



Citation for published version:

Lewis, S, Sims, M, Richardson, S, Langley, T, Szatkowski, L, McNeill, A & Gilmore, AB 2015, 'The effectiveness of tobacco control television advertisements in increasing the prevalence of smoke-free homes', *BMC Public Health*, vol. 15, no. 1, 869. <https://doi.org/10.1186/s12889-015-2207-2>

DOI:

[10.1186/s12889-015-2207-2](https://doi.org/10.1186/s12889-015-2207-2)

Publication date:

2015

Document Version

Peer reviewed version

[Link to publication](#)

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1 **Title:** The effectiveness of tobacco control television advertisements in
2 increasing the prevalence of smoke-free homes

3

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26

27 **Keywords:** mass media campaigns, smoke-free homes, tobacco control policy

28 **Abstract**

29 **Background:** There is considerable evidence that tobacco control mass media
30 campaigns can change smoking behaviour. In the UK, campaigns over the last decade
31 have contributed to declines in smoking prevalence and been associated with falls in
32 cigarette consumption among continuing smokers. However, it is less evident whether
33 such campaigns can also play a role in changing smokers' behaviour in relation to
34 protecting others from the harmful effects of their smoking in the home. We investigated
35 whether exposure to English televised tobacco control campaigns, and specifically
36 campaigns targeting second hand smoking, is associated with smokers having a smoke-
37 free home.

38

39 **Methods:** We used repeated cross-sectional national survey data on 9872 households
40 which participated in the Health Survey for England between 2004 and 2010, with at
41 least one adult current smoker living in the household. Exposure to all government-
42 funded televised tobacco control campaigns, and to those specifically with a second hand
43 smoking theme, was quantified in Gross Rating Points (GRPs), an average per capita
44 measure of advert exposure where 100 GRPs indicates 100% of adults exposed once or
45 50% twice. Our outcome was self-reported presence of a smoke-free home (where no
46 one smokes in the home on most days). Analysis used generalised additive models,
47 controlling for individual factors and temporal trends.

48

49 **Results:** There was no association between monthly televised campaigns overall and the
50 probability of having a smoke-free home. However, exposure to campaigns specifically
51 targeting second hand smoke was associated with increased odds of a smoke-free home
52 in the following month (odds ratio per additional 100 GRPs, 1.07, 95% CI 1.01 to 1.13),
53 though this association was not seen at other lags. These effects were not modified by
54 socio-economic status or by presence of a child in the home.

55

56 **Conclusions:** Our findings provide tentative evidence that mass media campaigns
57 specifically focussing on second hand smoke may be effective in reducing smoking in the
58 home, and further evaluation of campaigns of this type is needed. General tobacco
59 control campaigns in England, which largely focus on promoting smoking cessation, do
60 not impact on smoke-free homes over and above their direct effect at reducing smoking.

61

62

63

64 **BACKGROUND**

65

66 Secondhand smoke (SHS) exposure is a serious danger to health [1], and children are
67 particularly vulnerable [2]. Globally, approximately 600,000 deaths a year, 28% of them
68 in children, result from non-smokers' involuntary exposure to other people's tobacco
69 smoking [3]. The numerous diseases caused by SHS mimic those caused by active
70 smoking and include, in adults, cardiovascular disease and lung cancer, and in children,
71 sudden infant death as well as a range of respiratory and other illnesses [1]. In
72 jurisdictions which have introduced smoke-free legislation which prohibits smoking in
73 enclosed public places, the predominant place of exposure for children and most non-
74 smoking adults is now the home [1]. The priority now for public health practitioners and
75 policy makers is therefore to reduce exposure, especially of children, in the home.
76 People who live in "smoke-free homes" - that is, homes where smokers only smoke
77 outside the home - have much lower levels of SHS exposure [4]. Smokers living in
78 smoke-free homes are also more likely to attempt to quit [5,6], to succeed in doing so
79 [5-8], are less likely to relapse [6-8], and their children may be less likely to take up
80 smoking themselves [9]. Yet, whilst it is known that smokers are more likely to make
81 their home smoke-free if they have young children, live with a non-smoking adult
82 [5,6,10], or are relatively socially advantaged [11], there are to date few insights into
83 how to encourage more smokers to make their homes smoke-free. A range of household
84 and individual-level interventions have been proposed and tested but few have been

85 effective, and these tend to have been intensive interventions which may not be cost
86 effective [12]. From a theoretical standpoint, it has been argued that what is needed is
87 to make control of SHS around children more socially acceptable and eventually the
88 norm, and that this may be more effectively achieved through population-based
89 strategies [13].

90

91 At the population level, there is some evidence that having a comprehensive tobacco
92 control programme is associated with a higher prevalence of smoke-free homes [14]; for
93 example, prevalence of smoke-free homes is seen to vary across US and Australian
94 states in line with the comprehensiveness of tobacco control programmes implemented.
95 Mass media campaigns are an important component of most tobacco control
96 programmes. Research with smokers in the UK shows that whilst the majority are aware
97 that SHS can be harmful, they underestimate the real risks to children's and adults'
98 health [10]. There is some limited evidence that mass media campaigns can change
99 knowledge and attitudes about SHS [10,15,16]. Furthermore, there is also now
100 considerable evidence that mass media campaigns can change smoking behaviour
101 [17,18]; in the UK we have recently shown that campaigns over the last decade have
102 contributed to declines in smoking prevalence and have been associated with falls in
103 cigarette consumption in those who continue to smoke [19]. However, it is less evident
104 whether such campaigns can also play a role in changing smokers' behaviour in relation
105 to protecting others from the harmful effects of their smoking in the home.

106

107 This paper therefore used repeated cross-sectional data from a large national survey to
108 investigate whether televised government-funded tobacco control campaigns - both
109 overall and those specifically aimed at influencing smokers' knowledge and behaviour in
110 relation to the effects of their smoking on others - resulted in an increase in the number
111 of smokers maintaining a smoke-free home in England.

112

113 **METHODS**

114

115 **Survey data**

116 We used data from the Health Survey for England, from January 2004 to April 2010
117 inclusive. This is an annual cross-sectional survey designed to be representative of adults
118 and children living in private households in England [20]. A sample of adults and children
119 is drawn each year using a clustered, stratified, multistage design. This involves selecting
120 a random sample of postcode sectors (the primary sampling units; PSUs) with probability
121 proportional to the total number of addresses within them. PSUs are stratified before
122 selection by two variables: local authority (government boundaries) and proportion of
123 households in the 2001 Census with a head of household with a non-manual occupation
124 (NS-SEC groups 1-3). Within each selected PSU, a random sample of postal addresses is
125 then selected. Once selected, PSUs are randomly allocated to the 12 months of the year
126 for the interview to be conducted. The Health Survey for England data is sponsored by the
127 Information Centre for Health and Social Care and the Department of Health, and made
128 freely available in an anonymised form to registered users through the UK Data Archive
129 [21].

130

131 At each co-operating eligible household, the interviewer first completed a household
132 questionnaire, with information being obtained from the household reference person or
133 their partner. An individual interview was then carried out with all adults aged 16 years
134 old and over and with up to two children in each household.

135

136 The trend in number of smoke-free homes is in part determined by smoking rates (a
137 household of non-smokers is significantly more likely to have a smoke-free home [22]).
138 To avoid the indirect effect television advertisements may have on the prevalence of
139 smoke-free homes via its influence on smoking rates that we have previously
140 demonstrated [19], we restricted our analysis to households with at least one adult
141 smoker (aged 18 and over). Information on month and year of interview was used to
142 match the survey data to campaign exposure data.

143

144 Adults were defined as smokers if they responded 'Yes' when asked "*Do you smoke*
145 *cigarettes at all nowadays?*". A home was defined as smoke-free if the respondent
146 completing the household questionnaire said 'No' to the question: "*Does anyone smoke*
147 *inside the home on most days?*".

148

149 **Campaign Exposure**

150 Exposure to government-funded national televised tobacco control campaigns, or those
151 run by charities such as the British Heart Foundation and Cancer Research UK but
152 funded by the Department of Health, was quantified in Gross Rating Points (GRPs). GRPs
153 are a standard broadcasting industry measure of advertising exposure, commonly used
154 in evaluations of televised mass media campaigns. Television viewer figures at the time
155 when the advertisements are shown are collected by the Broadcasters' Audience
156 Research Board via a metered panel, and GRPs combine reach and frequency and are
157 equivalent to the summed ratings of individual advertisements [television ratings
158 (TVRs)]. GRPs are a population-averaged indicator of exposure, for example, 100 GRPs
159 could indicate that 100% of adults were exposed to an advertisement once, or that 50%
160 were exposed twice. They do not provide a measure actual exposure on the individual-
161 level, which would be dependent on an individual's time, channel and frequency of
162 television viewing. We categorised campaign types according to their theme, content
163 and style using their video recordings and/or creatives, described in detail elsewhere
164 [23]. As part of this coding process, campaigns were categorised as focusing on a
165 second hand smoking theme, or other theme. Campaigns with a second hand smoking
166 theme included the 'Second hand smoke is a killer' campaign which aimed to show
167 smokers the health effects that SHS can have on adults that are around the smoker
168 [24], and the 'Invisible killer' campaign which aimed to show the hidden dangers of SHS
169 on both young and old, in particular that 85% is invisible and odourless [25]. Other
170 campaigns predominantly had a smoking cessation theme. For each month, we then

171 summed GRPs for each of these two campaign themes to derive time series of monthly
172 GRPs for each.

173

174 **Statistical Analysis**

175 We analysed the association between overall exposure to televised tobacco control
176 campaigns, and exposure to the two types of campaign themes, on the probability of a
177 household with at least one adult smoker being smoke-free. We used binary logistic
178 generalised additive (GAM) models in the statistical package R using the gamm4 function
179 [26]. These models allow us to fit non-linear effects of exposures. The effects of GRP
180 exposures were initially considered as non-linear effects, specifically cubic restricted
181 splines, and the effective degrees of freedom (edf) was used to assess linearity. All these
182 effects were found to be linear (i.e., the edf obtained was not significantly different to 1)
183 and were subsequently fitted as linear terms, expressing exposure in units of increasing
184 100 GRPs per month. Since evidence suggests that tobacco control campaigns have their
185 effects on smoking behaviour while campaigns are being broadcast and for a short time
186 afterwards, we assessed the effects on current smoke-free home status of exposure in
187 the same month, and exposure in the two previous months using lag terms in each
188 model.

189

190 To allow for the sampling design, we adjusted for the stratification factors, Government
191 office region and the NS-SEC (National Statistics Socio-economic Classification) of the
192 household reference person in the model, and fitted the cluster indicator (PSU) as a
193 random effect. Furthermore it was possible that the unequal selection probabilities for
194 sampling postcode sectors might be correlated with the outcome variable and therefore
195 induce bias in estimators of model parameters in this multi-level model [27]. We
196 therefore included a further variable in our multi-level models representing the number
197 of addresses in each postcode sector provided by NatCen Social Research [28] (who
198 deliver the Health Survey for England) to control for this.

199

200 We also adjusted for a number of other household-level determinants of smoke-free
201 homes, which were considered as possible confounders. These included measures of the
202 number of smokers in the household, gender composition of smokers in the household,
203 average age of smokers in the household, the average level of dependence of smokers in
204 the household (determined using the Heaviness of Smoking Index for individual smokers
205 averaged across all smokers in the household) [29], age of the youngest child in the
206 household, household Index of Multiple Deprivation (IMD) score [30], and season of
207 questionnaire, all coded as categorical variables.

208

209 We also adjusted for a monthly time trend. Although this was initially fitted as a non-
210 linear effect using a thin plate regression spline term, the trend was found to be linear,
211 and was subsequently fitted as a linear term in all models. We additionally adjusted for a
212 measure of the extent of other current tobacco policies in England from 2004 to 2010
213 based on the Tobacco Control Scale (TCS) developed by Joossens and Raw [31],
214 including a step increase in relation to the introduction of smoke-free legislation, but
215 omitting scores relating to price, and operationalised as a four-level categorical variable
216 for increasing tobacco control activity over time. In a sensitivity analysis, we also
217 adjusted for population level smoking prevalence, as estimated from the Health Survey
218 for England data, as an alternative marker of the effects of population-level smoking
219 cessation interventions. We fitted interaction terms into our final models between socio-
220 economic indicators (NS-SEC classification and IMD score) and campaign GRPs to
221 determine whether socio-economic status might modify the effect of campaign
222 exposures, and also fitted interaction terms with the presence of a child in the home to
223 assess whether this may modify the effect of campaign exposures.

224

225

226

227 **RESULTS**

228

229 Between 2004 and 2010, the response rate for the Health Survey for England varied
230 between 64% and 74%. Of the 9,872 households interviewed with at least one smoker
231 aged 18 or over 3,181 (32.2%) reported being smoke-free (Figure 1). The prevalence of
232 smoke-free homes in our sample was found to increase over time (Figure 1). Over this
233 timeframe, the mean monthly exposure for all campaigns was 344.7 GRPs, ranging from
234 a minimum of 0 to a maximum of 1,135.2 GRPs per month. GRPs specifically on the
235 second hand smoking theme were low, occurring in only 12 of the 75 months in our
236 study period, with a mean of 155.2 GRPs in the months that they occurred, ranging from
237 a minimum of 0 to a maximum of 514.6 GRPs per month (Figure 2).

238

239 The characteristics of the sample are shown in Table 1. In our multivariable models of
240 the effects of tobacco control campaigns, overall (Table 2), and those specific to second
241 hand smoking themes (Table 3), households that were more socioeconomically deprived
242 (as measured by IMD or by socioeconomic status of the head of the household) were
243 less likely to report being smoke-free. Households with children, where smokers were
244 younger, where all smokers were male, and where smokers had lower levels of nicotine
245 addiction, were more likely to report being smoke-free. The odds of a household being
246 smoke-free increased over time in a linear fashion, and homes were more likely to be
247 smoke-free in the summer than in the winter. The odds of a smoke-free home tended to
248 increase with tobacco control score, though not significantly so in our final model for all
249 campaigns (Table 2).

250

251 We found no association between overall GRPs from all campaigns and odds that a given
252 home was smoke-free. During the period 2004–2010, for every additional 100 GRPs of
253 exposure to all televised tobacco control campaigns in the same month, there was a
254 non-significant 1% increase in the odds that a given household was smoke-free (OR:
255 1.01, 95% CI: 0.99–1.04), as shown in Table 2. Neither the one or two-month lag terms
256 were found to be statistically significant.

257

258 When campaign exposure was classified as that specific to a second hand smoking
259 theme or otherwise, there was a significant positive association between exposure to
260 campaigns with a second hand smoking theme at a one-month lag and the odds that a
261 given household was smoke-free. For each additional 100 GRPs in exposure to these
262 campaigns, we found a 7% in the odds that a given household was smoke-free one
263 month later (OR: 1.07, 95% CI: 1.01–1.13). We found no such association between
264 second hand smoking campaigns either in the same month or at a two-month lag, and
265 exposure to all other types of campaigns had no significant impact at any lag.

266

267 Adjustment for smoking prevalence did not change these effects, and specifically, the
268 effect of second hand smoking campaigns at 1 month lag was unchanged (OR: 1.07,
269 95% CI 1.01-1.14).

270

271 There was no evidence of modification of the effect of all campaigns, or specifically
272 second hand smoking campaigns, in relation to either measure of socio-economic status
273 either at 1 month lag (all campaigns: NS-SEC $p = 0.7$, IMD $p = 0.2$; second hand
274 smoking campaigns NS-SEC: $p = 0.4$, IMD $p = 0.11$) or at other lags. There was also no
275 significant interaction with the presence of a child in the home at 1 month lag (all
276 campaigns: $p = 0.6$) or at other lags.

277

278

279 **Discussion**

280

281 Televised tobacco control campaigns can change smoking behaviour [17,18], but this is
282 the first national study to investigate whether such campaigns can alter a smoker's
283 behaviour in the home. Our analyses show that, in those who continued to smoke,
284 exposure to the varied mix of campaigns shown over recent years in England has not
285 been associated with an increase in smoking restrictions in the home over and above the
286 impact on smoking cessation. Campaigns with a specific second hand smoking theme

287 have been limited in number, but our results provide an indication that such specifically
288 targeted campaigns may have had some effect in reducing smoking in the home.

289

290 One limitation of our study was that household smoking behaviour was self-reported. It
291 also used a different definition of smoke-free home ie no one smokes in the home on
292 most days, from the more conservative definition of no one smoking at all in the home
293 used in many studies. However, previous work in the Health Survey for England has
294 demonstrated that in the subset of children with cotinine measurements of SHS
295 exposure, the response to the question on smoking behaviour in the home is very
296 strongly predictive of children's cotinine levels [32] suggesting that this question does
297 reflect relevant smoking behaviour. We used repeated cross-sectional surveys rather
298 than longitudinal data. Moreover, GRPs are a population rather than an individual level of
299 exposure. We were therefore unable to evaluate changes in smoking rules in individual
300 households in relation to the household's exposure; rather our findings are based on
301 aggregate changes in the population over time in relation to estimated population levels
302 of campaign exposure. This limited us to looking at short-term effects. Our results
303 indicated that whether a home was smoke-free was strongly associated with season of
304 the year, suggesting that the prevalence of smoke-free homes is influenced by short-
305 term factors. Although we found an association with second hand smoking campaigns at
306 1 month lag, we found no association at 2 months lag which could indicate that any
307 impact of the campaigns is short-lived. The small number of second hand smoke theme
308 campaigns may explain why we did not find a stronger or longer lasting impact; 400
309 TVRs per month have been suggested to be needed to change smoking prevalence [17]
310 and the exposure to second hand smoke campaigns was seldom anywhere close to this
311 level. However, as we explored the impact of two different campaign themes at 3 lags
312 and found one borderline significant result, it is also possible that the significant effect of
313 campaigns with a second hand smoking theme at lag 1 may have arisen by chance, and
314 our findings should be interpreted accordingly.

315

316 Nonetheless, the present study is the first of its kind to evaluate the impact of televised
317 tobacco control campaigns on smoke-free homes using a large, country-wide sample.
318 The patterns of associations of individual factors with having a smoke-free home in this
319 study, including the composition of the household, age and gender of smokers within the
320 household, the presence of children, occupation and socioeconomic status of the head of
321 household are similar to those seen in other countries [5,6]. The proportion of homes
322 that were smoke-free increased over the period of this study, corresponding to similar
323 trends in other countries [33,34] and existing evidence from England [22]. The results of
324 our multivariable models give some indication of an increase in smoke-free homes with
325 increasing tobacco control score, and particularly with the introduction of smoke-free
326 legislation (indicated in the tables by a rise in tobacco control score to 48). Our analysis
327 has nevertheless allowed us to adjust for all of these individual factors, time trends and
328 the growing strength of wider tobacco control policies in the UK over this time frame,
329 and our results are therefore unlikely to be due to confounding. We have previously
330 shown that televised tobacco control campaigns in England have made a small
331 contribution to reductions in smoking prevalence [19], and it is therefore likely that they
332 impact indirectly on the prevalence of smoke-free homes by encouraging smoking
333 cessation; we therefore limited our sample to smokers in order to exclude any indirect
334 effect occurring via reductions in smoking prevalence.

335

336

337 A review exploring the effects of population level interventions on smoke-free homes
338 [14] found some direct evidence that comprehensive tobacco control programmes,
339 including effective education, smoke-free places policies, and smoking cessation
340 services, can increase the prevalence of smoke-free homes. However, it found only
341 indirect support for other population-level interventions including mass media
342 campaigns, based on the fact that those who believe SHS is harmful appear to be less
343 likely to smoke in the home [6], and that mass media campaigns that have included SHS
344 themes have been effective in increasing knowledge about the harms of SHS [15,16]. A

345 1992 mass media campaign in Victoria, Australia, was found to have increased the
346 proportion of non-smokers asking their visitors not to smoke, but seemed to have less
347 effect on smokers [35]. In the USA, exposure to a media campaign on SHS resulted in
348 increased intent to have smoke-free homes [15]. Previous studies from the UK showed
349 that knowledge of SHS harms increased during 2003-2006 when more frequent SHS-
350 related mass media campaigns were run compared to earlier years, and that smokers
351 with better knowledge were more likely to have smoke-free homes (10). Regional mass
352 media campaigns promoting smoke-free homes were effective in increasing knowledge
353 of the health impacts of SHS [36]. A small non-significant impact on the proportion of
354 smoke-free homes was also seen but the study was underpowered. Our current study
355 therefore provides the first tentative evidence that televised campaigns with a second
356 hand smoking theme may be associated with an increase in smoke-free homes, at least
357 in the month following the campaign. The lack of effect modification by socio-economic
358 group provides some reassurance with respect to the concern that such population based
359 interventions might potentially widen disparities in smoking through having less effect in
360 more deprived groups; we found no evidence that this was the case though power for
361 detecting interactions was inevitably low given the data available.

362

363 The theory around behaviour change and SHS has been reviewed by Borland [13]. This
364 review advocates use of mass media firstly to increase knowledge and community-wide
365 acceptance that second hand smoking is harmful, and once that is established, to
366 promote control of SHS exposure in the home. Several recent studies from the UK
367 suggest that there remains a lack of knowledge, and some resistance to the health
368 messages, regarding the harms of smoking to others [10, 37] and that knowledge may
369 be declining where mass media campaigns are not continued [36]; our findings therefore
370 support the need for future mass media campaigns highlighting the dangers of SHS. We
371 have recently shown in relation to mass media campaigns aimed at promoting smoking
372 cessation that more positive messages providing information on how to quit are
373 important alongside those showing the health consequences [38, 39]. If the same were

374 true for second hand smoking campaigns, it may be helpful to include campaigns which
375 show how smoke-free homes can be successfully achieved.

376

377 **Conclusion**

378 There is considerable evidence of the harms of SHS exposure in children and other non-
379 smokers living with a smoker, and evidence that living in a smoke-free home is also
380 beneficial to the smoker who is more likely to quit smoking. However, many homes with
381 a smoker are not smoke-free. Our findings suggest that televised media campaigns
382 promoting smoking cessation may not be effective in reducing smoking in the home, but
383 we found tentative evidence that campaigns specifically targeting second hand smoke
384 may do so. Further use of this type of campaign, with appropriate evaluation to confirm
385 its effectiveness, would be appropriate.

386

387

388

389

390

391 **Declaration of interests:** The authors declare that they have no competing interests.

392

393 **Author's contributions:** SL, MS, TL, LS, AM, AG conceived and designed the study;

394 MS, SL, SR performed the statistical analysis; SL, MS, SR, TL, LS, AM and AG helped to

395 draft the manuscript. All authors read and approved the final manuscript.

396

397 **Acknowledgements:**

398 The work was undertaken by the University of Nottingham, University of Bath and King's

399 College London, which received funding from the National Prevention Research Initiative

400 www.mrc.ac.uk/npri (Grant number MR/J00023X/1). NPRI is supported by the following

401 funding partners: Alzheimer's Research Trust; Alzheimer's Society; Biotechnology and

402 Biological Sciences Research Council; British Heart Foundation; Cancer Research UK;

403 Chief Scientist Office, Scottish Government Health Directorate; Department of Health;

404 Diabetes UK; Economic and Social Research Council; Health and Social Care Research

405 and Development Division of the Public Health Agency (HSC R&D Division); Medical

406 Research Council; The Stroke Association; Wellcome Trust; and Welsh Assembly

407 Government.

408

409 Michelle Sims, Anna Gilmore, Sol Richardson, Tessa Langley, Lisa Szatkowski, Ann

410 McNeill, and Sarah Lewis are members of the UK Centre for Tobacco and Alcohol Studies

411 (UKCTAS), a UK Centre for Public Health Excellence. Funding to UKCTAS from the British

412 Heart Foundation, Cancer Research UK, the Economic and Social Research Council, the

413 Medical Research Council and the National Institute of Health Research, under the

414 auspices of the UK Clinical Research Collaboration, is gratefully acknowledged.

415

416 ASH UK funded the collection, cleaning and preparation of the advertising data.

417 Data for individual charity-run tobacco control campaigns were provided by Cancer

418 Research UK and the British Heart Foundation.

419

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528 **FIGURES**

529 **Figure 1.**

530 **Proportion of households with at least one smoker that are smoke-free**
531 **(January 2004 to April 2010)**

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534 **Figure 2.**

535 **Time series of monthly campaign exposures by campaign type**

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Table 1. Sample characteristics (2004–2010)

Covariate	Categories	Number	%
Total Sample		9,872	100
Government office region	North East	719	7.3
	North West	1,508	15.3
	Yorkshire and the Humber	1,092	11.1
	East Midland	1,007	10.2
	West Midland	1,038	10.5
	East of England	1,041	10.5
	London	1,126	11.4
	South East	1,449	14.7
	South West	892	9.0
Gender of smokers in household	All female smokers	4,450	45.1
	All male smokers	3,679	37.3
	Mixed smokers	1,743	17.7
Average age of smokers in household	18-24	833	8.4
	25-39	3,396	34.4
	40-54	2,970	30.1
	55+	2,673	27.1
NS-SEC of head of household	Managerial & Professional	2,675	27.1
	Intermediate	1,917	19.4
	Routine & manual	4,914	49.8
	Other	354	3.6
Average level of dependence of smokers in household	0 (least addicted)	2,661	27.0
	1	1,409	14.3
	2	2,085	21.1
	3	1,958	19.8
	4	1,316	13.3
	5	324	3.3
	6 (most addicted)	119	1.2
Age of youngest child in household	No child	1,786	18.1
	0-5	1,401	14.2
	6-15	6,685	67.7
Number of adult smokers	Two or more smokers	3,475	35.2
	Lone smoker	4,372	44.3
	Lone smoker (lives alone)	2,025	20.5
Index of Multiple Deprivation	1 (least deprived)	1,346	13.6
	2	1,602	16.3
	3	1,870	18.9
	4	2,363	23.9
	5 (most deprived)	2,691	27.3
Season	Summer (Jun–Aug)	2,721	27.6
	Autumn (Sep–Nov)	2,560	25.9
	Spring (Mar–May)	2,674	27.1
	Winter (Dec–Feb)	2,367	24.0

540 Figures show baseline for categorical variables. ^a The HSE surveys include two measures of nicotine dependence:
541 cigarette consumption and time to first cigarette. Dependence score for a smoker was derived using these measures
542 and scored based on the Modified Fagerstrom Test for Nicotine Dependence. A household measure of dependence was
543 derived by averaging the score across all smokers in the household.

Table 2. Effect of all tobacco control campaigns (2004-2010) and other factors on odds of smoke-free home, n = 9,872

Covariate	Categories	OR (95% CI)	p	
Time ^a		1.01 (1.01-1.02)	<0.001*	
Tobacco control campaigns	Total GRPs ^a	1.01 (0.99-1.04)	0.184	
	Total GRPs (1 month) ^a	1.00 (0.98-1.02)	0.959	
	Total GRPs (2 months) ^a	1.00 (0.98-1.02)	0.921	
TCS Score	24.5	1		
	27	1.07 (0.84-1.36)	0.595	
	48	1.41 (0.95-2.10)	0.092	
	51	1.14 (0.74-1.74)	0.548	
Season	Summer	1		
	Autumn	0.98 (0.84-1.13)	0.756	
	Spring	0.88 (0.74-1.04)	0.135	
	Winter	0.84 (0.71-0.98)	0.030*	
Government office region	North East	1		
	North West	0.67 (0.52-0.87)	0.027*	
	Yorkshire and the Humber	0.78 (0.59-1.02)	0.0366	
	East Midland	0.71 (0.54-0.93)	0.013*	
	West Midland	0.85 (0.65-1.12)	0.246	
	East of England	0.92 (0.70-1.20)	0.526	
	London	0.71 (0.54-0.92)	0.010	
	South East	0.73 (0.56-0.95)	0.017*	
Government office region	South West	1.09 (0.82-1.43)	0.557	
	Gender of smokers in household	All female smokers	1	
		All male smokers	1.43 (1.29-1.60)	<0.001*
Mixed smokers		1.18 (0.87-1.61)	0.276	
Average age of smokers in household	18-24	1		
	25-39	0.74 (0.62-0.87)	<0.001*	
	40-54	0.52 (0.43-0.62)	<0.001*	
	55+	0.32 (0.26-0.39)	<0.001*	
NS-SEC of head of household	Managerial & Professional	1		
	Intermediate	0.79 (0.69-0.91)	<0.001*	
	Routine & manual	0.64 (0.57-0.72)	<0.001*	
	Other	0.58 (0.43-0.78)	<0.001*	
Average level of addictedness of smokers in household ^b	0 (least addicted)	12.59 (6.72-23.61)	<0.001*	
	1	5.03 (2.67-9.48)	<0.001*	
	2	3.46 (1.84-6.51)	<0.001*	
	3	2.26 (1.20-4.25)	<0.012*	
	4	1.25 (0.66-2.37)	0.501	
	5	0.42 (0.19-0.94)	0.034*	
Age of youngest child in household	6 (most addicted)	1		
	No child	1		
	0-5	2.59 (2.24-3.00)	<0.001*	
Age of youngest child in household	6-15	1.34 (1.18-1.53)	<0.001*	
	Number of adult smokers	Two or more smokers	1	
		Lone smoker	2.83 (2.12-3.78)	<0.001*
Lone smoker (lives alone)		0.84 (0.63-1.11)	0.223	
Index of Multiple deprivation	1 (least deprived)	1		
	2	1.02 (0.86-1.21)	0.847	
	3	0.79 (0.66-0.93)	0.006	
	4	0.60 (0.50-0.71)	<0.001*	
	5 (most deprived)	0.41 (0.34-0.49)	<0.001*	

Table 3. Effect of second hand smoking campaigns (2004-2010) on odds of smoke-free home, n = 9,872

Covariate	Categories	OR (95% CI)	p
Time ^a		1.01 (1.01-1.02)	0.005*
Tobacco control campaigns	Second Hand Smoke GRPs ^a	0.99 (0.93-1.05)	0.740
	Second hand Smoke GRPs (1 month) ^a	1.07 (1.01-1.13)	0.033*
	Second Hand Smoke GRPs (2 months) ^a	0.98 (0.92-1.04)	0.490
	Other GRPs ^a	1.02 (0.99-1.04)	0.134
	Other GRPs (1 month) ^a	1.00 (0.98-1.02)	0.755
	Other GRPs (2 months) ^a	1.01 (0.98-1.03)	0.561
TCS Score	24.5	1	
	27	1.13 (0.88-1.46)	0.334
	48	1.53 (1.02-2.31)	0.041*
	51	1.25 (0.81-1.94)	0.320
Season	Summer	1	
	Autumn	0.97 (0.84-1.13)	0.695
	Spring	0.86 (0.73-1.02)	0.098
	Winter	0.84 (0.71-0.99)	0.041*
Government office region	North East	1	
	North West	0.67 (0.52-0.87)	0.003*
	Yorkshire and the Humber	0.78 (0.59-1.02)	0.069
	East Midland	0.71 (0.54-0.93)	0.014*
	West Midland	0.85 (0.65-1.12)	0.246
	East of England	0.91 (0.70-1.20)	0.514
	London	0.71 (0.54-0.92)	0.010*
	South East	0.73 (0.56-0.94)	0.017*
Gender of smokers in household	South West	1.08 (0.82-1.43)	0.567
	All female smokers	1	
	All male smokers	1.44 (1.29-1.60)	<0.001*
Average age of smokers in household	Mixed smokers	1.18 (0.87-1.60)	0.280
	18-24	1	
	25-39	0.73 (0.62-0.87)	<0.001*
	40-54	0.51 (0.43-0.62)	<0.001*
NS-SEC of head of household	55+	0.32 (0.26-0.38)	<0.001*
	Managerial & Professional	1	
	Intermediate	0.79 (0.69-0.91)	0.001*
	Routine & manual	0.64 (0.57-0.72)	<0.001*
Average level of addictedness of smokers in household ^b	Other	0.58 (0.43-0.77)	<0.001*
	0 (least addicted)	12.51 (6.67-23.45)	<0.001*
	1	5.00 (2.65-9.42)	<0.001*
	2	3.43 (1.83-6.46)	<0.001*
	3	2.25 (1.19-4.23)	0.012*
	4	1.24 (0.65-2.35)	0.512
	5	0.42 (0.19-0.93)	0.033*
Age of youngest child in household	6 (most addicted)	1	
	No child	1	
	0-5	2.60 (2.24-3.01)	<0.001*
Number of adult smokers	6-15	1.34 (1.17-1.53)	<0.001*
	Two or more smokers	1	
	Lone smoker	2.82 (2.12-3.77)	<0.001*
Index of Multiple deprivation	Lone smoker (lives alone)	0.83 (0.63-1.11)	0.217
	1 (least deprived)	1	
	2	1.02 (0.86-1.21)	0.839
	3	0.79 (0.66-0.93)	0.006*
	4	0.60 (0.50-0.71)	<0.001*
	5 (most deprived)	0.41 (0.34-0.50)	<0.001*

546 **Caption for Tables 2 and 3:**

547 ^aTime and GRPs at different lags were initially considered as nonlinear smooth terms and as they
548 were found to be linear (spline effective degrees of freedom=1), replaced with linear terms. The
549 table presents the ORs for having a smoke-free home associated with a 100 point increase in GRPs.
550 Also included in the model is a covariate for number of addresses in each PSU. Likelihood ratio test
551 p values are not shown for categorical variables as modelling was based on quasi-likelihood.

552