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# Comparative impact of smoke-free legislation on smoking cessation in three European countries

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**Background:** Little is known about the differential impact of comprehensive and partial smoke-free legislation on smoking cessation. This study aimed to examine the impact of comprehensive smoke-free workplace legislation in Ireland and England, and partial hospitality industry legislation in the Netherlands on quit attempts and quit success. **Methods:** Nationally representative samples of 2,219 adult smokers were interviewed in three countries as part of the International Tobacco Control (ITC) Europe Surveys. Quit attempts and quit success were compared between period 1 (in which smoke-free legislation was implemented in Ireland and the Netherlands) and period 2 (in which smoke-free legislation was implemented in England). **Results:** In Ireland, significantly more smokers attempted to quit smoking in period 1 (50.5%) than in period 2 (36.4%) ( $p < 0.001$ ). Percentages of quit attempts and quit success did not change significantly between periods in the Netherlands. English smokers were significantly more often successful in their quit attempt in period 2 (47.3%) than in period 1 (26.4%) ( $p = 0.011$ ). In the first period there were more quit attempts in Ireland than in England and fewer in the Netherlands than in Ireland. Fewer smokers quitted successfully in the second period in both Ireland and the Netherlands than in England. **Conclusion:** The comprehensive smoke-free legislation in Ireland and England may have had positive effects on quit attempts and quit success respectively. The partial smoke-free legislation in the Netherlands probably had no effect on quit attempts or quit success. Therefore, it is recommended that countries implement comprehensive smoke-free legislation.

## Introduction

Smoke-free legislation is one of the policies recommended by the World Health Organization (WHO) in the Framework Convention on Tobacco Control (FCTC).<sup>1</sup> According to the WHO, countries should implement smoke-free legislation that bans smoking in indoor workplaces and other public places to decrease exposure to tobacco smoke pollution (second-hand smoke). Studies have shown that smoke-free legislation can also stimulate smokers to quit smoking.<sup>2,3</sup> This may happen because smoke-free legislation reduces the social acceptability of smoking,<sup>4,5</sup> increases support for regulating smoking,<sup>4,6</sup> limits smoking opportunities,<sup>7,8</sup> and leads to less socially cued smoking<sup>9,10</sup>.

There is evidence that comprehensive smoke-free legislation (i.e. 100% smoke-free legislation, without exemptions or designated smoking rooms) has larger effects on improving indoor air quality,<sup>11</sup> reducing exposure to tobacco smoke pollution<sup>12,13</sup> and on reducing acute coronary syndrome admissions<sup>14</sup> than partial smoke-free legislation. However, any differences in the effects of comprehensive and partial smoke-free legislation on smoking cessation are not yet studied.

Our study uses data from the International Tobacco Control (ITC) Europe Project to compare the impact of comprehensive smoke-free workplace legislation in Ireland and England with the impact of partial smoke-free hospitality industry legislation in the Netherlands on quit attempts and success.

### Ireland

Ireland implemented comprehensive smoke-free workplace legislation that included the hospitality industry in March 2004.

The implementation of the smoke-free legislation received extensive national<sup>15</sup> and international<sup>16</sup> media attention, as Ireland was the first country in the world to implement national comprehensive smoke-free legislation. There was an increase in available smoking cessation support in the period of the implementation of the smoke-free legislation, but it was considered a missed opportunity that cessation support was not emphasized in the mass media campaign.<sup>17</sup>

Data from a repeated cross-sectional national survey showed that smoking prevalence first declined from 29% to 26% one year after the implementation, but increased to 28% another year later.<sup>18</sup> Data from the ITC Project showed that 80% of smokers who had quit smoking after the ban reported the ban helped them quit and 88% reported the ban helped them stay quit.<sup>19</sup> However, changes in actual quit rates and success rates after the implementation of the legislation were not studied.

### England

England implemented comprehensive smoke-free workplace legislation that included the hospitality industry in July 2007. At the same time, the 17.5% rate of value-added tax on nicotine replacement therapy sold over-the-counter was reduced to 5%.

Data from a repeated cross-sectional national survey showed that the introduction of smoke-free legislation was not associated with additional reductions in smoking prevalence above the secular trend.<sup>20</sup> Data from the longitudinal Smoking Toolkit Study showed a small temporary increase in quit attempts in July and August 2007 compared to July and August 2008, but did not control for longer term quitting activity.<sup>21</sup> A further study suggested that the smoke-free legislation caused an increase in prescribing of smoking cessation medications, but indicated that

there may have only been a temporal displacement of quit attempts.<sup>22</sup> Changes in quit success after the implementation of the legislation were not studied.

### The Netherlands

The Netherlands implemented smoke-free workplace legislation that excluded the hospitality industry in January 2004 and implemented smoke-free hospitality industry legislation in July 2008. Both the 2004 and 2008 bans were implemented in conjunction with a tobacco tax increase. Tobacco prices increased by 19% in 2004 and 8% in 2008. There were also intensive mass media smoking cessation campaigns in both years. Workplaces and hospitality venues were allowed to create designated smoking rooms. Therefore, the Dutch smoke-free legislation is considered partial instead of comprehensive.

Data from a repeated cross-sectional national survey showed that quit attempts and quit success increased after the implementation of the 2004 smoke-free workplace legislation, resulting in a decline in smoking prevalence from 30% in 2003 to 28% in 2004.<sup>23</sup> There was a smaller increase in quit attempts and success after the implementation of the smoke-free hospitality industry legislation, and this resulted in a non-significant decline in smoking prevalence. However, only short-term effects of the 2008 ban were assessed.

### This study

The current study used three consecutive annual surveys from each country. In Ireland and the Netherlands, national smoke-free legislation was implemented between the first and second survey. In England, the smoke-free legislation was implemented between the second and third survey. This allowed for a quasi-experimental design in which the change over time in quit attempts and quit success in Ireland and the Netherlands could be compared with England.

## Methods

### Sample

The International Tobacco Control (ITC) Europe Project is a longitudinal study in which nationally representative samples of adult smokers are surveyed at regular time intervals.<sup>24</sup> The current study used three consecutive annual surveys from Ireland, England, and the Netherlands. We refer to the three surveys as wave 1, wave 2, and wave 3. However, for England, wave 1 is actually the fourth wave of ITC United Kingdom. To make the England sample comparable to the wave 1 samples from Ireland and the Netherlands, we have excluded respondents who had quit smoking between the first and fourth survey.

Respondents from Ireland and England were recruited using a stratified random digit dialling (RDD) probability sampling design of fixed line telephone numbers and were surveyed using telephone interviewing. Respondents from the Netherlands were recruited from a large probability-based database with respondents who indicated their willingness to participate in surveys on a regular basis and were surveyed using web interviewing.<sup>25</sup>

Before the implementation of smoke-free legislation in Ireland, England, and the Netherlands, 3,754 smokers aged 18 years and older were surveyed. Smokers were defined as having smoked at least 100 cigarettes in their lifetime and currently smoked at least once per month. One year later, 2,826 respondents (75.3%) completed the first follow-up survey. Of those, 2,219 (78.5%) completed the second follow-up survey. See Figure 1 for a timeline of the survey waves, sample sizes, and smoke-free legislation implementation dates per country. Smokers who were lost to follow-up were younger ( $M = 39.8$ ,  $SD = 15.2$ ) than smokers who were followed-up ( $M = 43.6$ ,  $SD = 14.1$ ;  $t = 7.77$ ,  $p < 0.001$ ) and smokers who were lost to follow-up were more often weekly bar

visitors ( $\chi^2 = 30.66$ ,  $p < 0.001$ ) and more likely to be employed ( $\chi^2 = 4.46$ ,  $p = 0.035$ ).

### Measurements

Gender, age, educational level, bar visiting, employment, and heaviness of smoking were assessed in the surveys. Age at recruitment was categorised into four groups: 18 to 24, 25 to 39, 40 to 54, and 55 years and older. Education was categorised into three levels (low, moderate, and high) that were only partly comparable across the three countries because of differences in educational systems. Bar visiting was categorized as weekly and non-weekly visiting. The Heaviness of Smoking Index (HSI) was created as the sum of two categorical measures: number of cigarettes smoked per day and time before smoking the first cigarette of the day.<sup>26</sup> HSI was categorized as low (0 to 1), moderate (2 to 4), and high (5 to 6).

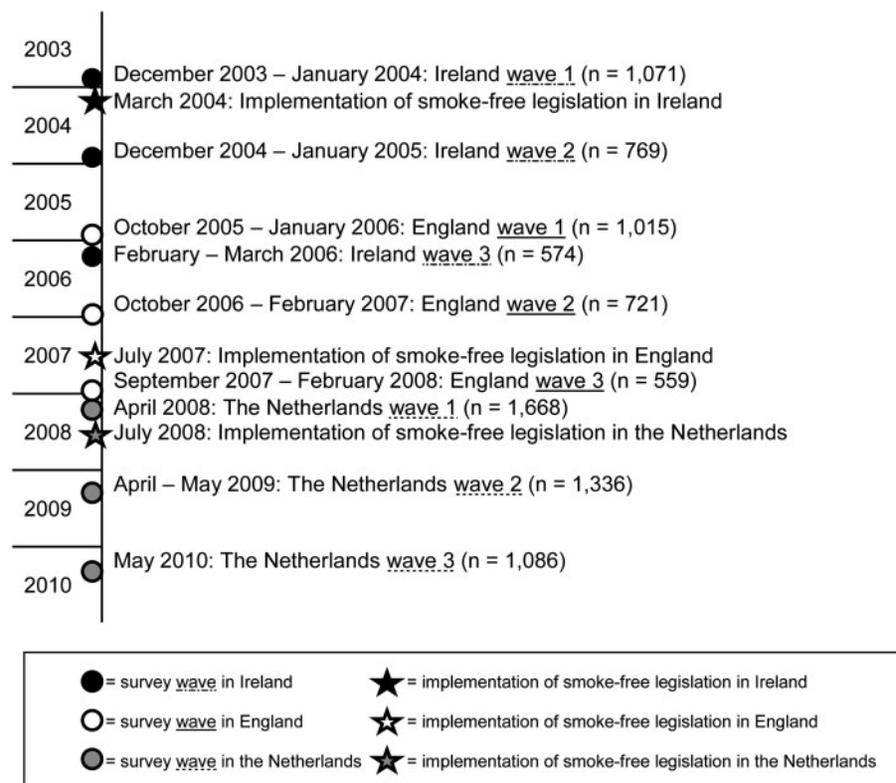
Quit attempts were assessed at waves 2 and 3 with the question "Have you made any attempts to stop smoking since the last survey?" Success of quit attempts among respondents who attempted to quit smoking since the last survey was assessed at waves 2 and 3 by asking whether they were back to smoking or still stopped. Respondents who were back to smoking, but reported smoking less than once a month, were defined as quitters.<sup>27</sup>

### Analyses

All analyses were weighted and performed with SAS version 9.2. The sampling weights were calibrated to smoking prevalence by gender-age groups within country, and the weighted data is thus representative of the adult smoker population within each country. Generalised Estimating Equation (GEE) models<sup>28,29</sup> were employed to test whether quit attempts and success differed between countries and across time periods. Correlations between observations from individuals who completed multiple waves was handled through the GEE approach, and all confidence intervals and p-values reported in this paper are based on the so-called "sandwich" variance estimator. All GEE models used binomial variations, the logit link, and an exchangeable correlation structure.

Since quit attempts and success were not measured at the baseline surveys, only two time periods were used in the GEE analyses. Quit attempts between waves 1 and 2 (first period) were compared with quit attempts between waves 2 and 3 (second period) and quit success at wave 2 (first period) was compared with quit success at wave 3 (second period). Smoke-free legislation was implemented in the first time period in Ireland and the Netherlands, and in the second time period in England.

Four GEE models were fitted. Dependent variables were quit attempts (Models 1 and 2) and quit success (Models 3 and 4). For Models 1 and 3 the independent variables were period, country, their interaction, gender, and age at recruitment. As mentioned above, sampling weights are calibrated to smoking prevalence by gender-age groups, and these two variables were included in all models, as recommended by survey sampling theory. Of key interest in this study is the period by country interaction, as it allows for formal testing of whether quit attempts and/or success evolved over the two time periods differently in each of the three countries. Models 2 and 4 were also adjusted for educational level at recruitment, and bar visiting, employment, and heaviness of smoking at prior wave (i.e. bar visiting, employment, and heaviness of smoking at wave 1 were used to model quitting in the first time period, and bar visiting, employment, and heaviness of smoking at wave 2 were used to model quitting in the second time period). Contrast statements were added to the four models to examine whether differences in quit attempts and quit success between periods were statistically significant in each of the three countries.



**Figure 1** Timeline of the survey waves, sample sizes, and smoke-free legislation implementation dates for Ireland, England, and the Netherlands

## Results

### Characteristics

Baseline characteristics of respondents are shown in Table 1. There were significant differences between countries on all baseline characteristics, except for gender. Differences between countries were large for educational level and bar visiting. Smokers from Ireland had the lowest educational level and visited bars most often. Smokers from the Netherlands had the highest educational level and visited bars least often. Note that educational levels were only partly comparable across the three countries because of differences in educational systems. To account for differences in characteristics between countries, GEE models 2 and 4 are adjusted for all covariates.

### Quit attempts

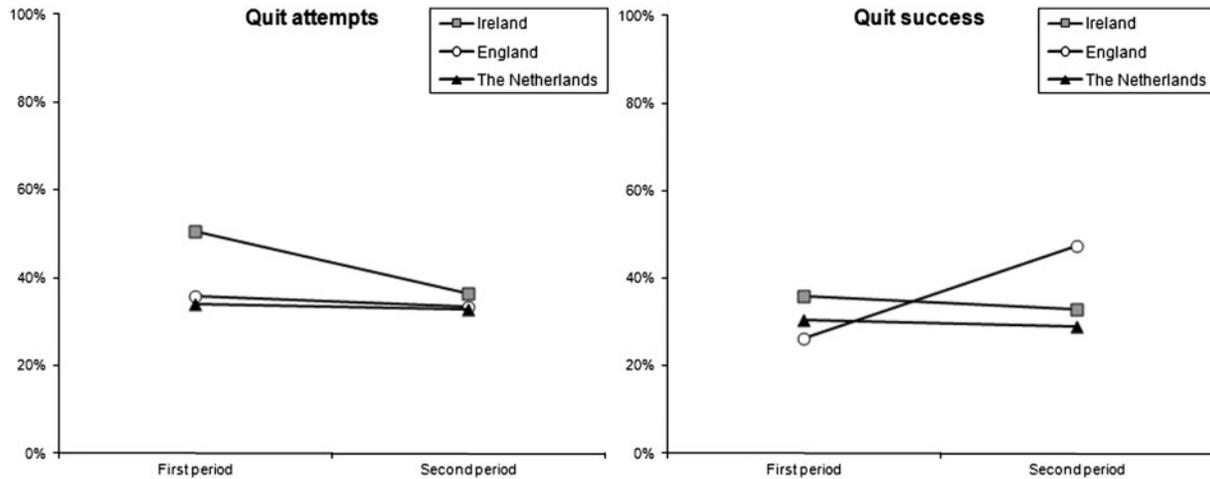
Figure 2 shows that more Irish smokers attempted to quit smoking in the first period (when the smoke-free legislation was implemented) (50.5%) than in the second period (36.4%). In England and the Netherlands, the percentage of quit attempts remained at the same level. Within-country GEE contrasts (not shown in Tables) confirmed that the difference in quit attempts between periods was only significant for Ireland ( $p < 0.001$ ). This difference remained highly significant after controlling for all covariates ( $p = 0.003$ ).

The between-country GEE analyses shown in Table 2 (Models 1 and 2) revealed that there were significant differences in quit attempts between countries and periods, as indicated by the significant  $p$ -values for the overall tests for country by period interactions. GEE Model 1 showed that in the first period there were more quit attempts in Ireland than in England (OR = 1.77,  $p < 0.001$ ) and fewer quit attempts in the Netherlands than in Ireland (OR = 0.54,  $p < 0.001$ ). These differences remained

**Table 1** Baseline characteristics of respondents by country

	Ireland (n = 574)	England (n = 559)	The Netherlands (n = 1,086)	Between country differences
Gender				
Male	50.0	52.2	52.9	$\chi^2$ (2) = 1.32
Female	50.0	47.8	47.1	$p = 0.518$
Age group				
18-24 years old	14.6	11.6	8.6	$\chi^2$ (6) = 21.30
25-39 years old	30.6	29.7	27.0	$p = 0.002$
40-54 years old	32.7	34.9	38.3	
55 years and older	22.1	23.7	26.2	
Educational level				
Low	65.8	55.9	39.7	$\chi^2$ (4) = 113.17
Moderate	22.0	27.7	41.4	$p < 0.001$
High	12.2	16.4	18.8	
Bar visiting				
Weekly	61.0	30.8	18.9	$\chi^2$ (2) = 303.08
Non-weekly	39.0	69.2	81.1	$p < 0.001$
Employment				
Yes	64.6	71.7	58.5	$\chi^2$ (2) = 28.48
No	35.4	28.3	41.5	$p < 0.001$
Heaviness of smoking				
0 to 1	30.8	24.4	26.6	$\chi^2$ (4) = 15.04
2 to 4	58.5	67.7	66.2	$p = 0.005$
5 to 6	10.7	7.9	7.1	

statistically significant in Model 2 that controlled for all covariates (OR Ireland versus England = 1.76,  $p = 0.001$ ; OR the Netherlands versus Ireland = 0.55,  $p < 0.001$ ). Significant covariates were age and employment. Smokers aged 40 to 54 years were less likely to attempt to quit smoking than smokers aged 18 to 24 (OR = 0.60,  $p = 0.003$ ). Employed smokers were more likely to attempt to quit smoking than unemployed smokers (OR = 1.32,  $p = 0.003$ ).



**Figure 2** Percentage of quit attempts and quit success in two periods<sup>†</sup> in Ireland, England, and the Netherlands.

<sup>†</sup>National smoke-free legislation was implemented in the first period in Ireland and the Netherlands, and in the second period in England

**Table 2** GEE analyses of country and period predicting quit attempts and quit success (Odds Ratios with 95% confidence interval)

	Model 1 <sup>†</sup> Quit attempts	Model 2 Quit attempts	Model 3 Quit success	Model 4 Quit success
First period: Ireland versus England	1.77 (1.28 to 2.46)***	1.76 (1.26 to 2.47)**	1.55 (0.92 to 2.59)	1.52 (0.91 to 2.53)
First period: The Netherlands versus England	0.95 (0.72 to 1.26)	0.97 (0.74 to 1.29)	1.22 (0.76 to 1.96)	1.27 (0.77 to 2.11)
First period: The Netherlands versus Ireland	0.54 (0.42 to 0.69)***	0.55 (0.42 to 0.73)***	0.79 (0.53 to 1.16)	0.84 (0.55 to 1.28)
Second period: Ireland versus England	1.11 (0.79 to 1.56)	1.19 (0.83 to 1.72)	0.55 (0.31 to 0.98)*	0.56 (0.30 to 1.06)
Second period: The Netherlands versus England	1.00 (0.76 to 1.33)	1.07 (0.80 to 1.42)	0.45 (0.27 to 0.76)**	0.47 (0.28 to 0.78)**
Second period: The Netherlands versus Ireland	0.90 (0.70 to 1.17)	0.89 (0.66 to 1.21)	0.83 (0.52 to 1.31)	0.83 (0.49 to 1.41)
	<0.001 <sup>a</sup> ; 0.490 <sup>b</sup> ; 0.012 <sup>c</sup>	<0.001 <sup>a</sup> ; 0.434 <sup>b</sup> ; 0.046 <sup>c</sup>	0.226 <sup>a</sup> ; 0.003 <sup>b</sup> ; 0.021 <sup>c</sup>	0.280 <sup>a</sup> ; 0.002 <sup>b</sup> ; 0.021 <sup>c</sup>

<sup>†</sup>Model 1 and 3: Adjusted for gender and age. Model 2 and 4: Adjusted for gender, age, educational level, bar visiting, employment, and heaviness of smoking.

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

a: p-value for overall 2 df test for country

b: p-value for overall 1 df test for period

c: p-value for overall 2 df test for country by period interaction

### Quit success

As can be seen in Figure 2, English smokers who attempted to quit smoking were more successful in the second period (when the smoke-free legislation was implemented) (47.3%) than in the first period (26.4%). In Ireland and the Netherlands, the level of quit success did not change between periods. Within-country GEE contrasts (not shown in Tables) confirmed that the differences in quit success between periods was only significant for England ( $p = 0.011$ ). This difference remained significant after controlling for all covariates ( $p = 0.006$ ).

The between-country GEE analyses (Models 3 and 4 in Table 2) showed that there were significant differences in quit success between countries and periods, as indicated by the significant p-values for the overall tests for country by period interactions. Model 3 showed that fewer smokers successfully quit in the second period in both Ireland (OR=0.55,  $p = 0.044$ ) and the Netherlands (OR=0.45,  $p = 0.003$ ) than in England. The differences between the Netherlands and England remained statistically significant in Model 4 that controlled for all covariates (OR=0.47,  $p = 0.004$ ), while the difference between Ireland and England was borderline significant in Model 4 (OR=0.56,  $p = 0.076$ ). Significant covariates were gender and heaviness of smoking. Men were less successful in their quit attempts than women (OR=0.68,  $p = 0.008$ ). Moderate heavy smokers (HSI: 3 to 4) were less successful in their quit attempt than not heavy smokers (HSI: 0 to 2) (OR=0.70,  $p = 0.024$ ).

### DISCUSSION

In this study, we found that Irish smokers made more quit attempts in the period in which comprehensive smoke-free workplace legislation was implemented than in the period after the implementation. This suggests that if the smoke-free legislation has increased quit attempts in Ireland, the effect was not sustained. This finding is in line with the Irish national survey showing a large temporary decline in smoking prevalence after the implementation of smoke-free legislation.<sup>18</sup>

In England, we found more quit success in the period in which comprehensive smoke-free workplace legislation was implemented than in the period before. This suggests that the smoke-free legislation increased quit success. Previous research from England found a small temporary increase in quit attempts after the smoke-free legislation<sup>21</sup> and no effects on smoking prevalence.<sup>20</sup> We did not find an increase in quit attempts in our study, which can be explained by the fact that the increase that was found in the earlier study was small and their study sample was three times larger. Also, the English legislation may not have had an effect on quit attempts because many English workplaces were already smoke-free when the national legislation was implemented.<sup>20,30</sup> The reduction in value-added tax on nicotine replacement therapy in England may have helped smokers who attempted to quit smoking to be more successful. More research is needed on the synergistic effects of smoke-free legislation with other tobacco control interventions before strong conclusions can be made.<sup>8</sup>

We found no changes in quit attempts or quit success between the period in which partial smoke-free hospitality industry legislation was implemented in the Netherlands and the period after the implementation. This suggests that the smoke-free legislation in the Netherlands either did not have an impact on smoking cessation or that there was a sustained impact. Since the percentage of quit attempts (33%) and quit success (30%) in the Netherlands was in both periods comparable to the percentage of quit attempts (36%) and quit success (30%) in the other countries in the periods in which no legislation was implemented, we believe it is more likely that the smoke-free legislation in the Netherlands had no impact on smoking cessation. This may be explained by the limited scope of the legislation (the hospitality industry) and the fact that only 19% of Dutch smokers visited bars weekly. Previous research found small short-term increases in quit attempts and success after the implementation of smoke-free hospitality industry legislation in the Netherlands.<sup>23</sup> The fact that we did not find these small short-term increases could be explained by the smaller sample size in our study.

Smoking cessation can be an important effect of smoke-free legislation.<sup>2</sup> However, smoke-free legislation is implemented primarily to protect non-smokers from exposure to tobacco smoke pollution. In the Netherlands, the implementation of smoke-free legislation was not accompanied by a campaign about tobacco smoke pollution. This may have resulted in low levels of support for the legislation and high levels of non-compliance among bars.<sup>31,32</sup> Although an intensive smoking cessation campaign ran during the implementation of the Dutch legislation, there was no measurable impact on smoking prevalence.<sup>23</sup> In Ireland, it was considered a missed opportunity that cessation support was not emphasized in the mass media campaign.<sup>17</sup> Campaign evaluations should assess whether mentioning cessation support in mass media campaigns about smoke-free legislation can stimulate smoking cessation without diluting the message that the legislation is implemented for the protection of non-smokers.

In most quasi-experimental studies, a control country is used in which no legislation is implemented and in which cessation behaviour is stable. Unfortunately, there were no data available from an ITC Europe country with three annual waves during which no legislation was implemented and cessation behaviour was thus stable. The lack of data on smoking cessation before the implementation of smoke-free legislation in Ireland and the Netherlands precluded conclusions about before-and-after differences in smoking cessation in these countries. Also, stronger conclusions could have been drawn about the comparative impact of comprehensive and partial smoke-free legislation when data from more countries was available. Furthermore, we have not controlled for intention to quit smoking in our GEE models. This could be seen as a limitation, because intention to quit smoking is an important causal predictor of smoking cessation.<sup>27</sup> However, including intention to quit in the models would overcorrect the models, because smoke-free legislation makes smokers more likely to quit.<sup>21</sup> Finally, more than 40% of baseline respondents were lost to follow-up by the third survey. These respondents were younger, were more often weekly bar visitors, and more likely to be employed. Therefore, our results may not be fully generalizable to the smoker population in the three countries.

We found an increase in quit success after the implementation of comprehensive smoke-free legislation in England. Also, there were indications that there might have been a temporary increase in quit attempts after the implementation of comprehensive smoke-free legislation in Ireland. The most likely explanation for the unchanged percentage of quit attempts and quit success after the implementation of partial smoke-free legislation in the Netherlands is that the legislation had no impact on smoking cessation. It would appear, therefore, that as well as offering greater protection from tobacco smoke pollution for all

employees, comprehensive smoke-free legislation might also maximise quitting behaviour. Therefore, we recommend that countries implement comprehensive smoke-free legislation.

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*Conflicts of interest:* None declared.

## Key points

- The comprehensive smoke-free workplace legislation in England was followed by an increase in quit success.
- If the comprehensive smoke-free workplace legislation in Ireland has increased quit attempts, the effect was not sustained.
- The partial smoke-free hospitality industry legislation in the Netherlands probably had no impact on quit attempts or quit success.
- It is recommended that countries implement comprehensive smoke-free legislation.

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