

The impact of smokefree legislation in Scotland: results from the Scottish ITC Scotland/UK longitudinal surveys

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Background: To evaluate how Scotland's smokefree law impacted self-reported secondhand smoke (SHS) exposure in hospitality venues, workplaces and in people's homes. In addition, we examine changes in support for the law, pub and restaurant patronage, smoking cessation indicators and whether any observed changes varied by socioeconomic status. **Methods:** A quasi-experimental longitudinal telephone survey of nationally representative samples of smokers and non-smokers interviewed before the Scottish law (February to March 2006) and 1 year later after the law (March 2007) in Scotland ($n=705$ smokers and $n=417$ non-smokers) and the rest of the UK ($n=1027$ smokers and $n=447$ non-smokers) where smoking in public places was not regulated at the time. **Results:** Dramatic declines in the observance of smoking in pubs, restaurants and workplaces were found in Scotland relative to the rest of the UK. The change in the percent of smokers reporting a smokefree home and number of cigarettes smoked inside the home in the evening was comparable in Scotland and the rest of the UK. Support for smokefree policies increased to a greater extent in Scotland than in the rest of the UK. Self-reported frequency of going to pubs and restaurants was generally comparable between Scotland and the rest of the UK; however, non-smokers in Scotland were more likely to frequent pubs more often. No differences in smoking cessation indicators were observed between countries. **Conclusion:** The Scottish smokefree law has been successful in decreasing secondhand smoke exposure while causing none of the hypothesized negative outcomes.

Keywords: Scotland, smokefree, international tobacco control.

Introduction

Comprehensive reviews by health agencies have consistently concluded that secondhand smoke (SHS) causes lung cancer, heart disease and adverse respiratory outcomes in children.^{1–3} Worldwide since 1 July 2007, 200 million people are protected from SHS in public places by comprehensive smokefree laws.⁴ SHS is the cause of an estimated 79 000 premature deaths in the EU with 7000 of these deaths as a direct result of exposure to smoke at work.⁵ In the UK, research has suggested that smoking at work is the cause of death of more than two employed persons per day, with SHS exposure at home accounting for a further 10 700 deaths per year.⁶ In children, research has found that cotinine levels have declined over the past decade, partly due to increased restrictions on smoking in public places.⁷

The rate of smokefree policy implementation has increased since the Framework Convention for Tobacco Control (FCTC) treaty, which obligates ratifying nations to expand SHS worker protection policies at the national and sub-national level, among many other tobacco control activities.⁸ Several nations now have comprehensive smokefree policies in effect whereas none existed prior to 2004, and as of December 2008, 160 nations have ratified the FCTC.⁹

The main argument for comprehensive smokefree policies is that they dramatically reduce SHS exposure and improve health. For example, after Ireland implemented the world's first nationwide smokefree policy in March 2004, the observation of smoking in Irish pubs went from nearly 100% before to law to nearly 0% after the law,¹⁰ concentrations of indoor air pollutants benzene and 1,3-butadiene decreased by over 90%,¹¹ the pulmonary health of bartenders improved,¹² and hospital admissions for acute coronary syndrome were reduced.¹³ Counterarguments to comprehensive SHS policies include a lack of public support for the policies, anticipated poor compliance, the potential for adverse economic outcomes, and the displacement of smoking from pubs to inside the home. However, the published studies evaluating smokefree laws do not support these arguments.^{10,14–18}

On the 26 March 2006, Scotland implemented a comprehensive nationwide smokefree law that includes restaurants and pubs, and evaluation of the law has shown that compliance has been high and there has been a reduction in secondhand smoke concentration in Scottish pubs.¹⁹ The results from the Irish smokefree experience helped to inform the Scottish policy debate; however, locally relevant information is particularly useful to decision makers.²⁰ Therefore, it is important to evaluate what happened after Scotland implemented smokefree regulations in order to help inform other policy debates happening in the rest of the EU and the world. This paper

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extends the research conducted to evaluate the Irish smokefree legislation by including samples of non-smokers in both Scotland and the rest of the UK.

The present study reports analyses from the ITC Scotland/UK Survey to address the following five study questions: (i) Did Scotland's smokefree law decrease SHS exposure in the home, hospitality venues and the workplace? (ii) Did support for Scotland's smokefree law increase after its implementation? (iii) Did Scotland's smokefree law cause people to frequent restaurants and pubs less often? (iv) Did indicators of smoking cessation increase in Scotland after the legislation? and (v) Did socioeconomic status moderate the impact of the smokefree law?

Methods

Sample

The ITC Scotland/UK Survey is a quasi-experimental longitudinal telephone survey of nationally representative samples of smokers and non-smokers aged 18 years or older in Scotland and the rest of the UK. Respondents were interviewed before the Scottish law (February to March 2006) and 1 year later after the law (March 2007). These respondents are part of a larger cohort study conducted as part of the International Tobacco Control (ITC) Policy Evaluation Project.²¹ Respondents were recruited by geographically stratified probability sampling with telephone numbers selected at random from the population of each country. List assisted telephone numbers were obtained from Survey Sampling International, which excludes cell phone numbers.²² The next birthday method²³ was used to select a single respondent in households with more than one eligible respondent. The procedures to compute survey weights are described in more details below. A smoker was defined as an individual who reported smoking at least once in the month prior to interview and had smoked at least 100 cigarettes in their lifetime. For the first criterion, respondents were asked, 'How often have you allowed yourself a cigarette?' The following responses resulted in categorization as a smoker: 'Daily', 'Less than daily, but at least once a week', 'Less than weekly, but at least once month'. Smokers received a £7 Boots voucher as an incentive to take part, while non-smokers received a £4 Boots voucher.

A sample of $n = 1335$ smokers (507 in Scotland and 828 in the rest of the UK) and $n = 601$ non-smokers (301 in Scotland and 300 in the rest of the UK) were recruited pre-legislation (i.e. at baseline). The response rates for the pre-legislation survey were 29% in Scotland and 30% in the rest of the UK; these figures are based on a small variation of the AAPOR²⁴ RR4 formula. It should be noted that the UK sample of 828 smokers consists of 507 newly recruited respondents and of 321 respondents originally recruited as part of the ITC Ireland/UK Survey, whereas in Scotland these were all newly recruited respondents. The 321 respondents recruited as part of the ITC Ireland/UK Survey were not followed for the post-legislation survey. Excluding these 321 individuals, the retention rate (both countries combined) for the follow-up post-legislation survey was 61% for smokers and 74% for non-smokers. However, the retention rate for smokers includes 101 respondents (46 from Scotland and 55 from the rest of the UK) who had quit smoking between the pre- and post-legislation surveys. These respondents were retained, but administered the quitter version of the post-legislation survey. Their pre-legislation observations were included in the various analyses of this paper, but their post-legislation observations were not. Hence, 513 smokers (263 in Scotland and 250 in the rest of the UK) and 445 non-smokers (216 in Scotland and 229 in the rest of the UK) completed both the pre- and

post-legislation surveys. To compensate for attrition, the sample was replenished. Finally, 397 additional smokers (198 in Scotland and 199 in the rest of the UK) and 263 non-smokers (116 in Scotland and 147 in the rest of the UK) were recruited post-legislation. There were thus a total of 910 smokers (461 in Scotland and 449 in the rest of the UK) and 708 non-smokers (332 in Scotland and 376 in the rest of the UK) that completed the post-legislation survey.

The study was approved by Ethics Review Boards at the University of Stirling (Scotland), University of Waterloo (Canada), Roswell Park Cancer Institute (United States) and the Cancer Council Victoria (Australia).

Outcome variables

A total of 13 outcomes were analyzed to assess the five study questions in this project. To assess levels of SHS smoke exposure in drinking establishments and restaurants (outcomes 1 and 2), respondents were asked, 'In the last 6 months, how often have you visited a [drinking establishment, bar or pub/restaurant or café] where you live?' Only those who reported that they have visited these venues at least once a month were asked, 'The last time you did so, were people smoking inside?' (Yes, No). Worksite SHS exposure was assessed by asking respondents who reported currently working outside the home, 'In the last month, have people smoked in indoor areas where you work?' (Yes, No). Smoking behavior at home was evaluated by asking the following questions. For all respondents, 'Which of the following best describes smoking in your home?' (allowed anywhere, never allowed anywhere or something in between). Responses were then dichotomized to 'never allowed anywhere' vs. 'allowed'. For respondents that 'allowed' smoking inside their home, the numbers of cigarettes smoked inside and outside were assessed with the questions, 'When you are spending an evening at home, about how many cigarettes do you smoke [inside/outside] your house during the evening (i.e. from after-work onward)?' This outcome is simply taken as the percentages of cigarettes smoked inside the house; for respondents that reported that they never allowed smoking inside their home, this percentage was taken to be 0%.

To assess the level of support for clean indoor air rules, respondents were asked, 'What do you think smoking rules should be in [pubs and bar/restaurants/workplace]?' (smoking should be allowed in all indoor areas, smoking should be allowed in some indoor areas, or smoking should not be allowed at all), and the latter two response options were combined to form a dichotomous outcome indicating support for 'smoking should not be allowed at all' vs. those who believe that 'smoking should be allowed'.

To assess patronage patterns in bars and restaurants, respondents were asked, 'Do you now visit [bars and pubs/restaurants and cafes] more often than a year ago, less often, or about the same amount?' These response options were also dichotomized for analyses as 'less often' vs. 'more or about the same'.

Use of stop smoking medications was assessed with the question, 'In the last 6 months, have you used any stop-smoking medication such as nicotine replacement therapies like nicotine gum or the patch, or pills such as Zyban?' (Yes, No).

Quit attempts are assessed by the question, 'Have you made any attempts to stop smoking since we last talked with you?' (Yes, No). Note that this question was only asked in the post-legislation survey. Lastly, a respondent was deemed to have quit smoking, if he/she was categorized as a smoker in the pre-legislation survey and as a non-smoker in post-legislation survey.

Covariates

Covariates considered were country (Scotland vs. the rest of the UK), wave (pre- vs. post-legislation), sex (male vs. female), age (18–24 vs. 25–39 vs. 40–54 vs. or 55+), socioeconomic status or SES (low vs. moderate vs. high), heaviness of smoking index or HSI (low vs. moderate vs. high) and ethnicity (Caucasian vs. other). Heaviness of smoking index (HSI)²⁵ was defined as the sum of amount smoked (coded 0, 1, 2 or 3 for those smoking 1–10 cigarettes per day, 11–20, 21–30 or 31+, respectively) and of time to first cigarette in the morning (coded 0, 1, 2 or 3 for those smoking more than 60 min after waking, within 31–60 min, within 6–30 min or <5 min, respectively). Because some of the HSI categories had very low frequencies, HSI values of 0 or 1 were coded as low HSI, 2 or 3 as moderate, and 4, 5 or 6 as high; and this later coding was used in all models. Income (low = <£15 000, moderate = £15 000–30 000, and high = >£30 000), and education (low = below college level, moderate = some college/university and high = university degree or more) were combined to create a three-level SES covariate. This was done by dichotomizing income and education into low vs. moderate/high, and summing these indicators. Therefore, low SES corresponds to both low education and low income, high SES corresponds to moderate or high education and income, and moderate SES corresponds to all other combinations.

Survey weights

Survey weights were calculated separately for smokers and non-smokers. For each of these groups, weights were constructed beginning with reciprocals of inclusion probabilities. Adjustments were made for departures from proportional allocation to geographic strata and were calibrated to sum to numbers of smokers (non-smokers) in age–sex groups. In other words, respondents are weighted to be representative of the adult smoker (non-smoker) population in each country. For respondents that also completed the post-legislation survey, their pre-legislation weights were adjusted for attrition. It should be noted that all figures in the present article are weighted.

Analysis plan

Generalized Estimating Equations^{26,27} (GEE) were used to model outcomes all outcomes except quitting and quit attempts. Because behaviors and attitudes of smokers regarding these various outcomes are likely to differ greatly from those of non-smokers, the two groups were considered to be distinct populations and separate models were fitted. Barring missing values, GEE models for smokers are based on 2055 observations from 1732 smokers who completed either the pre- or post-legislation survey, or both. Similarly, GEE models for non-smokers are based on 1160 observations from 864 non-smokers who completed either the pre- or post-legislation survey, or both. Correlation between pre- and post-legislation observations for individuals who completed both surveys was handled through the GEE approach, and all standard errors reported in this paper for the above outcomes are the empirical-based ones (i.e. the co-called ‘sandwich’ variance estimates). Except for the outcome of the percentage of cigarettes smoked inside the home, all GEE models used binomial variations and the logit link. For that particular outcome, the normality assumption was found to be satisfied, and a GEE model with Gaussian variations and the identity link was fitted.

For each of these outcomes, the aim of is to determine if the observed changes from pre- to post-legislation were greater in Scotland than they were in the rest of the UK. This was done

by testing the country × wave interaction in the various GEE models. Hence, country, wave and their interaction were retained in all steps of model building. SES was another key covariate of interest, and it too was systematically retained. As mentioned above, age and sex are weighting variables. They were thus also retained in all steps of model building, as recommended by survey sampling theory. For the other covariates considered (i.e. HSI, race and the various two-way interactions involving SES), a forward stepwise selection process was used, and only those attaining a *P*-value ≤ 0.01 were considered statistically significant and held in the final model. A significance level of 0.01 rather than 0.05 was chosen because of the many models fitted (and thus multiple comparisons performed) in this paper. For conciseness, the results of these covariates are not presented, rather we focus on the country × wave interaction while controlling for these other factors. Although the statistical methodology on diagnostic procedures for weighted GEE models is very limited, various residual plots were constructed and none showed any indication of lack of fit.

Quit attempts and smoking cessation were only assessed in the post-legislation survey, providing only a single observation per respondent; therefore, a weighted logistic regression model was fitted for these outcomes instead. Except for the fact that wave is no longer a relevant covariate and was thus excluded, model building proceeded as described above for GEE.

Results

Study question 1—Did Scotland’s smokefree law decrease SHS exposure in the home, hospitality venues, and the workplace?

Table 1 shows the weighted percentages (and their corresponding 95% confidence intervals) of respondents who reported observing smoking in bars/pubs, restaurants and their workplace, as well as the home smoking policy of respondents in Scotland and the rest of the UK before and after the Scottish smokefree law. These descriptive statistics show dramatic reductions to reported rates of observed smoking to between 1% and 8% in the different types of venues in Scotland. In the rest of the UK, where no smokefree laws had been passed, smoking was commonly observed at the post-law survey in bars/pubs (85%), restaurants (46%), and in the workplace (24%). Table 2 outlines the GEE models for smokers and non-smokers for the five outcomes of table 1. The first row of each GEE model shows the country effect (i.e. odds ratio, and its corresponding 95% confidence interval and two-sided *P*-value) pre-legislation, whereas the second row shows the same country effect post-legislation. The other key elements of table 1 are the *P*-values for the various country × wave interactions (footnote c). A significant interaction indicates that SHS exposure decreased to a greater extent in one country from pre- to post-legislation than it did in the other country. Combining these results, yields the following conclusions. Pre-legislation, the odds that a smoker reports observing smoking in bars/pubs are the same in Scotland as in the rest of the UK (*P*-value = 0.1193). However, the country × wave interaction is significant (*P*-value < 0.0001) and, post-legislation, the odds that a smoker reports observing smoking in bars/pubs in Scotland are 417 (1/0.0024 = 416.6) times less than in the rest of the UK (OR = 0.0024, *P*-value < 0.0001). The same applies to non-smokers observing smoking in bars/pubs; that is, no difference pre-legislation, but Scottish non-smokers were 135 (1/0.0074 = 135.1) times less likely than other UK non-smokers (OR = 0.0074, *P*-value < 0.0001) post-legislation. Similarly, country × wave interactions are also

Table 1 Weighted percentages (and corresponding 95% confidence intervals) for SHS exposure in bars, restaurants, workplaces and home

	Scotland		Rest of UK	
	2006	2007	2006	2007
Percent who observed smoking inside a bar or drinking establishment				
Overall	94 (92–96)	3.1 (1.4–4.9)	93 (92–95)	85 (82–88)
Smokers	97 (95–99)	2.5 (0.4–4.5)	95 (93–96)	90 (86–93)
Nonsmokers	89 (85–93)	4.1 (0.9–7.3)	91 (87–95)	80 (74–85)
Percent who observed smoking inside a restaurant or café				
Overall	60 (55–65)	0.7 (0.1–1.4)	56 (53–60)	46 (42–50)
Smokers	61 (55–68)	0.6 (<0.1–1.4)	59 (55–64)	54 (49–60)
Nonsmokers	57 (50–64)	1.0 (<0.1–2.3)	54 (47–61)	38 (32–44)
Percent who observed smoking in indoor areas where they work				
Overall	32 (26–38)	7.4 (4.4–10)	35 (30–39)	24 (19–29)
Smokers	37 (29–46)	7.3 (3.8–11)	40 (34–45)	33 (27–40)
Nonsmokers	26 (17–34)	8.0 (2.5–13)	22 (14–29)	9.3 (4.5–14)
Percent who never allow smoking anywhere in their home				
Overall	32 (28–36)	40 (36–44)	38 (34–41)	51 (47–54)
Smokers	10 (6.1–14)	13 (8.6–18)	21 (17–24)	23 (18–27)
Nonsmokers	68 (62–74)	73 (68–79)	78 (72–83)	82 (78–86)
Percentage of cigarettes smoked inside home during the evening (i.e. after work)				
Smokers	70 (66–74)	65 (60–69)	59 (56–62)	55 (51–59)

Table 2 Summary of GEE model results for smokers and nonsmokers

Outcome	Smokers			Nonsmokers		
	OR	95% CI	P-value	OR	95% CI	P-value
Observed people smoking in pubs—for those who visit pubs at least once a month						
Pre-law: Scotland vs. UK	1.7600	0.86–3.6	0.12	0.75	0.40–1.4	0.38
Post-law: Scotland vs. UK	0.0024	0.00090–0.0064	<0.0001	0.0074	0.0027–0.021	<0.0001
	0.12 ^a ; 0.0099 ^b ; <0.00010 ^c			0.38 ^a ; 0.0017 ^b ; <0.00010 ^c		
Observed people smoking in a restaurant or café—for those who visit restaurants or cafe at least once a month						
Pre-law: Scotland vs. UK	1.1	0.80–1.6	0.51	1.95	0.92–4.1	0.083
Post-law: Scotland vs. UK	0.0057	0.0017–0.0190	<0.0001	0.024	0.0054–0.10	<0.0001
	0.51 ^a ; 0.29 ^b ; <0.00010 ^c			0.083 ^a ; 0.0030 ^b ; <0.00010 ^c		
Observed smoking indoor at work—for those employed outside the home						
Pre-law: Scotland vs. UK	0.82	0.55–1.2	0.32	1.34	0.69–2.6	0.38
Post-law: Scotland vs. UK	0.16	0.089–0.29	<0.0001	0.86	0.34–2.2	0.76
	0.32 ^a ; 0.15 ^b ; <0.00010 ^c			0.38 ^a ; 0.022 ^b ; 0.45 ^c		
Never allow smoking in their home						
Pre-law: Scotland vs. UK	0.43	0.29–0.64	<0.0001	0.67	0.43–1.0	0.071
Post-law: Scotland vs. UK	0.51	0.34–0.77	0.0012	0.65	0.42–1.0	0.057
	<0.00010 ^a ; 0.24 ^b ; 0.50 ^c			0.071 ^a ; 0.41 ^b ; 0.94 ^c		
Percent of cigarettes smoked in home						
Pre-law: Scotland vs. UK	1.1	1.0–1.1	0.00090			
Post-law: Scotland vs. UK	1.1	1.1–1.1	0.0019			
	0.00090 ^a ; 0.053 ^b ; 0.93 ^c					

a: P-value for overall 1 d.f. test for country (UK vs. Scotland)

b: P-value for overall 1 d.f. test for wave (pre- vs. post-law)

c: P-value for 1 d.f. test for country × wave interaction. This is the key term of interest to assess the association with the Scottish smokefree law with the change in outcomes examined

significant for observing smoking in restaurants (both smokers and non-smokers) and at workplace (smokers only). Contrary to these observed differences in observing SHS in public places after the legislation, no differences were observed in the rate of change of smokefree homes or the percentage of cigarettes smoked inside the home in Scotland compared to the rest of the UK.

Study question 2—Did support for Scotland's smokefree law increase after its implementation?

Support for a total smoking ban in bars/pubs, in restaurants and cafes, and in workplaces is presented in table 3. Support

for comprehensive smoking restrictions generally increased between waves for both smokers and non-smokers in Scotland and in the rest of the UK; although, the increase was larger in Scotland. Table 4 outlines the GEE models for smokers and non-smokers for the three outcomes of table 4. Combining the statistically significant country × wave interactions for both smokers and non-smokers when it comes to support of a total smoking ban in bars/pubs and in restaurants/cafes yields the following conclusions for those two outcomes. Pre-legislation, the odds that a smoker or non-smoker supported a total smoking ban in bars/pubs were the same in Scotland as in the rest of the UK. While support of workplace smoking bans remained comparable between Scotland and the rest of the UK,

the post-legislation support for smoking bans in bars/pubs and in restaurants/cafes was greater in Scotland.

Study question 3—Did Scotland's smokefree law cause people to frequent restaurants and pubs less often?

Weighted percentages in self-report patterns of patronage of pubs and restaurants are presented in table 5, and the corresponding GEE models are presented in table 6. For smokers, all *P*-values are > 0.01, and there is thus no difference between Scotland and the rest of the UK, both pre- and post-legislation, in terms of frequenting pubs and restaurants. The same also applies to non-smoker patronage of restaurants. However, post-legislation, Scottish non-smokers were significantly less likely to report a decrease in pub visits than their peers residing in the rest of the UK.

Study question 4—Did indicators of smoking cessation increase in Scotland after the legislation?

Cessation indicators are presented in table 7 and 8. No statistically significant post-legislation differences between

Table 3 Weighted percentages (and corresponding 95% confidence intervals) for support of smokefree workplaces, restaurants and cafes, bars

	Scotland		Rest of UK	
	2006	2007	2006	2007
Percent who support a total smoking ban in bars and drinking establishments				
Overall	33 (28–37)	58 (54–63)	24 (21–27)	42 (38–46)
Smokers	17 (12–23)	37 (32–42)	12 (9.6–14)	18 (14–22)
Nonsmokers	59 (52–65)	88 (84–92)	54 (48–61)	67 (62–72)
Percent who support a total smoking ban in restaurants and cafes				
Overall	61 (56–66)	82 (78–86)	57 (53–60)	70 (67–74)
Smokers	49 (42–55)	73 (68–79)	45 (41–49)	53 (47–58)
Nonsmokers	82 (76–88)	96 (93–98)	84 (79–89)	89 (86–96)
Percent who support a total smoking ban in workplaces				
Overall	52 (48–57)	66 (62–71)	49 (45–52)	61 (58–65)
Smokers	39 (33–45)	54 (48–59)	38 (34–42)	43 (38–48)
Nonsmokers	76 (69–82)	84 (80–89)	75 (70–81)	81 (77–86)

Table 4 Summary of GEE model results for smokers and nonsmokers

Outcome	Smokers			Nonsmokers		
	OR	95% CI	<i>P</i> -value	OR	95% CI	<i>P</i> -value
Support total ban in pubs						
Pre-law: Scotland vs. UK	1.64	1.1–2.5	0.019	1.2	0.83–1.8	0.29
Post-law: Scotland vs. UK	3.2	2.2–4.7	<0.00010	3.8	2.3–6.0	<0.00010
	0.019 ^a ; 0.015 ^b ; 0.0069 ^c			0.29 ^a ; 0.019 ^b ; 0.00060 ^c		
Support total ban in restaurant or café						
Pre-law: Scotland vs. UK	1.23	0.92–1.6	0.16	0.90	0.53–1.5	0.70
Post-law: Scotland vs. UK	3	2.1–4.2	<0.00010	3.1847	1.5–6.9	0.0034
	0.16 ^a ; 0.062 ^b ; <0.00010 ^c			0.70 ^a ; 0.25 ^b ; 0.0089 ^c		
Support total ban in workplace						
Pre-law: Scotland vs. UK	1.1	0.81–1.5	0.55	1.1	0.68–1.7	0.76
Post-law: Scotland vs. UK	1.8	1.3–2.5	0.00040	1.2	0.72–2.0	0.49
	0.55 ^a ; 0.20 ^b ; 0.013 ^c			0.76 ^a ; 0.22 ^b ; 0.75 ^c		

a: *P*-value for overall 1 d.f. test for country (UK vs. Scotland)

b: *P*-value for overall 1 d.f. test for wave (pre- vs. post-law)

c: *P*-value for 1 d.f. test for country × wave interaction. This is the key term of interest to assess the association with the Scottish smokefree law with the change in outcomes examined

countries were observed in the self-report rates of making a quit attempt or successful cessation. For the use of nicotine replacement therapy, the country × wave interaction was statistically significant indicating a greater decrease in NRT use in Scotland after the legislation took effect compared to the rest of the UK.

Study question 5—Did socioeconomic status moderate the impact of the smokefree law?

To explore this study question, the interaction of country by SES was also investigated for each of these outcomes, but none approached statistical significance.

Discussion

The most striking finding from this study is that SHS exposure was dramatically reduced in Scottish pubs, restaurants and workplaces following their nationwide smokefree regulations, while exposure continues at high levels in the rest of the UK. Furthermore, in 2006–07 support for the law has increased faster in Scotland than in the rest of the UK, and there is no evidence of an economic downturn in Scotland or displacement of smoking from pubs to the home following the smokefree law. Smoking cessation outcomes in Scotland in the year following the implementation were comparable to outcomes in the rest of the UK.

Table 5 Weighted percentages (and corresponding 95% confidence intervals) for self-reported patronage patterns in pubs and restaurants

	Scotland		Rest of UK	
	2006	2007	2006	2007
Percent who visit pubs less often				
Overall	29 (24–34)	19 (16–22)	27 (24–30)	23 (20–26)
Smokers	34 (27–41)	31 (26–36)	27 (23–30)	26 (21–31)
Nonsmokers	21 (15–27)	4.5 (2.3–6.6)	29 (22–35)	21 (16–25)
Percent who visit restaurants less				
Overall	15 (12–19)	13 (11–16)	18 (15–21)	13 (11–16)
Smokers	18 (14–23)	21 (17–26)	20 (16–24)	17 (13–20)
Nonsmokers	11 (6.9–15)	4.1 (1.2–7.0)	14 (9.5–19)	12 (7.5–16)

Table 6 Summary of GEE model results for smokers and nonsmokers

Outcome	Smokers			Nonsmokers		
	OR	95% CI	P-value	OR	95% CI	P-value
Visit pubs less often						
Pre-law: Scotland vs. UK	1.5	1.0–2.1	0.032	0.65	0.40–1.0	0.074
Post-law: Scotland vs. UK	1.4	1.0–2.0	0.048	0.16	0.086–0.30	<0.00010
	0.032 ^a ; 0.73 ^b ; 0.86 ^c			0.074 ^a ; 0.025 ^b ; 0.00060 ^c		
Visit restaurants less often						
Pre-law: Scotland vs. UK	0.91	0.60–1.4	0.63	0.68	0.37–1.3	0.22
Post-law: Scotland vs. UK	1.4	0.96–2.1	0.082	0.31	0.12–0.76	0.010
	0.63 ^a ; 0.28 ^b ; 0.12 ^c			0.22 ^a ; 0.31 ^b ; 0.15 ^c		

a: P-value for overall 1 d.f. test for country (UK vs. Scotland)

b: P-value for overall 1 d.f. test for wave (pre- vs. post-law)

c: P-value for 1 d.f. test for country × wave interaction. This is the key term of interest to assess the association with the Scottish smokefree law with the change in outcomes examined

Table 7 Weighted percentages (and corresponding 95% confidence intervals) for comparison of smoking cessation indicators

	Scotland	Rest of UK
Quit Smoking by 2007	19 (9.8–29)	21 (14–28)
Cessation attempts by 2007	42 (33–51)	48 (41–54)
Use of NRT in the six months prior to the baseline survey	44 (35–53)	27 (23–32)
Use of NRT in the six months prior to the follow-up survey	31 (26–36)	26 (21–31)

Table 8 Summary of logistic and GEE models for smokers and quitters

Variables	OR	95% CI	P-value
Logistic Models for Quitters and Quit Attempts			
Quit smoking post-legislation			
Scotland vs. UK	0.91	0.47–1.7 0.51 ^d	0.77
Any Cessation attempts post-legislation			
Scotland vs. UK	0.86	0.56–1.3 0.25 ^d	0.49
GEE Model for Use of NRT			
Pre-law: Scotland vs. UK	1.9	1.2–2.9	0.0033
Post-law: Scotland vs. UK	0.83	0.53–1.3	0.44
	0.0033 ^a ; 0.0070 ^b ; 0.0077 ^c ; 0.23 ^d		

a: P-value for overall 1 d.f. test for country (UK vs. Scotland)

b: P-value for overall 1 d.f. test for wave (pre- vs. post law)

c: P-value for 1 d.f. test for country × wave interaction

d: P-value for overall 2 d.f. test for SES (low vs. moderate vs. high)

These results are largely consistent with the existing literature in each of these areas. The self-reported data on changes in the observation of smoking in various public places and on support for smokefree policies in Scotland mirrors the findings of an earlier evaluation of Ireland's smokefree law.¹⁰ Several studies have shown that respirable suspended particulate concentrations decrease by 90% or more in pubs and restaurants following smokefree regulations.^{28,29} It is also important to note that in England and the rest of the UK, where smoking had previously not been regulated in public places, the rate of observing smoking in pubs, restaurants, and workplaces also decreased from 2006 to 2007, and the fraction of homes that prohibit smoking increased. This suggests that

the public awareness efforts and debates may have played a role in educating people about the dangers of SHS and altering smoking practices in public and at home. This is similar to what was observed when comparing the Republic of Ireland (that had adopted a smokefree policy) with Northern Ireland (that had not yet adopted a smokefree policy) where contemporaneous improvements were found in both countries.³⁰

Some have posited that smokefree pub and restaurant policy encourages smokers to smoke and drink alcohol more in their home, thereby decreasing revenues in these businesses and increasing their family members' SHS exposure.^{31,32} This study found no evidence to support this theory: the prevalence of smokefree home policies among smokers was comparable, and the number of the cigarettes Scottish smokers consumed after work inside their home was unchanged after the smokefree law. A previous study found that smokefree pub regulations were a significant predictor of the subsequent adoption of a smokefree home policy among nationally representative samples of smokers in the UK, Australia, Canada and the US.³³ We did not observe a significant association in this smaller sample. Compared to smokers in the UK, Irish smokers had lower alcohol consumption in the home and consumed comparable levels of cigarettes in the home,¹⁶ something we did not investigate in this paper.

The findings from the questions assessing economic indicators reveal a similar pattern to what is observed in other studies of self-reported changes in frequenting pubs and restaurants. Most people report going to these establishments at about the same frequency or perhaps increased in some people as pub patronage among non-smokers appears to have increased relative to non-smokers in the rest of the UK.

We did not observe differences in smoking cessation indicators in Scotland compared to the rest of the UK and NRT use decreased in Scotland relative to the rest of the UK. The direct goal of smokefree policies is to reduce SHS exposure and not to increase cessation. Another paper by Brown and Moodie analyzing the same ITC Scotland data found a borderline non-significant association between the smokefree law in Scotland and increased quit intentions relative to smokers in the rest of the UK, although no clear associations were observed.³⁴ The literature is clear that smokefree worksite policies increase smoking cessation,^{35–37} although the evidence is more limited that smokefree worksite policies promote quit attempts.³⁶ Possible reasons for not observing a cessation association include: (i) longer follow-up time may be needed; (ii) the marginal change in SHS exposure resulting from the national-level law in Scotland may not have been large enough

because many workplaces had already adopted voluntary policies; (iii) Scottish smokers may have begun making preparations to stop smoking in advance of the law; and (iv) the quit rates in the rest of the UK may have been unusually high due to increased media activity about SHS in England as well as the recent comprehensive campaigns in Scotland, nearby Ireland, and other EU nations such as France, Germany and Italy.

Considerable emphasis has been placed in the UK on reducing health disparities between those of low and high SES.³⁸ In this study, we tested for differential response to the Scottish smokefree law and generally found no association, which suggests the smokefree policy works equally well across all SES groups. Given the higher prevalence of smoking in poorer communities, smokefree policies should have a direct impact on reducing inequalities.

Strength of the study is the pre/post matched comparison quasi-experimental design. Limitations include the loss to follow-up of about one-third of the original sample although the data are weighted to minimize this potential bias. Also, the analyses were conducted using weighted Generalized Estimating Equations,^{26,27} (GEE) the GEE models are based on a larger number of observations from respondents who completed either the pre- or post-legislation survey, or both, minimizing the effects of the loss to follow-up. Data are self-reported and may not accurately reflect some measures although the results are consistent with previous studies as noted above, and the measures used in this study have been used in previous similar studies in other countries. Longer follow-up time may be needed to detect more subtle differences in economic and smoking cessation outcomes. In addition, cell phones were not included in the sampling frame, which may have excluded some segments of the population disproportionately (but similarly in the two countries); however, the achieved sample was weighted to reflect the demographic distribution of smokers within each country.

In summary, these findings demonstrate that the Scottish smokefree law has been a success. SHS exposure has been dramatically reduced, support for the law was high and increased after the law, and there is no evidence of adverse economic outcomes in pubs and restaurants or displacement of smoking from pubs to the home. These findings should be useful for helping to inform smokefree policy debates that are taking place in many other countries in the wake of the FCTC. The message of the present study is clear: comprehensive smokefree legislation decreases secondhand smoke exposure while causing none of the hypothesized negative outcomes.

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Key points

- This paper reports on the results of an evaluation of Scotland's smokefree law that was implemented in March, 2006.
- Our evaluation found dramatic declines in the observance of smoking in pubs, restaurants, and workplaces in Scotland relative to the rest of the UK.
- Support for the law has increased faster in Scotland than in the rest of the UK, and there is no evidence of an economic downturn in Scotland or displacement of smoking from pubs to the home following the smokefree law.

References

- 1 Proposed identification of environmental tobacco smoke as a toxic air contaminant. Part B: health effects. California environmental protection agency. Office of environmental health hazard assessment. Air Toxicol Epidemiol Branch. (Available at <http://www.arb.ca.gov/toxics/ets/finalreport/finalreport.htm>) (accessed 7 June 2008)
- 2 U.S. Department of Health and Human Services. The health consequences of involuntary exposure to tobacco smoke: a report of the surgeon general. US department of health and human services, centers for disease control and prevention, coordinating center for health promotion, national center for chronic disease prevention and health promotion, office on smoking and health, 2006.
- 3 International Agency for Research on Cancer Monograph's Program, 'Monograph on Tobacco Smoking, both Active and Passive,' World Health Organization, June 2002. Available at <http://www.iarc.fr/pageroot/PRELEASES/pr141a.html> (accessed 25 November 2003).
- 4 Global Voices for a Smokefree World: Movement Towards a Smokefree Future, Global Smokefree Partnership, 2007. Available at <http://www.globalsmokefreepartnership.org/files/members/files/82.pdf> (accessed 11 October 2007).
- 5 Jamrozik K. An estimate of deaths attributable to passive smoking in Europe. *Smoke free partnership. Lifting the smokescreen: 10 reasons for a smoke free Europe.* Brussels: ERSJ Ltd, 2006, 17–41.
- 6 Jamrozik K. Estimate of deaths attributable to passive smoking among UK adults: database analysis. *Br Med J* 2005;330:812–6.
- 7 Martin J, Jarvis MJ, Goddard E, et al. Children's exposure to passive smoking in England since the 1980s: cotinine evidence from population surveys. *Br Med J* 2000;321:343–5.
- 8 World Health Organization. Tobacco Free Initiative. Information on global tobacco use. Available at http://www.who.int/tobacco/health_priority/en/index.html (accessed 7 October 2008).
- 9 Framework Convention on Tobacco Control. Available at <http://www.fctc.org/index.php> (accessed 7 October 2008).
- 10 Fong GT, Hyland A, Borland R, et al. Reductions in tobacco smoke pollution and increases in support for smoke-free public places following the implementation of comprehensive smoke-free workplace legislation in the Republic of Ireland: findings from the ITC Ireland/UK Survey. *Tobacco Control* 2006;15(Suppl III):iii51–8.
- 11 McNabola A, Broderick B, Johnston P, Gill L. Effects of the smoking ban on benzene and 1,3-butadiene levels in pubs in Dublin. *J Environ Sci Health. Part A, Environ Sci Eng Toxic Hazard Subst Control* 2006;41:799–810.
- 12 Allwright S, Paul G, Greiner B, et al. Legislation for smoke-free workplaces and health of bar workers in Ireland: before and after study. *Br Med J* 2005;331:1117.

- 13 Pell JP, Haw S, Cobbe S, et al. Smoke-free legislation and hospitalizations for acute coronary syndrome. *N Engl J Med* 2008;359:482–91.
- 14 Scollo M, Lal A, Hyland A, Glantz S. Review of the quality of studies on the economic effects of smoke-free policies on the hospitality industry. *Tob Control* 2003;12:13–20.
- 15 Fernando D, Fowles J, Woodward A, et al. Legislation reduces exposure to secondhand tobacco smoke in New Zealand bars by about 90%. *Tob Control* 2007;16:235–8.
- 16 Hyland A, Higbee C, Hassan L, et al. Does smoke-free Ireland have more smoking inside the home and less in pubs than the United Kingdom? Findings from the international tobacco control policy evaluation project. *Eur J Public Health* 2008;18:63–5.
- 17 Haw SJ, Gruer L. Changes in exposure of adult non-smokers to secondhand smoke after implementation of smoke-free legislation in Scotland: national cross sectional survey. *Br Med J* 2007;335:549.
- 18 Akhtar PC, Currie DB, Currie CE, et al. Changes in child exposure to environmental tobacco smoke (CHETS) study after implementation of smoke-free legislation in Scotland: national cross sectional survey. *Br Med J* 2007;335:545.
- 19 Semple S, Creely KS, Naji A, et al. Secondhand smoke levels in Scottish pubs: the effect of smoke-free legislation. *Tob Control* 2007;16:127–32.
- 20 Rogers EM. *Diffusion on innovations*, 5th edn. New York: Free Press, 2003.
- 21 Fong GT, Cummings KM, Borland R, et al. The conceptual framework of the international tobacco control (ITC) policy evaluation project. *Tob Control* 2006;15(Suppl 3):iii3–11.
- 22 Survey Sampling International. RDD telephone random digit samples. Available at <http://www.surveysampling.com/> (accessed 30 June 2008).
- 23 Binson D, Canchola JA, Catania JA. Random selection in a national telephone survey: a comparison of the Kish, next-birthday, and last-birthday methods. *J Official Stat* 2000;16:53–60.
- 24 The American Association for Public Opinion Research. 2008. *Standard definitions: final dispositions of case codes and outcome rates for surveys*, 5th edn. Lenexa, Kansas: AAPOR. Available at http://www.aapor.org/uploads/Standard_Definitions_07_08_Final.pdf (accessed 7 October 2008).
- 25 Heatherton TF, Kozlowski LT, Frecker RC, et al. Measuring the heaviness of smoking: using self-reported time to the first cigarette of the day and number of cigarettes smoked per day. *Br J Addict* 1989;84:791–9.
- 26 Hardin JW, Hilbe JM. *Generalized Estimating Equations*. Boca Raton, FL: Chapman & Hall/CRC, 2003.
- 27 Liang KY, Zeger SL. Longitudinal data using generalized linear models. *Biometrika* 1986;73:13–22.
- 28 Repace J. Respirable particles and carcinogens in the air of Delaware hospitality venues before and after a smoking ban. *J Occup Environ Med* 2004;46:887–905.
- 29 Travers M, Cummings KM, Repace J, et al. Indoor air quality in hospitality venues before and after the implementation of a clean indoor air law—New York, 2003. *MMWR* 2004;53:1038–41.
- 30 Allwright S, Paul G, Greiner B, et al. Legislation for smoke-free workplaces and health of bar workers in Ireland: before and after study. *Br Med J* 2005;331:1117. Erratum in: *Br Med J* 2006;332:151.
- 31 Beverage Daily News Headlines. UK government unveils pub smoking ban choices. Available at <http://www.beveragedaily.com/news/ng.asp?n=65556-pub-smoking-ban-government-drinks-industry> (accessed 6 December 2006).
- 32 Reid J. (The Secretary of State for Health, England). *Testimony. The government's public health white paper (Cm 6374)*. UK: Hearing Before the House of Commons Health Committee, 2005.
- 33 Borland R, Yong HH, Cummings KM, et al. Determinants and consequences of smoke-free homes: findings from the international tobacco control (ITC) four country survey. *Tob Control* 2006;15(Suppl 3):iii42–50.
- 34 Brown A, Moodie C. A longitudinal study of policy effect (smoke-free legislation) on smoking norms: ITC Scotland/UK. *Nicotine Tob Res* (in press).
- 35 Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behavior: systematic review. *Br Med J* 2002;325:188.
- 36 Bauer JE, Hyland A, Li Q, et al. A longitudinal assessment of the impact of smoke-free worksite policies on tobacco use. *Am J Public Health* 2005;95:1024–9.
- 37 Borland R, Davey C. Impacts of smoke-free bans and restrictions. Chapter 41. In: Boyle P, Gray N, Henningfield J, et al. editors. *Tobacco: science, policy and public health*. Oxford: Oxford University Press, 2004.
- 38 Wanless D. *Securing good health for the whole population*. London: HMSO, 2004.

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