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The impact of TV mass media campaigns on calls to a National Quitline and the use of prescribed nicotine replacement therapy: a structural vector autoregression analysis

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ABSTRACT

Aims To estimate (1) the immediate impact; (2) the cumulative impact; and (3) the duration of impact of Scottish tobacco control TV mass media campaigns (MMCs) on smoking cessation activity, as measured by calls to Smokeline and the volume of prescribed nicotine replacement therapy (NRT). **Design** Multivariate time–series analysis using secondary data on population level measures of exposure to TV MMCs broadcast and smoking cessation activity between 2003 and 2012. **Setting and participants** Population of Scotland. **Measurements** Adult television viewer ratings (TVRs) as a measure of exposure to Scottish mass media campaigns in the adult population; monthly calls to NHS Smokeline; and the monthly volume of prescribed NRT as measured by gross ingredient costs (GIC). **Findings** Tobacco control TVRs were associated with an increase in calls to Smokeline but not an increase in the volume of prescribed NRT. A 1 standard deviation (SD) increase of 194 tobacco control TVRs led to an immediate and significant increase of 385.9 [95% confidence interval (CI) = 171.0, 600.7] calls to Smokeline (unadjusted model) within 1 month. When adjusted for seasonality the impact was reduced, but the increase in calls remained significant (226.3 calls, 95% CI = 37.3, 415.3). The cumulative impact on Smokeline calls remained significant for 6 months after broadcast in the unadjusted model and 18 months in the adjusted model. However, an increase in tobacco control TVRs of 194 failed to have a significant impact on the GIC of prescribed NRT in either the unadjusted (£1361.4, 95% CI = –£9138.0, £11860.9) or adjusted (£6297.1, 95% CI = –£2587.8, £15182.1) models. **Conclusions** Tobacco control television mass media campaigns broadcast in Scotland between 2003 and 2012 were effective in triggering calls to Smokeline, but did not increase significantly the use of prescribed nicotine replacement therapy by adult smokers. The impact on calls to Smokeline occurred immediately within 1 month of broadcast and was sustained for at least 6 months.

Keywords Mass media campaign, multivariate time–series analysis, NRT, smoking cessation, structural vector autoregressive model, tobacco control.

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INTRODUCTION

Mass media campaigns (MMCs) have been used widely as part of public health strategies to influence health behaviours. The mediums of television and radio, with their considerable reach into the general population, have been used most commonly to deliver health messages on tobacco control [1]. There is a growing body of international evidence that MMCs can prevent both the uptake of smoking in young people and promote smoking cessation in adults [2–6]. Most recently, evidence from England has shown that TV MMCs are effective in triggering quitting behaviour in adults and were responsible for an 11.2% decline in cigarette consumption and 13.5% of the decline in prevalence between 2002 and 2009 [7]. However, English studies also found that while the broadcast of TV MMCs was associated with an increase in calls to the national Quitline, there was no significant impact on either prescribed or over-the-

counter (OTC) nicotine replacement therapy (NRT) [8]. Campaigns that generated negative emotions were the most recalled, but recall did not necessarily translate into quitting behaviour [9]. Instead, both types of campaign had an effect upon important measures of quitting behaviour—quitline calls, quit attempts and prevalence. However, consumption among smokers was affected only by campaigns evoking negative emotions [7].

The importance of TV MMCs has been recognized by The World Health Organization, which recommends that high-income countries spend approximately one-quarter of their tobacco control budgets on these [10]. This was the case in Scotland and the rest of the United Kingdom in the first decade of the 21st century, when TV MMCs were one of the central pillars of tobacco control strategies [11,12]. However, they are expensive to develop and must be broadcast with sufficient, reach, intensity and duration to promote quitting and reduce smoking prevalence, particularly in lower-income smokers [5]. This adds further to the cost of the intervention, and with continuing pressure on public health expenditure, both English and Scottish Governments reduced investment in TV MMCs. In England, there were no TV MMCs for a period of 17 months from April 2010, and after that the return to TV advertising in September 2011 was at a much lower intensity than before the freeze [13]. In Scotland, no TV MMCs were broadcast between April 2009 and December 2011, with only one further campaign following that in early 2012 (see TVR data presented in Fig. 1). As in England, the expense of the development and broadcast of new TV MMCs was considered prohibitive. The focus has now shifted to smaller, less expensive community-based events which have much less reach into the smoking population. An analysis of the impact of the English freeze found that it was associated with a reduction in quitting behaviour [7]. This change in strategy is also at odds with evidence from a systematic review of 10 economic evaluations which, although unable to conduct a meta-analysis due to heterogeneity, concluded that MMCs still represent 'good value for money' [14].

Targets for reducing smoking prevalence have been set in the United Kingdom. In England, the most recent target was to reduce adult smoking prevalence from 21.2% in 2009/10 to 18.5% or less by 2015 [15], while in Scotland a longer-term target to reduce smoking prevalence from 20% in 2013 to 5% or less by 2034 has been set [16]. How achievable this longer-term target is will depend largely upon the extent to which smokers in lower socio-economic groups (whose smoking prevalence are nearly twice the national average [17,18]) can be encouraged to quit smoking. A recent literature review found that higher MMC exposure appears to confer greater benefit on socio-economically disadvantaged smokers, while message type and emotional content have the potential to both increase and reduce socio-economic inequalities in smoking [19]. The authors of the review concluded that negative health messages that elicit negative emotions are more effective at increasing knowledge and generating quit attempts compared with other kinds of messages, for which there is more mixed evidence. However, disentangling which elements (which often co-occur) contribute to the observed effects is difficult to ascertain.

Given the importance of reaching smokers of lower socio-economic status [5] and the recent switch in investment from tobacco control TV MMCs to lower-reach community-based campaigns, it is now even more important to understand what contribution TV MMCs can make to increasing quitting behaviour in adult smokers and ultimately to reducing smoking prevalence.

Here we report the first results of a study which aimed to estimate (1) the immediate impact; (2) the cumulative impact; and (3) the duration of impact of Scottish tobacco control MMCs (which ran between 2003 and 2012) on

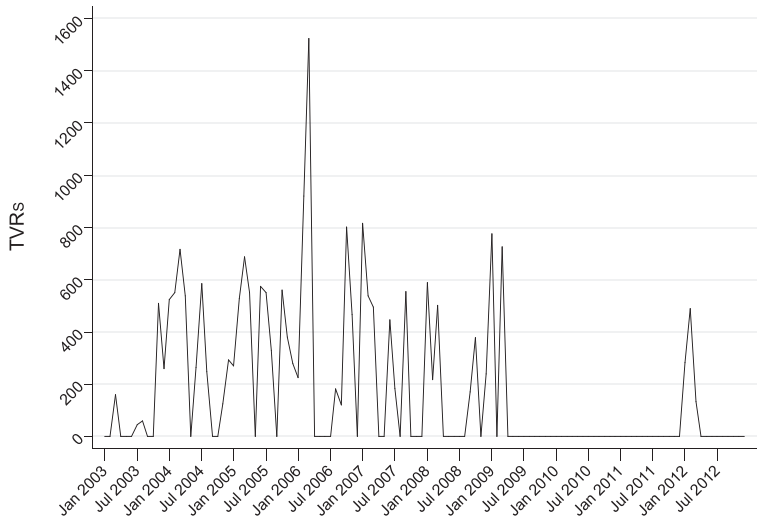

Figure 1 Television ratings (TVRs) for tobacco control mass media campaigns (MMCs), January 2003–December 2012

indicators of smoking cessation activity, calls to Smokeline and the volume of prescriptions for NRT. We focused specifically upon TV MMCs as, although leaflets and information packs were also made available, the TV components represented the major part of the campaigns and exposure in the general population could more easily estimated.

METHOD

Design

We adopted a multivariate time–series approach called 'structural vector autoregression' (SVAR). This is a standard econometric method of analysis for estimating the effects and impacts of a number of different time–series on each other. SVAR has the useful property of being able to incorporate contemporaneous effects between the series which a standard VAR does not allow.

Measures

We used 30-second equivalized television rating points (TVRs) [20] as a population measure of exposure to tobacco control TV MMCs. This is a standardized estimate of broadcasting reach into the population. TVR is defined as the estimated percentage of a specified audience that has seen any particular advert during a TV commercial break. Data for TVRs for the Scottish adult population were supplied by Mediacom [21] for all tobacco control TV MMCs that were broadcast in Scotland between January 2003 and December 2012. Monthly TVRs were derived by aggregating tobacco control TVRs for each month. TVR data for tobacco control advertisements broadcast by terrestrial TV in England were not included in the analysis because they had only partial reach into the Scottish population.

We used two main outcome measures in our analysis: (i) monthly calls to Smokeline—Scotland's national Smokeline—and (ii) monthly values for gross ingredient cost (GIC) of NRT. GIC of NRT is the cost of NRT before the deduction of any discounts or special payments made to those prescribing or dispensing the drug. It includes any costs reimbursed fully or partially via prescription charges and therefore reflects most accurately the volume of prescriptions rather than simply the number of prescriptions [17]. Both are regarded as important indicators of smoking cessation activity [8,22–24].

Calls to Smokeline were obtained for January 2003–August 2012 inclusive from National Health Service (NHS) Health Scotland. Data on GIC were supplied by the Practitioner Services Division (PSD) of the Scottish National Health Service. PSD is responsible for the pricing and processing of all prescriptions that are dispensed outside hospital, either by community pharmacies or dispensing practices. They also collect data on prescriptions that are issued in Scotland but are dispensed elsewhere in the United Kingdom.

Statistical analyses

In a standard VAR, each estimating equation contains lags of all the other series, with seasonality and trends incorporated where appropriate. Other factors that are hypothesized to affect the evolution of one or more series over time, such as intervention effects or outliers, can also be integrated into the model.

A VAR model is atheoretical, in the sense that all the time–series and their lags are allowed to affect each other because the direction of causality between individual series cannot be determined easily. When theoretical considerations suggest an underlying causality to the model, we can incorporate this causality by placing restrictions on the coefficients in the VAR, which results in a SVAR. SVARs have the useful property of being able to incorporate contemporaneous effects between the series which a normal VAR does not allow [25].

In our analysis we have assumed that there is an underlying temporal causality, in that TVRs will affect calls to Smokeline which, in turn, will impact upon demand for NRT. We also hypothesize that TVRs may have a direct impact on demand for NHS NRT prescriptions, but did not test this in our analysis.

All three series—the measure of exposure and the two outcome measures—were adjusted for differing month length using the formula, for example GIC × (365.25/12)/days per month [26], with the GIC series adjusted further for trading day effects.

Prior to estimation, we checked the mean and variance properties of the series to look for non-stationarity (i.e. strong trends and changing variance) using standard unit root tests [27,28]. The results indicated the presence of a unit root, indicating non-stationarity in both Smokeline calls and NRT volume (GIC) series but not in the TVR series. The presence of a unit root often leads researchers using multivariate time–series to difference the data [29]. However, in the econometric literature this is considered inefficient, as the loss of information through differencing (the elimination of trends, for example) outweighs the gains in estimation [30,31]. We therefore chose to estimate our SVAR in levels; that is, using their actual values [32–35]. Estimation in levels also has the additional benefit of clarifying the outputs of the model, as results are interpreted using the original scale of the variable. With differenced data the results are interpreted as growth rates, which is intuitively less appealing.

In addition to calls to Smokeline, NRT volume and TVRs, we also incorporated into the model four exogenous variables: the implementation of the smoke-free legislation in Scotland in March 2006, monthly adult smoking

population, monthly inflation-adjusted price of cigarettes and trend [36]. These variables are necessary to capture the exogenous influences on quitting behaviour in addition to the effects of exposure to TV MMCs on calls to Smokeline and volume of prescribed NRT.

All series exhibited strong seasonality, so we ran two different SVAR models, one which modelled the seasonality directly in each equation and a second in which the seasonality was removed. Running separate models allowed us a clearer understanding of the impact that seasonality has on calls to Smokeline and NRT volume. To remove seasonality, we used the X13 autoregressive integrated moving average (ARIMA) technique incorporated within the Eviews 9.5 econometric software package [37]. This generated a new time–series but with the influence of seasonal and outlier effects reduced significantly.

SVAR estimation requires a lag structure to be specified for the model, so we used the Akaike information criterion (AIC) [38], the Schwarz Bayesian Information Criterion (SIC) [39] and the Hannan–Quinn Information Criterion (HQ) [40] statistics to determine the optimal number of lags to include. To ensure that the model was a good fit and had normally distributed and white noise (or random) residuals, we conducted tests of residual autocorrelation and skewness and fine-tuned the lag length in order to extract as much of the dynamic movement in the series as possible.

The results are presented using impulse response functions (IRF) and cumulative impulse response functions (CIRF). These functions reveal the response of one series after it has been impacted by another series and traces out the accumulation of such shocks over a specified period of time. Thus, in this case, the IRFs show the impact of a sudden increase in TVRs on calls to Smokeline and on volume of NRT during an 18-month period. We first calculated IRFs and CIRFs of an impulse of TVRs on calls to Smokeline and repeated this for the NRT. All analyses were conducted using Stata version 14.1, with the exception of the deseasonalizing, which was performed using Eviews 9.5 [37].

RESULTS

Estimated adult exposure to tobacco control TV MMCs

Figure 1 shows the TVRs plotted from January 2003 to December 2012. TVRs exhibit peaks and troughs up to early 2009, after which there were no tobacco control TV MMCs for almost 2 years and 9 months until early 2012, when there was a limited number of MMCs for a few months in 2012. While there is some variation across years, MMCs tended to occur at the beginning and end of the calendar year, and were of longer duration between 2003 and 2007.

Pattern of calls to Smokeline and volume of prescribed NRT

Calls to Smokeline (Fig. 2) show a gentle downward trend and considerable variability and seasonality between 2003 and 2007. Thereafter, volatility is lower and the downward trend levels off.

In Fig. 3, the volume of NRT displays strong seasonality and an upward underlying trend. NRT volume peaks in early 2006 before declining and then picking up again in 2009.

The statistical information criteria for the underlying seasonally unadjusted VAR model suggested that a lag length of 1 was the most appropriate lag structure to use. However, the Lagrange multiplier tests [41] for residual autocorrelation indicated that there was still some residual correlation in the model that was not captured by one lag and some residual seasonality. Therefore, we re-estimated

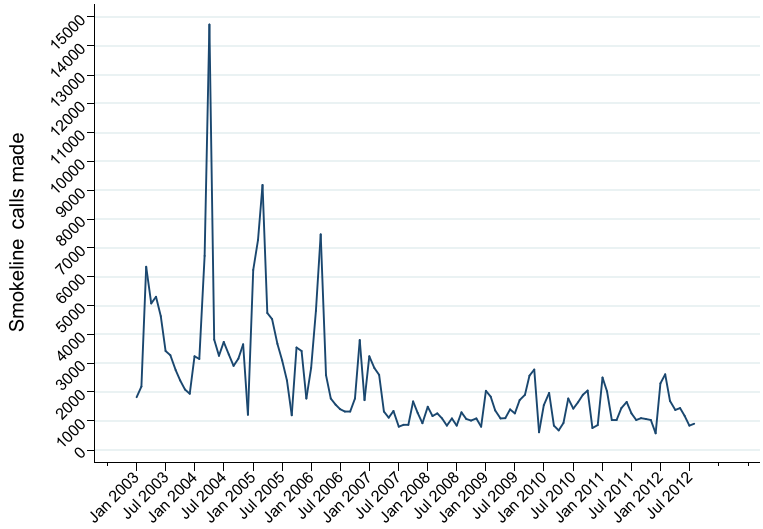

Figure 2 Calls to Smokeline, January 2003–August 2012. [Colour figure can be viewed at wileyonlinelibrary.com]

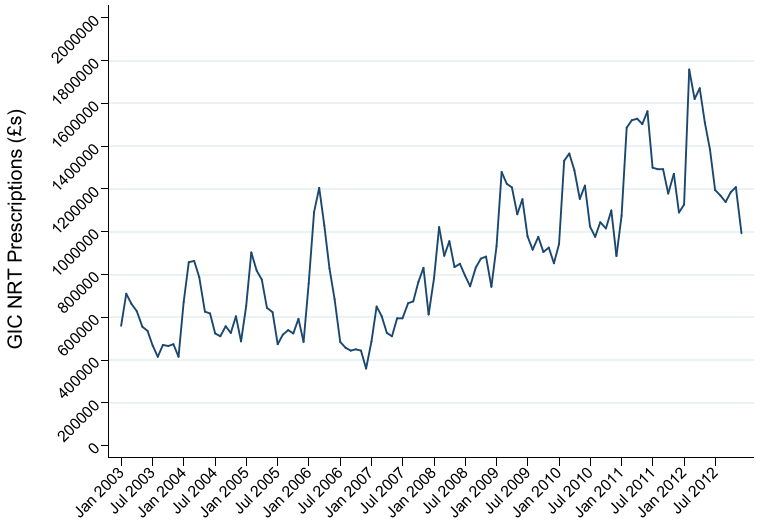

Figure 3 Gross ingredient costs (GIC) of National Health Service (NHS) prescriptions for nicotine replacement therapy (NRT), January 2003–December 2012. [Colour figure can be viewed at wileyonlinelibrary.com]

the SVAR model with an additional four lags (i.e. five lags in total). Diagnostic tests suggested that the resulting errors were white noise, with the underlying VAR also satisfying the stability condition [29].

Short-term impact of TVRs on calls to Smokeline and volume of NRT

The immediate effects for both the seasonality unadjusted and adjusted models are compared in Table 1. We interpret the immediate effect in the seasonally unadjusted model, as a 1 standard deviation (SD) increase in tobacco control MMC TVRs, equivalent to194 TVRs, resulted in an immediate 385.9 [95% confidence interval (CI) = 171.0, 600.7] increase in calls to Smokeline within 1 month, while in the seasonally adjusted model the impact was smaller, resulting in an increase of 226.3 (95% CI = 37.3, 415.3) calls. The impact of MMC TVRs on volume of prescriptions for NRT failed to reach significance in both the seasonally unadjusted and adjusted models. In absolute terms, and using the unadjusted model as an example, the average monthly broadcast of tobacco control during the study period was 179 TVRs, and this led to an additional 356.1 calls per month to Smokeline and increased NRT monthly costs of £1256.1. The highest monthly broadcast was 1496 TVRs, and this resulted in 2975.8 additional calls to Smokeline and NRT costs of £10498.2.

Cumulative and duration of impact of TV MMCs on calls to Smokeline and volume of prescribed NRT

The results of running SVAR models on the seasonally unadjusted data over 18 months are presented in Figs 4–7, and illustrate both the contemporaneous and cumulative impacts of TV advertising on calls to Smokeline and NRT prescribing, respectively. The plots of the seasonally adjusted data are available in online Supporting information tables.

Figure 4 shows the immediate and positive impact of a 1 SD increase in tobacco control MMCs on Smokeline calls. The impact decreases after 2 months, remains constant for 3 months and then drops for 1 month, and finally rises and dies out after the 8th month. The cumulative impulse responses in Fig. 5 have a statistically significant effect throughout the 6-month horizon. Initially, TVRs lead to a rapid increase of 634.4 (95% CI = 269.1, 999.7) in Smokeline calls during the first month and increase gradually to a cumulative increase in TVRs of approximately 730.2 (95% CI = 114.1, 1346.2) up to 5 months, and then decreases.

Table 1 Results of structural vector autoregression (SVAR) model—short-term contemporaneous effects.

		Seasonally unadjusted SVAR (absolute values)		*Seasonally adjusted SVAR (absolute values)*	
Exposure	*Outcome*	*IRF*	*95% CI*	*IRF*	*95% CI*
Tobacco control TVRs	Smokeline Calls	385.9	171.0 to 600.7	226.3	37.3 to 415.3
	GIC NRT	1361.4	–£9138.0 to £11860.9	6297.1	–£2587.8 to £15182.1

SVAR = structural vector autoregression; IRF = impulse response functions; CI = confidence interval; GIC = gross ingredient costs; NRT = nicotine replacement therapy.

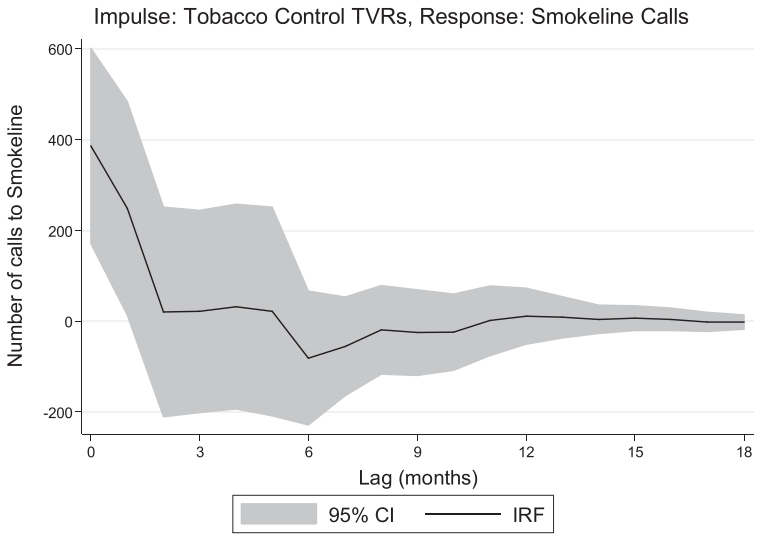

Figure 4 Impulse response function (IRF): impact of tobacco control television rating (TVRs) on Smokeline calls (seasonally unadjusted model)

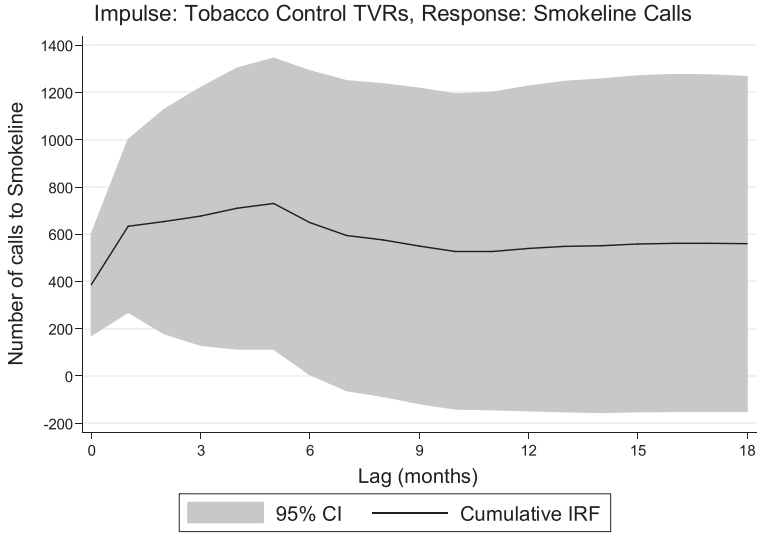

Figure 5 Cumulative impulse response function (CIRF): impact of tobacco control television ratings (TVRs) on Smokeline calls (seasonally unadjusted model)

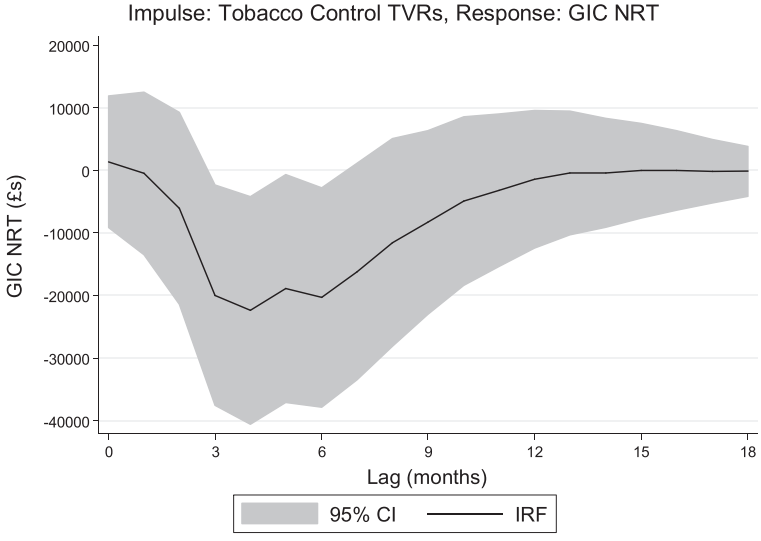

Figure 6 Impulse response function (IRF): impact of tobacco control television ratings (TVRs) on nicotine replacement therapy (NRT) costs (seasonally unadjusted model). GIC = gross ingredient costs

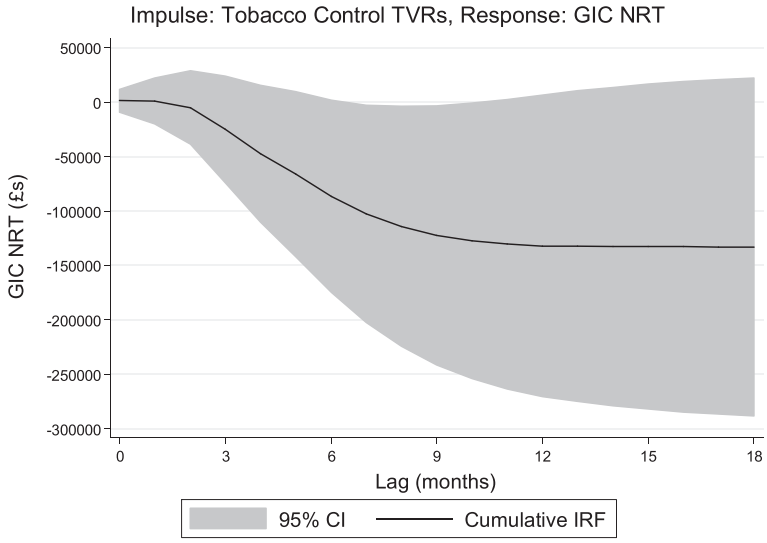

Figure 7 Cumulative impulse response function (CIRF): impact of tobacco control television ratings (TVRs) on nicotine replacement therapy (NRT) costs (seasonally unadjusted model). GIC =gross ingredient costs

As can be seen in Fig. 6, the immediate impact of an increase in TVRs on volume of prescribed NRT is much smaller. A 1 SD increase in TVRs leads to an immediate £1361.4 increase in GIC. The effect decreases up to 3 months, then levels out with some variations and starts to decrease after 6 months.

The cumulative effect of tobacco control TVRs on NRT volume is shown in Fig. 7. There is no statistically significant impact over the entire 18 months.

DISCUSSION

Our findings demonstrate that there is a positive relationship between tobacco control TV MMCs and calls to Smokeline, an indicator of quitting behaviour. A modest increase in exposure to tobacco control TV advertising by 1 SD, or 194 TVRs, resulted in an immediate 386 increase within 1 month in number of calls to Smokeline and a smaller and non-significant increase in the GIC of prescribed NRT of £1361.4. The impact upon Smokeline calls was cumulative, and was sustained for at least 6 months.

Our findings are similar to a recent study of English tobacco control TV MMCs [8]. Using a similar methodology, they also found that TV MMCs resulted in an immediate increase in calls to quitline, but unlike the present study there was no cumulative effect. The English study also failed to detect a significant effect on prescribed NRT. However, in a separate analysis of NRT advertising by pharmaceutical companies, the English study found a significant short-term increase within a month in OTC purchases of NRT, but not NHS prescriptions for NRT. Scottish data were not available to conduct an equivalent analysis.

The sustained impact of the Scottish TV MMCs upon Smokeline calls compared with the English study is striking, and may be linked to a higher proportion of advertisements that included the Smokeline number. However, the ethos underpinning the Scottish TV MMCs with a smoking cessation theme was that they should be supportive, show how to quit and evoke positive emotions about quitting [42]. On balance, the current evidence suggests that negative health messages warning of the health consequences of smoking and/or testimonial adverts have been shown to motivate calls to quitlines [5]. Further analyses of our Scottish data will help to untangle the relationship between message type, emotional content and impact.

The lack of an impact of TV MMCs on the volume of prescribed NRT is disappointing. However, the decision to focus exclusively upon positive messages in the Scottish smoking cessation campaigns and avoid negative health messages could account for this. Furthermore, the volume of NRT prescriptions continued to rise annually from 2008 onwards, at a time when there were no (or very few) TV MMCs. This rise appears to have been independent of TV MMCs, driven largely by the rapid expansion and uptake of support from smoking cessation services, which included the provision of prescribed NRT, during this period. This may have had the effect of obscuring any impact of TV MMCs on the use of prescribed NRT.

In this paper we have presented both seasonally unadjusted and adjusted results (seasonally adjusted series are available in the Supporting information tables). However, TVRs for tobacco control MMCs, calls to Smokeline and volume of prescribed NRT are all strongly seasonally patterned, and we were unable to separate out seasonal effects due to advertising and other factors independent of advertising. Therefore, in practice, the true size of effects of tobacco control advertising are likely to lie somewhere between our adjusted and unadjusted models.

The strengths of the study are the long duration (2003–2012) and the large number of data points, which permitted the use of multivariate time–series analysis. Specifically, we used SVAR with variables modelled in

levels. This allowed us to make better use of the information available in the time–series to discern the impact upon both our indicators of quitting behaviour, calls to Smokeline and volume of prescribed NRT [30,33–35]. In the analyses, we also controlled for the inflation-adjusted price of cigarettes [36] and implementation of comprehensive smoke-free legislation. Thus, we captured the exogenous influences of two major components of the Scottish tobacco control strategy [16]. Finally, we took into account the declining smoking prevalence, which fell from 28.1% in 2003 to 22.9% in 2012. However, no account was taken of the increase in the uptake of smoking cessation services between 2006 and 2012 or the use of e-cigarettes as a cessation aid between 2010 and 2012, both of which will have influenced the use of prescribed NRT independently.

The study has a number of other limitations. We set out to assess the impact of Scottish tobacco control TV MMCs overall and did not take into account TV MMCs broadcast from England, as their reach into the Scottish population is very small. Nor was account taken of the focus of campaigns (smoking prevention, smoking cessation or second-hand smoke), the target audience (young people or adults) or the overall tone of the advertisement. These limitations make it likely that the effect size of TV MMCs with a specific smoking cessation theme may have been underestimated. Additional data we have collected on MMCs classification and typologies will permit more detailed analysis in the future. Finally, we did not examine the impact of commercial adverts for NRT produced by the pharmaceutical industry, as we did not have access to data on Scottish commercial TVRs or OTC sales.

In conclusion, our findings indicate that tobacco control TV MMCs increase calls to Smokeline but have no significant impact upon the volume of prescribed NRT. Further research is required to determine the optimum intensity, frequency and duration necessary to support actual behaviour change, as well as the comparative impact of MMC message type and emotional content. Furthermore, with the advent of public health social marketing campaigns, reflecting the increased use of social media and the internet via a variety of devices including laptops, iPads and mobile phones, further research is also necessary to determine the relative contribution to behaviour change of the different components used in social media campaigns and the different communication platforms.

Declaration of interests

None.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article.

Figure S1 Impulse response function (IRF): impact of tobacco control television ratings (TVRs) on Smokeline calls (seasonally adjusted model).
Figure S2 Cumulative impulse response function (CIRF): impact of tobacco control television ratings (TVRs) on Smokeline calls (seasonally adjusted model).
Figure S3 Impulse response function (IRF): impact of tobacco control television ratings (TVRs) on nicotine replacement therapy (NRT) costs (seasonally adjusted model).
Figure S4 Cumulative impulse response function (CIRF): impact of tobacco control television ratings (TVRs) on nicotine replacement therapy (NRT) costs (seasonally adjusted model).

