insights, increase the salience of smoking harms and the benefits of quitting, encourage them to reflect on the implications of their own behaviour, and raise awareness of the support available to them should they decide to try and quit. On the other hand, tobacco control mass media campaigns may be better comparatively at 'converting' quit attempts among highly motivated people, by directing them to support or simply prompting them to act on their intention to quit. Finally, there may be no moderating impact, with tobacco control mass media campaign expenditure affecting quit attempts similarly among people who smoke at every level of motivation. Understanding how far, and among whom, mass media campaigns increase quit attempts is important for designing and targeting campaigns to achieve the greatest impact and informing policy decisions around their continued investment.

In England, large-scale tobacco control mass media campaigns have been run as part of a comprehensive national tobacco control programme since 1999. Over this period, adult smoking prevalence has fallen from 27% to 13% (Office for National Statistics, 2021; NHS Digital, 2020). These campaigns have used a range of mass media, including television, radio and press, and often advertised free local stop smoking services, the national quitline, free quit support packs, and the national smoking cessation website. More recent campaigns have targeted all smokers and focused around quitting for better health in January, No Smoking Day in March, and Stoptober which encourages smokers to stop smoking for the month of October. Expenditure on these campaigns has varied over time, providing a natural experiment within which to explore the impact of changes in mass media campaign expenditure on quitting outcomes in the English population.

This study aimed to explore whether expenditure on tobacco control mass media campaigns moderates the association between motivation to stop smoking and future quit attempts. Specifically, we aimed to address the following exploratory research question:

- Among people who smoke in England, is the association between motivation to stop smoking at baseline and quit attempts 12 months later moderated by mean monthly tobacco control mass media expenditure between baseline and 12-month follow-up, after adjusting for age, sex, occupational social grade, and region?

2. Method

2.1. Design and population

Data were drawn from the Smoking Toolkit Study; an ongoing monthly survey of representative samples of adults in England designed to provide insights into population-wide influences on smoking and cessation by monitoring trends on a range of variables relating to smoking (Fidler et al., 2011). The study uses a form of random location sampling to select a new sample of approximately 1700 adults aged ≥ 16 years each month, who each complete the same baseline survey. In certain waves since the study began in 2006 (due to availability of competitive research funding to pay for follow-up data to be collected), participants who report smoking have been invited to participate in a follow-up survey via telephone, adding a prospective element. In all monthly waves since April 2015, people who smoke have been invited to participate in a follow-up survey 12 months after baseline. Comparisons with sales data and other national surveys show that the Smoking Toolkit Study recruits a representative sample of the population in England with regard to key demographic variables, smoking prevalence, and cigarette consumption (Fidler et al., 2011; Jackson et al., 2019).

For the present study, we used aggregated data from respondents to the baseline survey in the period from April 2015 (the first wave to invite people who smoke to participate in a 12-month follow-up survey) to February 2020 (the last data collected before the pandemic). We decided against inclusion of baseline data beyond this point due to a change in method of data collection from face-to-face to telephone survey. Follow-up data were collected between April 2016 and February 2021.

Our sample comprised respondents who reported:

- smoking cigarettes (including hand-rolled) or any other tobacco product (e.g., pipe or cigar) daily or occasionally at the time of the baseline survey ('current smokers');
- their level of motivation to stop smoking at baseline;
- the number of past-year quit attempts they had made at 12-month follow-up.

2.2. Ethical approval

Ethical approval for the Smoking Toolkit Study was granted originally by the UCL Ethics Committee (ID 0498/001). The data are collected by Ipsos Mori and are anonymised when received by UCL.

2.3. Measures

The outcome variable was past-year quit attempts, measured at 12-month follow-up. This was assessed with the question: "How many serious attempts to stop smoking have you made in the past 12 months? By serious I mean you decided that you would try to make sure you never smoked again." Participants could report any number of quit attempts. Responses of ≥ 1 were coded 1 and 0 were coded 0, to distinguish between those making any vs. no attempt to quit between baseline and follow-up.

The explanatory variable was motivation to stop smoking, measured at baseline. This was assessed with the Motivation to Stop Scale (Kotz et al., 2013), a single-item measure with seven response options representing increasing motivation to quit:

- I don't want to stop smoking;
- I think I should stop smoking but don't really want to;
- I want to stop smoking but haven't thought about when;
- I REALLY want to stop smoking but I don't know when I will;
- I want to stop smoking and hope to soon;
- I REALLY want to stop smoking and intend to in the next 3 months;
- I REALLY want to stop smoking and intend to in the next month.

Responses were scored on a scale from 0 (lowest motivation) to 6 (highest motivation).

The potential moderator was tobacco control mass media expenditure. Data on monthly national tobacco control campaign expenditure in England were obtained from Public Health England and the Office for Health Improvement and Disparities. Monthly totals include expenditure on TV, radio, print, cinema, and online advertisements across all tobacco control campaigns. The main campaigns running across this period targeted all smokers and focused around quitting for better health in January, No Smoking Day in March, and Stoptober which encourages smokers to stop smoking for the month of October. In the months in which there was no campaign running and thus no campaign expenditure reported, campaign expenditure was entered as zero. This national expenditure is assumed not to be regionally specific (i.e., exposure, as is commonly measured using Gross Rating Points (Ipsos Encyclopedia, 2022), is assumed to be similar across the whole of England). Expenditure figures diverge from those reported in other publications (e.g. in Action on Smoking and Health (ASH) publications), as 'lead generation' expenditure was included in the ASH figures but was not included in the present study. Lead generation involves using databases to attempt to route individuals to stop smoking services. For our primary analysis, we analysed tobacco control mass media expenditure as the mean monthly spend between baseline and 12-month follow-up (e.g. for those surveyed in April 2015 and followed up in April 2016, we analysed the mean monthly spend between May 2015 and March 2016). Expenditure values were standardised as z-scores to allow for easier interpretation of higher versus lower expenditure. To check whether averaging values over this long a period obscures any effect, we conducted a sensitivity analysis on quit attempts that began 6–12 months before the follow-up survey (determined with the question: "How long ago did your most recent serious quit attempt start? By most recent we mean the last time you tried to quit"), with tobacco control mass media expenditure analysed as the mean monthly spend between baseline and 6 months (i.e. the mid-point between baseline and follow-up; e.g. for those surveyed in April 2015 and followed up in April 2016, the mean monthly spend between May 2015 and September 2015), z-transformed.

Covariates included age, sex, occupational social grade (ABC1, which includes managerial, professional and intermediate occupations, vs. C2DE, which includes small employers and own-account workers, lower supervisory and technical occupations, and semi-routine and routine occupations, state pensioners, never worked and long-term unemployed), and region in England (North, Central, South; to account for any potential regional differences in mass media campaign exposure). This occupational measure of social grade is a valid classification that is widely used in research in United Kingdom (UK) populations (Bartley, 2016). We also included past-year quit attempts reported at baseline (any vs. none; assessed with the same question as at the 12-month follow-up) in a sensitivity analysis to explore whether controlling for a behavioural marker of quitting intention changed the results. We did not include level of dependence as a covariate as while it is a strong predictor of cessation it does not appear to predict quit attempts (Vangeli et al., 2011).

2.4. Statistical analysis

The analysis plan was pre-registered on Open Science Framework (<https://osf.io/ctdjp/>). Data were analysed on complete cases using SPSS v.27.

Logistic regression was used to analyse the association between baseline motivation to stop smoking (analysed as a continuous variable on a scale from 0 = least motivated to 6 = most motivated) and quit attempts made over the 12-month follow-up period (≥ 1 versus none), with and without adjustment for the covariates listed above. We then repeated the adjusted model adding mean monthly tobacco control mass media expenditure between baseline and 12-month follow-up (as z-scores), and the interaction between baseline motivation to stop

smoking and mass media expenditure, to test for moderation.

We calculated (pre-planned) Bayes factors to aid understanding of the interaction result. These enabled us to examine whether the data supported an expected effect (i.e., mass media campaign expenditure moderated the association between motivation to stop smoking and future quit attempts), the null, or were insensitive. We calculated two separate Bayes factors, each using a half-normal distribution, the mode at 0 (no effect), and the standard deviation equal to expected effect sizes, which we set separately at OR = 1.5 and OR = 0.67 as an approximation of the effect of being at a different level of motivation on later quit attempts in either direction (Kotz et al., 2013). BFs ≥ 3 can be interpreted as evidence for the expected effect (and against the null), BFs $\leq 1/3$ as evidence for the null, and BFs between 1/3 and 3 suggest the data are insensitive to distinguish the expected effect from the null (Dienes, 2014; Jeffreys, 1961; Beard et al., 2016).

We conducted two sensitivity analyses. The first added past-year quit attempts assessed at baseline as a covariate, because past quit attempts are a strong predictor of future quit attempts (Vangeli et al., 2011). The second restricted the definition of quit attempts to those that occurred in the first 6 months of the follow-up period and calculated tobacco control mass media expenditure as mean monthly spend over the same period (i.e., baseline to 6 months), to provide more variability in the mass media expenditure variable by averaging over a shorter period.

3. Results

Between April 2015 and February 2020, 17,411 respondents to the baseline Smoking Toolkit Study survey reported current smoking, of whom 17,365 (99.7%) reported their current level of motivation to stop smoking. Follow-up data were collected 12 months later from 2601 (15%) of people who smoked, who formed the final sample for this analysis. Compared with those who did not respond to follow-up, the analytic sample overrepresented people who were older, from occupational social grades ABC1, and living in the North of England, but did not differ on sex or level of motivation to stop smoking (Table 1).

Between baseline and 12-month follow-up, 38.6% of participants (1004/2601) made a serious attempt to quit. Of these, the majority (66.6%, 669/1004) made just one quit attempt, 21.1% (212/1004) made two attempts, 7.1% (71/1004) three, and 5.2% (52/1004) four or more. The unadjusted analysis indicated that each one-level increase in

Table 1
Characteristics of participants who smoked who did and did not respond to follow-up.

	Analytic sample	Lost to follow-up	<i>p</i>
<i>N</i>	2601	14,764	–
Age in years			
16–24	8.8 (230)	20.0 (2946)	<0.001
25–34	10.8 (282)	21.6 (3186)	–
35–44	13.8 (360)	16.3 (2403)	–
45–54	19.4 (504)	16.3 (2410)	–
55–64	22.5 (584)	13.4 (1975)	–
≥ 65	24.6 (641)	12.5 (1844)	–
Female	46.0 (1197)	46.9 (6923)	0.412
Occupational social grade C2DE	48.8 (1270)	59.7 (8817)	<0.001
Region in England			
North	35.6 (926)	33.3 (4908)	0.029
Central	28.0 (728)	30.1 (4448)	–
South	36.4 (947)	36.6 (5401)	–
Motivation to stop smoking ^a , mean (SD)	2.10 (1.94)	2.15 (1.99)	0.226

Note: Figures are presented as percentage (*n*), unless stated otherwise. SD, standard deviation.

^a Motivation to Stop Scale: 0 (I don't want to stop smoking) to 6 (I REALLY want to stop smoking and intend to in the next month).

baseline motivation to stop smoking was associated with 1.37 times greater odds of making a quit attempt over 12-month follow-up (Table 2, primary analysis Model 1). This result did not change substantially after adjustment for age, sex, occupational social grade, or region (Table 2, primary analysis Model 2).

Over the study period, monthly tobacco control mass media expenditure ranged from £0 to £785,050. The median monthly expenditure was £100,000, the mean was £174,683, and the standard deviation was £204,671. Greater mean monthly tobacco control mass media expenditure between the time of participants' baseline and 12-month follow-up surveys was significantly associated with increased odds of making a serious quit attempt (Table 2, primary analysis Model 3): a 1 standard deviation increase in expenditure was associated with 13% higher odds of making a quit attempt. However, there was no statistically significant interaction between baseline level of motivation to stop smoking and mean monthly tobacco control mass media expenditure between baseline and 12-month follow-up (Table 2, primary analysis Model 4). The data provided strong evidence for the null (i.e., mass media expenditure does not moderate the association between motivation to stop smoking and future quit attempts; Bayes factors = 0.07 based on OR = 1.5 and 0.04 based on OR = 0.67).

The pattern of results was not substantially different in sensitivity analyses that (i) included past-year quit attempts reported at baseline as a covariate and (ii) restricted the outcome to quit attempts over the first six months of follow-up (Table 2, sensitivity analyses 1 and 2). The only exception was that in the latter analysis, the association between mass media expenditure and quit attempts became non-significant, although the effect size remained similar.

4. Discussion

People who smoked who reported higher levels of motivation to stop smoking at baseline were significantly more likely to make a serious quit attempt over 12-month follow-up. Greater mean monthly tobacco

control mass media expenditure between baseline and 12-month follow-up was associated with increased odds of making a quit attempt over this period. The data provided evidence that mass media expenditure did not moderate the association between baseline motivation to stop and subsequent quit attempts.

The association we observed between motivation to stop smoking and quit attempts is well documented in the Smoking Toolkit Study (Beard et al., 2020; Kotz et al., 2013; Smit et al., 2011) and other surveys (Kotz et al., 2013; Borland et al., 2010). Evidence linking tobacco control mass media campaigns with quit attempts has been less consistent, with some studies linking mass media campaigns (and expenditure thereon) with modest increases in quit attempts (McAfee et al., 2013; Kuipers et al., 2020; Wakefield et al., 2011) and others reporting no significant association (Kuipers et al., 2018; Beard et al., 2020; McPhee et al., 1995). While previous studies in England have not found evidence of an effect of mass media expenditure on quit attempts (Kuipers et al., 2018; Beard et al., 2020), our results show a significant benefit, adding to the rationale for the continued funding of mass media campaigns. The point estimate we observed (OR = 1.13) is consistent with previous evidence suggesting campaigns delivered to whole populations can generally expect smaller effect sizes than those delivered to several hundreds or thousands of individuals (e.g., drug or behavioural therapies) (Durkin et al., 2012). Nonetheless, this does not detract from the value of these campaigns for smoking cessation. While it may be the case that associations with quit attempts are relatively small, making them difficult to detect, the broad reach of these campaigns means this degree of change in quitting activity has the potential to translate to meaningful increases at the population-level. It is important that further studies are adequately powered to detect associations of this size in order not to overlook the benefits of large-scale mass media campaigns on smoking outcomes. In addition, a number of studies have documented a strong relationship between tobacco control mass media campaigns and quit success – rather than quit attempt – rates (Durkin et al., 2012; Kuipers et al., 2018; Bala et al., 2017; Beard et al., 2020). For example, a time

Table 2

Associations between motivation to stop smoking at baseline and past-year quit attempts at follow-up ($n = 2,601$).

	Model 1: unadjusted ¹			Model 2: adjusted ²			Model 3: adjusted ³			Model 4: adjusted ⁴		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Primary analysis												
Baseline motivation to stop ⁵	1.37	1.32–1.44	<0.001	1.37	1.31–1.43	<0.001	1.37	1.31–1.43	<0.001	1.37	1.31–1.43	<0.001
Mass media expenditure ⁶	–	–	–	–	–	–	1.13	1.05–1.23	0.002	1.11	0.98–1.26	0.091
Interaction between baseline motivation to stop and mass media expenditure	–	–	–	–	–	–	–	–	–	1.01	0.97–1.05	0.683
Sensitivity analysis 1⁷												
Baseline motivation to stop	1.37	1.32–1.44	<0.001	1.27	1.21–1.33	<0.001	1.27	1.21–1.34	<0.001	1.27	1.21–1.34	<0.001
Mass media expenditure	–	–	–	–	–	–	1.11	1.03–1.21	0.011	1.09	0.96–1.24	0.188
Interaction between baseline motivation to stop and mass media expenditure	–	–	–	–	–	–	–	–	–	1.01	0.97–1.06	0.638
Sensitivity analysis 2⁸												
Baseline motivation to stop	1.35	1.28–1.43	<0.001	1.34	1.26–1.42	<0.001	1.34	1.27–1.42	<0.001	1.34	1.27–1.42	<0.001
Mass media expenditure	–	–	–	–	–	–	1.10	0.98–1.23	0.097	1.09	0.91–1.30	0.357
Interaction between baseline motivation to stop and mass media expenditure	–	–	–	–	–	–	–	–	–	1.01	0.95–1.07	0.872

CI, confidence interval. OR, odds ratio.

¹ Main effect of baseline motivation to stop, no adjustment for covariates.

² Main effect of baseline motivation to stop, adjusted for age, sex, occupational social grade, and region in England.

³ Main effects of baseline motivation to stop and mass media expenditure, adjusted for age, sex, occupational social grade, and region in England.

⁴ Main effects of baseline motivation to stop, mass media expenditure, and the interaction between baseline motivation to stop and mass media expenditure, adjusted for age, sex, occupational social grade, and region in England.

⁵ Motivation to Stop Scale: 0 (I don't want to stop smoking) to 6 (I REALLY want to stop smoking and intend to in the next month).

⁶ Mean monthly tobacco control mass media expenditure between baseline and 12-month follow-up, z-transformed.

⁷ Models 2 and 3 additionally adjusted for past-year quit attempts reported at baseline.

⁸ Definition of quit attempts restricted to those that occurred in the first 6 months of the follow-up period; tobacco control mass media expenditure as mean monthly spend over the same period (i.e. baseline to 6 months), z-transformed.

series analysis of data between 2008 and 2016 showed that a 10% increase in monthly expenditure on tobacco control mass media campaigns in England was associated with a 0.5% increase in the success rate of quit attempts (Kuipers, Beard, West, & Brown, 2018). As the overall rate of cessation is a function of quit attempts and success, establishing a way to further increase quit attempts via mass media campaigns would increase the number of quits these campaigns generate and provide a greater return on investment (Atusingwize et al., 2015).

Our primary interest was whether tobacco control mass media expenditure moderated the association between baseline motivation to stop and future quit attempts. That is, if expenditure on mass media campaigns is increased, does this strengthen the association between motivation to stop and quit attempts (indicating mass media expenditure is more effective in ‘converting’ quit attempts among those motivated to quit)? Alternatively, does it weaken this association (indicating mass media expenditure is more effective in generating quit attempts in those who are less/unmotivated), or does this association not differ? We found no significant interaction between baseline motivation to stop and tobacco control mass media expenditure on quit attempts. Bayes factors provided evidence for the null (i.e., no evidence of moderation) compared with modest associations. This suggests that insofar that spending more on tobacco control mass media campaigns leads to small increases in the rate of quit attempts among people who smoke, it is likely to be similar across those with different levels of motivation to stop. Further research is needed to understand to what extent, and among which groups of people who smoke, mass media campaigns may increase quit attempts. In addition to the amount spent on them, the content of campaigns should be considered (Langley et al., 2013; Sims et al., 2016; Richardson et al., 2014). It is plausible that certain types of messaging may be more or less effective in prompting quit attempts depending on individuals’ level of motivation to stop.

Key strengths of this study were the prospective design and collection of baseline data over a six-year period. These features were essential in enabling us to analyse the impact of national tobacco control mass media expenditure, which varied over the study period, on the association between people’s level of motivation to stop smoking and their likelihood of making a future quit attempt. However, there were also limitations. First, while the Smoking Toolkit Study’s baseline survey recruits a nationally representative sample, there was a high rate of attrition. Those who responded to the follow-up survey differed from those who did not on several variables, meaning the results may not generalise to all people who smoke in England. There could be respondent bias related to quit attempts, whereby people who made quit attempts and especially those who succeeded may have been more likely to respond. Secondly, we relied on self-reports of quit attempts. This introduces scope for error, as failed quit attempts may be forgotten quickly, which may have reduced our ability to detect an association between mass media expenditure and quit attempts. Future studies could look at more immediate measures of quitting activity. Thirdly, we only considered expenditure on national tobacco control mass media campaigns. We controlled for region to account for the influence of any regional campaigns, but the classification was broad (North, Central, South) and may not fully capture the effect of local tobacco control activity (e.g., in Greater Manchester or the Northeast, which have dedicated regional tobacco control programmes). Fourthly, our measure of exposure to mass media campaigns was the level of monthly expenditure averaged across the 12-month follow-up period. While we ran a sensitivity analysis using data over a shorter interval and saw a consistent pattern of results, averaging mass media expenditure in this way may underestimate associations with quit attempts given previous evidence suggesting any effect of such campaigns on quitting behaviour may be closely related to the month of the campaign (Wakefield et al., 2011; Langley et al., 2012). Finally, this study was conducted in England, so results may not generalise to other countries with different levels of tobacco control activities and infrastructure. In particular, the UK has a much more advanced system of provision of cessation support

embedded in its healthcare system than most other countries, which might influence outcomes.

In conclusion, the self-reported level of motivation to stop smoking among people who smoked predicted whether they made a quit attempt in the subsequent year. Increased expenditure on tobacco control mass media was associated with increased quit attempts. The association between motivation and quit attempts did not differ according to mean monthly expenditure on national tobacco control mass media campaigns over this period.

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CRediT authorship contribution statement

Sarah E. Jackson: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft. **Lion Shahab:** Conceptualization, Funding acquisition, Investigation, Methodology, Writing – review & editing. **Jamie Brown:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

- Atusingwize, E., Lewis, S., & Langley, T. (2015). Economic evaluations of tobacco control mass media campaigns: A systematic review. *Tobacco Control*, 24, 320–327.
- Bala, M. M., Strzeszynski, L., & Topor-Madry, R. (2017). Mass media interventions for smoking cessation in adults. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD004704.pub4>
- Bartley, M. (2016). *Health inequality: An introduction to concepts, theories and methods*. John Wiley & Sons.
- Beard, E., Dienes, Z., Muirhead, C., & West, R. (2016). Using Bayes factors for testing hypotheses about intervention effectiveness in addictions research. *Addiction (Abingdon, England)*, 111, 2230–2247.
- Beard, E., Jackson, S. E., West, R., Kuipers, M. A. G., & Brown, J. (2020). Population-level predictors of changes in success rates of smoking quit attempts in England: A time series analysis. *Addiction*, 115, 315–325.
- Beard, E., Jackson, S. E., West, R., Kuipers, M. A. G., & Brown, J. (2020). Trends in attempts to quit smoking in England Since 2007: A time series analysis of a range of population-level influences. *Nicotine & Tobacco Research*, 22, 1476–1483.
- Borland, R., Yong, H.-H., Balmford, J., Cooper, J., Cummings, K. M., O’Connor, R. J., et al. (2010). Motivational factors predict quit attempts but not maintenance of smoking cessation: Findings from the International Tobacco Control Four country project. *Nicotine & Tobacco Research*, 12(Suppl), S4–S.
- Brown, J., Kotz, D., Michie, S., Stapleton, J., Walmsley, M., & West, R. (2014). How effective and cost-effective was the national mass media smoking cessation campaign ‘Stoptober’? *Drug and Alcohol Dependence*, 135, 52–58.
- Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: A scoping review. *Health Psychology Review*, 9, 323–344.
- Davis, K. C., Murphy-Hoefer, R., Levine, B., King, B. A., Hu, S., & Rodes, R. (2019). Evidence of the impact of the tips from former smokers campaign: results from the behavioral risk factor surveillance system. *Preventing Chronic Disease*, 16, E137.
- Davis, K. C., Patel, D., Shafer, P., Duke, J., Glover-Kudon, R., Ridgeway, W., et al. (2018). Association between media doses of the tips from former smokers campaign and cessation behaviors and intentions to quit among cigarette smokers, 2012–2015. *Health Education & Behavior*, 45, 52–60.
- Dienes, Z. (2014). Using Bayes to get the most out of non-significant results. *Frontiers in Psychology*, 5. <https://doi.org/10.3389/fpsyg.2014.00781>
- Durkin, S., Bayly, M., Brennan, E., Biener, L., & Wakefield, M. (2018). Fear, sadness and hope: Which emotions maximize impact of anti-tobacco mass media advertisements among lower and higher SES groups? *Journal of Health Communication*, 23, 445–461.
- Durkin, S., Brennan, E., & Wakefield, M. (2012). Mass media campaigns to promote smoking cessation among adults: An integrative review. *Tobacco Control*, 21, 127–138.
- Fidler, J. A., Shahab, L., West, O., Jarvis, M. J., McEwen, A., Stapleton, J. A., et al. (2011). ‘The smoking toolkit study’: A national study of smoking and smoking cessation in England. *BMC Public Health*, 11, 479.

- Ipsos Encyclopedia – Gross Rating Point. Ipsos. <<https://www.ipsos.com/en/ipsos-encyclopedia-gross-rating-point>>. Accessed 23 Feb2022.
- Jackson, S. E., Beard, E., Kujawski, B., Sunyer, E., Michie, S., Shahab, L., et al. (2019). Comparison of trends in self-reported cigarette consumption and sales in England, 2011 to 2018. *JAMA Network Open*, 2, e1910161.
- Jeffreys, H. (1961). *The theory of probability*. Oxford: Clarendon Press.
- Kotz, D., Brown, J., & West, R. (2013). Predictive validity of the Motivation To Stop Scale (MTSS): A single-item measure of motivation to stop smoking. *Drug and Alcohol Dependence*, 128, 15–19.
- Kuipers, M. A. G., Beard, E., West, R., & Brown, J. (2018). Associations between tobacco control mass media campaign expenditure and smoking prevalence and quitting in England: A time series analysis. *Tobacco Control*, 27, 455–462.
- Kuipers, M. A. G., West, R., Beard, E. V., & Brown, J. (2020). Impact of the 'Stoptober' smoking cessation campaign in England From 2012 to 2017: A quasiexperimental repeat cross-sectional study. *Nicotine & Tobacco Research*, 22, 1453–1459.
- Langley, T., Lewis, S., McNeill, A., Gilmore, A., Szatkowski, L., West, R., et al. (2013). Characterizing tobacco control mass media campaigns in England. *Addiction (Abingdon, England)*, 108, 2001–2008.
- Langley, T. E., McNeill, A., Lewis, S., Szatkowski, L., & Quinn, C. (2012). The impact of media campaigns on smoking cessation activity: A structural vector autoregression analysis. *Addiction (Abingdon, England)*, 107, 2043–2050.
- McAfee, T., Davis, K. C., Alexander, R. L., Pechacek, T. F., & Bunnell, R. (2013). Effect of the first federally funded US antismoking national media campaign. *The Lancet London England*, 382, 2003–2011.
- McAfee, T., Davis, K. C., Shafer, P., Patel, D., Alexander, R., & Bunnell, R. (2017). Increasing the dose of television advertising in a national antismoking media campaign: Results from a randomised field trial. *Tobacco Control*, 26, 19–28.
- McPhee, S. J., Jenkins, C. N., Wong, C., Fordham, D., Lai, K. Q., Bird, J. A., et al. (1995). Smoking cessation intervention among Vietnamese Americans: A controlled trial. *Tobacco Control*, 4, S16–S24.
- Michie, S., Johnston, M., Abraham, C., Lawton, R., Parker, D., & Walker, A. (2005). Making psychological theory useful for implementing evidence based practice: A consensus approach. *BMJ Quality and Safety*, 14, 26–33.
- Murphy-Hoefer, R., Davis, K. C., King, B. A., Beistle, D., Rodes, R., & Graffunder, C. (2020). Association between the tips from former smokers campaign and smoking cessation among adults, United States, 2012–2018. *Preventing Chronic Disease*, 17, E97.
- NHS Digital. Smoking. Health Surv. Engl. 2020. <<http://healthsurvey.hscic.gov.uk/data-visualisation/data-visualisation/explore-the-trends/smoking.aspx>>. Accessed 12 Mar2023.
- Office for National Statistics. Adult smoking habits in England: 2021, 2022. <<https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/datasets/adultsmokinghabitsinengland>>. Accessed 7 Feb2022.
- Richardson, S., Langley, T., Szatkowski, L., Sims, M., Gilmore, A., McNeill, A., et al. (2014). How does the emotive content of televised anti-smoking mass media campaigns influence monthly calls to the NHS Stop Smoking helpline in England? *Preventive Medicine*, 69, 43–48.
- Sims, M., Langley, T., Lewis, S., Richardson, S., Szatkowski, L., McNeill, A., et al. (2016). Effectiveness of tobacco control television advertisements with different types of emotional content on tobacco use in England, 2004–2010. *Tobacco Control*, 25, 21–26.
- Smit, E. S., Fidler, J. A., & West, R. (2011). The role of desire, duty and intention in predicting attempts to quit smoking. *Addiction (Abingdon, England)*, 106, 844–851.
- Terry-McElrath, Y. M., Emery, S., Wakefield, M. A., O'Malley, P. M., Szczypka, G., & Johnston, L. D. (2013). Effects of tobacco-related media campaigns on young adult smoking: Longitudinal data from the United States. *Tobacco Control*, 22, 38–45.
- Vangeli, E., Stapleton, J., Smit, E. S., Borland, R., & West, R. (2011). Predictors of attempts to stop smoking and their success in adult general population samples: A systematic review. *Addiction (Abingdon, England)*, 106, 2110–2121.
- Wakefield, M. A., Loken, B., & Hornik, R. C. (2010). Use of mass media campaigns to change health behaviour. *Lancet*, 376, 1261–1271.
- Wakefield, M. A., Spittal, M. J., Yong, H.-H., Durkin, S. J., & Borland, R. (2011). Effects of mass media campaign exposure intensity and durability on quit attempts in a population-based cohort study. *Health Education Research*, 26, 988–997.
- West, R., & Michie, S. (2020). A brief introduction to the COM-B Model of behaviour and the PRIME theory of motivation. *Qeios*. <https://doi.org/10.32388/WW04E6>
- World Health Organization. WHO Framework Convention on Tobacco Control. World Health Organization: Geneva, 2003<https://www.who.int/tobacco/control/measures_art_12/en/>. Accessed 7 Apr2020.