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Papers

Legislation for smoke-free workplaces and health of bar workers in Ireland: before and after study

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Abstract

Objectives To compare exposure to secondhand smoke and respiratory health in bar staff in the Republic of Ireland and Northern Ireland before and after the introduction of legislation for smoke-free workplaces in the Republic.
Design Comparisons before and after the legislation in intervention and control regions.
Setting Public houses in three areas in the Republic (intervention) and one area in Northern Ireland (control).
Participants 329 bar staff enrolled in baseline survey; 249 (76%) followed up one year later. Of these, 158 were non-smokers both at baseline and follow-up.
Main outcome measures Salivary cotinine concentration, self reported exposure to secondhand smoke, and respiratory and sensory irritation symptoms.
Results In bar staff in the Republic who did not themselves smoke, salivary cotinine concentrations dropped by 80% after the smoke-free law (from median 29.0 nmol/l (95% confidence interval 18.2 to 43.2 nmol/l)) to 5.1 nmol/l (2.8 to 13.1 nmol/l) in contrast with a 20% decline in Northern Ireland over the same period (from median 25.3 nmol/l (10.4 to 59.2 nmol/l) to 20.4 nmol/l (13.2 to 33.8 nmol/l)). Changes in self reported exposure to secondhand smoke were consistent with the changes in cotinine concentrations. Reporting any respiratory symptom declined significantly in the Republic (down 16.7%, −26.1% to −7.3%) but not in Northern Ireland (0% difference, −32.7% to 32.7%). After adjustment for confounding, respiratory symptoms declined significantly more in the Republic than in Northern Ireland and the decline in cotinine concentration was twice as great.
Conclusion The smoke-free law in the Republic of Ireland protects non-smoking bar workers from exposure to secondhand smoke.

Introduction

In response to the evidence on the adverse effects of passive smoking on health,[1–3] on 29 March 2004 the Republic of Ireland introduced a comprehensive smoke-free law, covering all indoor workplaces, including bars and restaurants.[4–6] Introduction of this legislation in the Republic but not in neighbouring Northern Ireland, with its comparable population, environment, and culture, was a form of "policy randomisation,"[7] creating a natural experiment for identifying effects of the new law.

To date few studies have investigated whether legislation for smoke-free workplaces protects the health of workers. Cross sectional surveys before and after similar legislation in Finland in 1995 showed a decline in self reported exposure to secondhand smoke in workers from several non-hospitality workplace settings.[8] Some of the highest and most sustained occupational exposures to secondhand smoke occur in bar staff,[9 10] with non-smoking areas providing only limited protection.[11] Carbon monoxide concentrations in pubs in Galway indicated high exposure in Irish bar workers.[12] Eisner and colleagues examined 53 bar staff in San Francisco one month either side of the 1998 statewide law in California banning smoking in bars.[13] They concluded that the law was associated with a rapid improvement in respiratory health.

We examined the impact on bar staff of a national workplace smoke-free law by using laboratory assessment of exposure to secondhand smoke and by controlling for unrelated secular trends. We compared exposure to secondhand smoke and respiratory health in bar staff in rural and urban areas of the Republic of Ireland before and after the law and compared these changes with changes observed in Northern Ireland.

Methods

We enrolled staff working in pubs in the Republic and Northern Ireland in a baseline survey in the six months leading up to the ban (September 2003 to March 2004) and followed them up one year later (September 2004 to March 2005) to assess changes in exposure to secondhand smoke and symptoms (natural experiment).

Sample selection

Three areas in the Republic (Dublin, Cork, and County Galway) were selected to represent different types of pub environment, together with one area in the north west of Northern Ireland. Sampling procedures were adapted to local circumstances to maximise follow-up. In Dublin, we selected city centre and suburban pubs. The main trade union for Dublin bar workers (Mandate) forwarded our letter asking members to contact the research team if they were interested in participating. All pubs on randomly selected streets in Cork city were invited to participate and up to two bar staff were randomly selected from each pub. In Galway, we identified rural and family owned pubs by selecting electoral districts with populations of less than 1500. In Northern Ireland, we selected pubs from Derry City Council area and the adjoining rural Strabane and Limavady Council areas. All staff present in the Galway and Northern Ireland pubs on the day of the survey were asked to participate.

Although we enrolled both smokers and non-smokers, this analysis is restricted to participants who were non-smokers at both baseline and follow-up.

Conduct of survey

We invited Dublin bar staff to a hospital respiratory laboratory for salivary cotinine testing and administration of the questionnaire. Bar staff from the three other areas and the few Dublin staff who did not wish to attend the laboratory were interviewed in their workplace (pub). Most follow-up interviews were conducted in the same month as the baseline survey; at least two attempts at contact were made. GP trained all the interviewers.

Exposure to secondhand smoke

Salivary cotinine—Non-stimulated saliva samples (about 1 ml) were collected according to the protocol used in the Health Survey for England.[14] Samples were frozen and sent in batches to ABS Laboratories, London, who performed cotinine assays blind with a rapid gas-liquid chromatographic method suitable for use in non-smokers.[15] We ascertained smoking status because active smoking is the main influence on cotinine concentrations. As cotinine half life is about 20 hours,[16] length of time since last working also impacts on cotinine concentrations. This was therefore recorded for the Dublin participants. Participants interviewed in pubs were asked what time they started the current shift. The number of hours worked in the past two days was recorded for all participants.

Self reported exposure—We recorded hours of exposure to secondhand smoke at work and in total (including work, home, and other regular activities) over the past seven days and whether participants lived with a smoker.

Respiratory and sensory symptoms—We used questions developed by Eisner, Smith, and Blanc to get information on symptoms of respiratory and sensory irritation. Respiratory questions were adapted from the validated bronchial symptoms questionnaire of the International Union against Tuberculosis and Lung Disease.[13]

Statistical analysis

A nationally representative survey of the US population used 85.2 nmol/l (15 ng/ml) serum cotinine as a cut off for distinguishing smokers from non-smokers.[17] Heavy exposure to secondhand smoke, however, may produce saliva concentrations as high as 177.8 nmol/l (31.3 ng/ml).[10] Given the high exposures in bar workers,[9 10] and as salivary concentrations are 25% higher than serum concentrations,[18] we defined non-smokers as those who reported being former smokers or who had never smoked and had salivary cotinine concentration <113.6 nmol/l (20 ng/ml). We excluded people who claimed to be non-smokers but had salivary cotinine concentration ≥ 113.6 nmol/l as we considered them to be active smokers.

To measure any changes, we analysed symptoms individually, grouped into two dichotomous variables (any respiratory symptoms and any sensory symptoms), and as two symptom scores (total number of respiratory symptoms and total number of sensory symptoms reported by each individual).

Analyses (changes within pairs) were restricted to participants who took part in both baseline and follow-up surveys, who were still working in a pub, and who did not change their smoking status between baseline and follow-up. In before and after comparisons, differences between groups in characteristics that did not change, such as age and length of time in the bar trade (all increase by one year) and sex, are controlled internally. Univariate and bivariate analyses were conducted with JMP 5.0.1 (SAS Institute, Pacific Grove, CA), SPSS 12.0.1 (SPSS, Chicago, IL) and Mathematica 5.2 (Wolfram Research, Champaign, IL). As the data were skewed, we have presented medians and interquartile ranges for continuous data. We compared paired differences using Wilcoxon signed rank test or McNemar's χ^2 test for bivariate analyses and non-paired differences using Wilcoxon rank sum test, Pearson χ^2, or Fisher's exact test.

The requirement to compare the Republic with Northern Ireland while simultaneously testing outcomes (continuous—such as cotinine—or count—such as number of symptoms) at follow-up versus at baseline, together with the inclusion of both time varying covariates (such as hours worked in the past two days) and time constant covariates (such as sex), limits modelling possibilities to specific forms of generalised estimation equations.[19] We used versions of generalised estimation equations for multiple regression (for changes per person in cotinine before and after the ban) and for Poisson regression (rate ratio for changes per person in the reported numbers of symptoms before and after the ban) using Stata 9 (StataCorp, College Station, TX). All covariates were tested in the models, but we retained only those that proved significant, plus age and sex. Interaction terms between region and time period were always fitted and retained in the model if the associated P value was less than 0.10.

Table 1 Participants in baseline and follow-up surveys of bar staff before and after smoking ban

	Republic of Ireland	Northern Ireland
Enrolled in baseline survey	288 (207 from 140 pubs and 81 from Mandate*)	41 (41 from 24 pubs)
Not eligible for follow-up:		
Total	40	8
No longer in bar trade	36	4
Moved	3	4
Died	1	0
Not followed up:		
Total	28	4
Not contactable	19	4
Refused	9	0
Follow-up rate	76% (220/288)	71% (29/41)
Follow-up rate in those eligible for follow-up	89% (220/248)	88% (29/33)
Cotinine concentrations		
Available at baseline and follow-up	176	29
Not available†:		
Total	59	0
Insufficient	20	0
Contaminated	11	0
Refused	28	0
Non-smokers		
At baseline and follow-up	138	20
With cotinine concentrations at both surveys	111	20

*Mandate is the main trade union for Dublin bar workers.
†8 participants had no cotinine value at baseline, 21 had no cotinine value at follow-up, and 15 had no cotinine at either time.

Results

We enrolled 329 bar staff at baseline and 249 in the follow-up survey (table 1). Forty eight were not eligible for follow-up, 23 could not be contacted after several attempts, and nine refused, giving a follow-up rate of 89% of those eligible or 76% overall in the Republic, and 88% and 71% in Northern Ireland. In total 226 participants in the baseline survey and 213 in the follow-up survey provided analysable saliva samples; 205 provided analysable samples in both surveys.

Most participants (161/249, 65% at baseline) were non-smokers. We restricted analyses to the 158 who were still

Table 2 Baseline characteristics of non-smoking* bar staff enrolled in both baseline and follow-up surveys. Values are medians (interquartile ranges) unless stated otherwise

	Republic of Ireland (n=138)	Northern Ireland (n=20)	P value†
Age (years)	45.5 (35.0-54.9)	36.1 (20.9-43.8)	<0.001
No (%) of women	23 (17)	5 (25)	0.36
Time working in current bar (years)	9 (4-22)	2 (1.0-9.5)	0.002
Hours worked/ week in current job	40 (39.0-50.0)	40 (21.0-58.8)	0.46
No (%) with history of asthma diagnosed by physician	15 (11)	1 (5)	0.70
No (%) currently receiving asthma prescription	9 (7.9)	0	0.35

*Non-smoker defined as participants who said they did not smoke or had given up and had salivary cotinine concentrations <113.6 nmol/l. Excludes participants who changed smoking status between surveys.
†P value for comparison of medians (Wilcoxon rank sum test) and categorical variables (Pearson χ^2 or Fisher's exact test) at baseline and follow-up.

Table 3 Exposure to secondhand smoke in non-smokers* at baseline and follow-up surveys in the Republic of Ireland (n=138) and Northern Ireland (n=20). Values are medians (interquartile ranges) unless stated otherwise

	Baseline	Follow-up	P value†	Difference (95% CI)‡
Republic of Ireland				
Secondhand smoke exposure:				
Salivary cotinine (nmol/l)§	29.0 (18.2-43.2)	5.1 (2.8-13.1)	<0.001	–22.7 (–26.7 to –19)
Self reported exposure:				
Hours exposed at work (pub or bar) during past 7 days	40 (39-50)	0	<0.001	–40 (–47 to –41.5)
Hours exposed outside work (domestic or social) during past 7 days	4 (0-10)	0 (0-2)	<0.001	–1.25 (–4 to –1.5)
No (%) living with smoker	37 (26.8)	36 (26.1)	0.79	–0.7 (–6.9 to 5.5)
Hours worked in past 2 days	13 (9-19.5)	13 (7.1-18)	0.01	–2 (–3 to –0.5)
Northern Ireland				
Secondhand smoke exposure:				
Salivary cotinine (nmol/l)§	25.3 (10.4-59.2)	20.4 (13.2-33.8)	0.05	–5.7 (–21.3 to –3.7)
Self reported exposure:				
Hours exposed at work (pub or bar) during past 7 days	42 (15-55)	40 (6.5-45)	0.02	–3 (–11.5 to –0.5)
Hours exposed outside work (domestic or social) during past 7 days	0 (0-10)	2.5 (0-18)	0.41	0 (–2.5 to 7.5)
No (%) living with smoker	6 (30)	6 (31.6)	1.00	0 (–19.9 to 19.9)
Hours worked in past 2 days	12 (0-19)	10 (4-14)	0.63	–1.25 (–6 to 3.3)

IQR=interquartile range.
*Non-smokers defined as participants who said they did not smoke or had given up and had salivary cotinine concentrations <113.6 nmol/l at both baseline and follow-up surveys. Excludes participants who changed smoking status between surveys.
†P value for comparison of medians (Wilcoxon signed rank test) and categorical variables (McNemar χ^2 test) at baseline and follow-up.
‡Differences refer either to medians or percentages
§Values are for 131 participants (111 in the Republic of Ireland and 20 in Northern Ireland) with cotinine concentrations at both baseline and follow-up survey.

non-smokers at follow-up. Most participants were men. Participants from the Republic were older and had been working in the current pub for longer (table 2).

Those not followed up (n = 80) were significantly younger and more likely to be women, to smoke, to have worked for a shorter time in the current bar, and to have said they had asthma diagnosed by a physician than those followed up (data not shown).

Salivary cotinine concentrations declined significantly in both regions, but with a much greater decline in the Republic (80% *v* 20% in Northern Ireland). Cotinine concentrations for almost all the non-smokers in the Republic (106/111) fell compared with 14 out of 20 in Northern Ireland.

Self reported exposure to secondhand smoke was high before the ban, with smoke at work accounting for by far the greatest exposure (table 3). Work related exposure dropped to a far greater extent in the Republic (median of 40 *v* 0 hours in the past week, $P < 0.001$) than in Northern Ireland (median 42 *v* 40 hours, $P = 0.02$). Exposures outside work also dropped significantly in the Republic (median 4 *v* 0 hours, $P < 0.001$) but increased in Northern Ireland (0 *v* 2.5 hours, $P = 0.41$).

At baseline 65% of non-smokers in the Republic reported one or more respiratory symptom (table 4). This dropped by 25% to 49% ($P = 0.001$) at follow-up. After the ban, significantly fewer reported cough during the day or night ($P = 0.004$) or production of phlegm ($P = 0.002$). Similarly, after the ban, reporting any sensory symptom dropped from 67% to 45% ($P < 0.001$), reflecting significant declines in reporting red eyes ($P < 0.001$) and sore throat ($P = 0.004$). In Northern Ireland, the proportion reporting any respiratory symptom was lower at baseline (45%) than in the Republic and remained at 45% after the ban, although reporting any sensory symptom declined from 75% to 55% ($P = 0.13$).

We modelled changes in cotinine concentrations and in the number of respiratory and sensory symptoms (table 5). After adjustment for relevant covariates, cotinine concentrations in non-smokers in the Republic dropped by 71% (from 35.8 to 10.2 nmol/l), more than twice as much as in Northern Ireland (34% from 35.2 to 23.3 nmol/l) (table 6).

Table 6 also shows that the adjusted rate ratio for the number of respiratory symptoms (symptoms at follow-up relative to symptoms at baseline) in the Republic dropped (from 1.33 to 0.98), while in Northern Ireland it increased by 16% (from 0.67 to 0.83). The adjusted rate ratio for the number of sensory symptoms dropped substantially in both regions (by 50% in the Republic and by 44% in Northern Ireland).

Discussion

Main findings

This study shows that the smoking ban in the Republic of Ireland has led to a clear reduction in self reported exposure to secondhand smoke in and outside work. In non-smokers, salivary cotinine concentrations dropped by 80% and respiratory and sensory symptoms were significantly fewer. Smaller reductions were observed in Northern Ireland. The adjusted reduction in cotinine concentration was twice as great in the Republic as in Northern Ireland and respiratory symptoms also declined to a significantly greater extent.

It has been suggested that banning smoking in pubs and restaurants would lead to increased smoking in the home.[20] Although we did not ask specifically about exposure at home, our data do not support this contention as self reported exposure to secondhand smoke outside work dropped significantly in the Republic, but increased in Northern Ireland (table 3).

The unexpected improvements in Northern Ireland may be explained by a decline in the pub trade. At follow-up, participants from Northern Ireland reported working fewer hours in the past two days (12 hours *v* 10, table 3). An economic downturn in the north west region,[21] avoidance of drink driving, and stricter enforcement of regulations on underage drinking may be contributory factors. Some of the same factors may also

Table 4 Respiratory and sensory irritation symptoms at baseline and at follow-up surveys among non-smokers* in the Republic of Ireland and Northern Ireland (n=138 and 20). Values are numbers (percentages) unless stated otherwise

	No (%) with symptoms			
	Baseline	Follow-up	P value†	Difference (95% CI)‡
Republic of Ireland				
Respiratory symptoms:				
Median (IQR) No of symptoms	1 (0-2)	0 (0-2)	0.001	0 (–0.5 to 0)
Any symptom	90 (65)	67 (49)	0.001	–16.7 (–26.1 to –7.3)
Wheezing/whistling	29 (21)	27 (20)	0.86	–1.5 (–9.9 to 7.1)
Shortness of breath	22 (16)	22 (16)	1.00	0 (–8.2 to 8.2)
Cough, morning	29 (21)	20 (15)	0.14	–6.5 (–14.8 to 1.8)
Cough, rest of day or night	53 (38)	34 (25)	0.004	–13.8 (–23.1 to –4.5)
Phlegm production	59 (43) §	40 (29)	0.002	–14.7 (–24.0 to –5.4)
Sensory symptoms:				
Median (IQR) No of symptoms	1 (0-2)	0 (0-1)	<0.001	–1 (–1.27 to –0.7)
Any symptom	93 (67)	62 (45)	<0.001	–22.5 (–33.8 to –11.1)
Eyes, red or irritated	57 (41)	19 (14)	<0.001	–27.5 (–37.4 to –17.7)
Nose, runny or sneezing	61 (44)	48 (35)	0.08	–9.4 (–19.8 to 0.9)
Throat, sore or scratchy	46 (33)	26 (19)	0.004	–14.5 (–24.3 to –4.7)
Northern Ireland				
Respiratory symptoms:				
Median (IQR) No of symptoms	0 (0-1)	0 (0-1)	0.53	0 (–0.5 to 1)
Any symptom	9 (45)	9 (45)	1.00	0 (–32.7 to 32.7)
Wheezing/whistling	1 (5)	1 (5)	1.00	0 (–18.9 to 18.9)
Shortness of breath	5 (25)	3 (15)	0.69	–10 (–38.6 to 18.6)
Cough, morning	1 (5)	3 (15)	0.50	10.0 (–8.1 to 28.1)
Cough, rest of day or night	2 (10)	3 (15)	1.00	5.0 (–16.8 to 26.8)
Phlegm production	4 (20)	6 (30)	0.63	10.0 (–14.1 to 34.1)
Sensory symptoms:				
Median (IQR) No of symptoms	1 (0.3-2)	1 (0-1)	0.07	0 (–1 to 0.5)
Any symptom	15 (75)	11 (55)	0.13	–20.0 (–42.5 to 2.5)
Eyes, red or irritated	9 (45)	8 (40)	1.00	–5.0 (–31.8 to 21.8)
Nose, runny or sneezing	10 (50)	5 (25)	0.06	–25 (–49.0 to –1)
Throat, sore or scratchy	4 (20)	3 (15)	1.00	–5.0 (–35.8 to 25.8)

IQR=interquartile range.
*Non-smokers defined as participants who said they did not smoke or had given up and had salivary cotinine concentrations <113.6 nmol/l at baseline and follow-up surveys. Excludes participants who changed smoking status between surveys.
†P value for McNemar χ^2 test for paired comparison of individual symptoms and Wilcoxon signed rank test for comparing median number of symptoms at baseline and follow-up.
‡Differences refer either to medians or percentages.
§Two respondents did not answer this question.

be operating in the Republic alongside the high cost of drinking in pubs and a 9 pm watershed for people aged under 18, all contributing to a downturn in the pub trade.[6]

Comparison with other studies

There have been few follow-up studies of bar workers. The San Francisco study was small, based in a single city, and did not include biomarkers for assessment of secondhand smoke.[13] Follow-up studies in New York[22] and Norway[23] were not focused (exclusively) on bar staff and had low follow-up rates. None included a control population.

As in the San Francisco study,[13] we found dramatic decreases in self reported exposure to secondhand smoke at work and reductions in respiratory and sensory symptoms. The reductions in salivary cotinine concentrations in non-smoking hospitality workers in New York[22] were of a similar magnitude to those in our study. They reported significant reductions in the numbers of sensory symptoms but not of respiratory symptoms.

Table 5 Modelled changes in non-smokers. Figures are regression coefficients (95% confidence intervals) for cotinine concentrations and rate ratios (95% confidence intervals) for respiratory and sensory symptoms

	Regression coefficient or rate ratio (95% CI)	P value
Cotinine concentrations (nmol/l) (n=131)		
Region (Republic:Northern Ireland)	0.022 (–1.56 to 1.61)	0.978
Time period (follow-up:baseline)	–1.99 (–3.64 to –0.36)	0.017
Live with smoker (yes:no)	1.62 (0.62 to 2.62)	0.002
Hours worked in past 2 days	0.07 (0.01 to 0.13)	0.011
Age (years)	–0.03 (–0.07 to 0.001)	0.053
Sex (female:male)	0.94 (–0.28 to 2.16)	0.134
Interaction between region and time period	–2.40 (–4.18 to –0.62)	0.008
Constant	6.19 (4.25 to 8.12)	<0.001
Respiratory symptoms (n=158)		
Region (Republic:Northern Ireland)	1.96 (1.11 to 3.48)	0.021
Time period (follow-up:baseline)	1.22 (0.72 to 2.08)	0.447
Age (years)	1.00 (0.99 to 1.01)	0.487
Sex (female: male)	0.44 (0.28 to 0.69)	<0.001
Interaction between region and time period	0.60 (0.35 to 1.04)	0.070
Sensory symptoms (n=158)		
Region (Republic:Northern Ireland)	1.14 (0.77 to 1.70)	0.507
Time period (follow-up:baseline)	0.57 (0.47 to 0.71)	<0.001
Age (years)	0.99 (0.98 to 1.00)	0.063
Sex (female:male)	0.86 (0.60 to 1.22)	0.398
Hours worked in past week	0.99 (0.98 to 1.00)	0.089

Preliminary results from Norway show significant reductions in both respiratory and sensory symptoms.[23]

Strengths of study

We managed to enrol a large number of bar staff and our follow-up rate was high. The study evaluated a national law, bar staff were enrolled from three differing areas, and the inclusion of Northern Ireland allowed us to control for secular trends unrelated to the legislative change and hence estimate how much of the change was due to the new law.

In bodily fluids, cotinine, with a half life of around 20 hours,[16] is a good indicator of exposure to smoke over the previous two to three days. We used a combination of cotinine and self reported exposure as this is considered the best way of estimating exposure.[24]

The substantial declines in personal exposure of bar staff reported here are corroborated by measurements of particulate concentrations in pubs. Significant reductions (typically 60-80%) were observed after the introduction of the workplace smoking

Table 6 Modelled estimates (95% confidence intervals) for time period within region

	Baseline	Follow-up
Cotinine concentration*		
Republic of Ireland	35.8 (31.8 to 39.2)	10.2 (6.8 to 13.6)
Northern Ireland	35.2 (27.3 to 43.7)	23.3 (15.3 to 32.4)
Rate ratios for respiratory symptoms†		
Republic of Ireland	1.33 (1.14 to 1.54)	0.98 (0.83 to 1.16)
Northern Ireland	0.67 (0.39 to 1.17)	0.83 (0.50 to 1.36)
Rate ratios for sensory symptoms‡		
Republic of Ireland	1.19 (1.02 to 1.39)	0.69 (0.57 to 0.85)
Northern Ireland	1.09 (0.75 to 1.56)	0.65 (0.44 to 0.97)

*Adjusted for region, time period, living with smoker, hours worked in past 2 days, age, sex, interaction between region and time period, and constant, all set to average values.
†Adjusted for region, time period, age, sex, and interaction between region and time period all set to average values.
‡Adjusted for region, time period, age, sex, and hours worked in past week all set to average values.

What is already known on this topic

Secondhand smoke has adverse effects on health, including respiratory health

Smoke-free policies are associated with decreased exposure in the hospitality sector and possibly a rapid improvement in respiratory health in bar workers, though the size of these effects relative to underlying trends is unknown

What this study adds

After the introduction of comprehensive smoke-free workplace legislation in the Republic of Ireland, exposure to secondhand smoke and respiratory symptoms declined in non-smoking bar staff

The reductions were significantly higher than the unanticipated reductions observed in the control region

ban in both Dublin (http://tri.ie/ResearchResults/tabid/61/Default.aspx) and Galway pubs.[25]

Limitations of study

The lack of national or regional sampling frames precluded random sampling. The low take up at baseline, a feature of other studies in this setting,[13 22] reflects the pervasive anxiety in the trade at that time about the impending ban. Because we used volunteer sampling, the cotinine concentrations and frequencies of symptoms reported here may not be generalisable. By choosing different types of pub from urban and rural areas, however, we have provided an overall picture of the impact of the ban.

The small number not followed up differed from the overall group but this does not compromise study validity because of the paired design. Although the numbers enrolled from Northern Ireland were small, they were sufficient to detect significant changes.

Recommendations for further research

Although perceived health is important, objective testing of lung function and longer follow-up are required to assess the long term impact of the ban. Our results suggest that home exposure may have declined after the ban. Incorporation of testing of salivary cotinine concentrations in children into national longitudinal studies would be an objective way to monitor future exposures in countries considering the introduction of similar legislation. Secondhand exposure to smoke in exempted workplaces (such as prisons, psychiatric institutions, and hospices) should be monitored to assess the need for protection of their staff.

Implications of findings

The smoke-free workplace law in the Republic of Ireland has provided protection for one of the most heavily exposed occupational groups by reducing their exposure to secondhand smoke both in and out of the workplace. The reduced exposure has led to a decline in respiratory and sensory symptoms in non-smokers. The increase in support for the law in the Republic since its introduction, even among smokers, underpins its effectiveness.[26] These findings have implications for policy makers and legislators in other countries currently considering the nature and extent of their smoke-free workplace legislation.

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