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Smoking ban and myocardial infarction in Chile

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Lower incidence of myocardial infarction after smoke-free legislation enforcement in Chile

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Abstract

Objective To evaluate the impact of a complete smoking ban in enclosed spaces on the incidence of acute myocardial infarction in Chile.

Methods The population-based study involved residents of urban areas, where 80\% of the Chilean population live, aged 20 years or older who had a myocardial infarction. Monthly myocardial infarction incidence and mortality rates at health-care facilities between January 2011 and December 2014 were derived from admission and mortality databases. Regression discontinuity methods were used to estimate the near-immediate impact on disease incidence of enforcing smoke-free legislation in March 2013. The same analysis was performed for ischaemic stroke, degenerative disc disease and colon cancer. Data on the concentration of fine respirable particulates were included in an additional analysis of myocardial infarction incidence in the Santiago metropolitan area.

Results The enforcement of smoke-free legislation was associated with an abrupt, near-immediate decline of 0.639 cases of myocardial infarction per 100 000 adults per month (95\% confidence interval, CI: 0.242 to 1.036; relative decline: 7.8\%). Similar abrupt declines were observed in men and women and in people aged over and under 70 years. However, enforcement of the legislation was not associated with a significant change in the rate of ischaemic stroke, degenerative disc disease or colon cancer. The abrupt decline in myocardial infarction incidence was also observed when data on fine respirable particulates were included in an analysis for Santiago.

Conclusion The enforcement of extensive smoke-free legislation in Chile was associated with an abrupt, near-immediate decline in the incidence of myocardial infarction.
Introduction

After ratifying the World Health Organization’s Framework Convention on Tobacco Control in June 2005, Chile enacted its first round of tobacco control legislation in May 2006.¹ The law completely prohibited smoking in public transport, in cinemas and in or near schools but permitted designated smoking spaces in public facilities and workplaces with more than 10 employees.²

In February 2013, Chile enacted a second round of strengthened tobacco control legislation, which took effect on 1 March 2013.³ The new law extended the complete prohibition of smoking to all enclosed spaces accessible to the public, all enclosed commercial spaces and all open and closed sports arenas.⁴ Compliance with the new prohibitions on public smoking was almost immediate and virtually complete. Once the law took effect, inspections of bars, restaurants, educational establishments, health-care institutions and other public spaces increased four-fold. Violations were identified in only 1.7% of inspections (unpublished data, Ministerio de Salud de Chile, 2016). Despite the new tobacco control measures, the prevalence of tobacco use in Chile has remained one of the highest in the Americas.⁵ Among people aged 12 to 64 years, the proportion who reported smoking in the past month declined from 43.6% in 2002 to 34.0% in 2012 but rose to 39.7% in 2014.⁶

Extensive international literature supports the association between smoke-free legislation and a subsequent reduction in the incidence of myocardial infarction.⁷ Moreover, it has been estimated that exposure to second-hand tobacco smoke increases the risk of myocardial infarction in nonsmokers by approximately 30%.⁸ As with active smoking, some of the adverse effects of exposure to second-hand smoke occur almost immediately, including endothelial dysfunction, activation of platelet aggregation and lower heart rate variability.⁹ In addition, short-term exposure to tobacco smoke has been reported to reduce the coronary flow velocity reserve in healthy young adults¹⁰ and aortic distensibility in smokers and nonsmokers.¹¹ Longer-term effects include an increase in oxidative stress, a decrease in high-density lipoprotein cholesterol levels, systemic inflammatory effects and an acceleration of atherosclerosis.⁸,¹² At least some of the adverse effects of exposure to second-hand smoke are reversible.¹³
In Chile, ischaemic heart disease is the second largest cause of death after cerebrovascular accident in both sexes.\textsuperscript{14} We decided to study the potential impact of Chile’s extensive prohibition of smoking in urban public and private spaces in March 2013 on hospitalizations and deaths from acute myocardial infarction. Previous studies in South America – in Argentina and Uruguay – investigated only hospitalizations but, nevertheless, reported a reduction in the incidence of myocardial infarction after smoke-free legislation was implemented.\textsuperscript{15,16} Ours is the first population-based study of the effects of smoke-free legislation in the region.

In view of the short-term adverse effects of second-hand smoke exposure and the rapid and near-complete compliance with Chile’s March 2013 smoking prohibition, we employed an analytic strategy based on a regression discontinuity method to determine whether a discrete change in the myocardial infarction rate occurred almost immediately after the prohibition took effect. This strategy avoids many of the pitfalls of before-and-after study designs, particularly their limited capacity to take into account other confounding influences that could concurrently affect the myocardial infarction rate, such as changes in public policy and environmental factors.\textsuperscript{17} Because of evidence that smoke-free legislation may also reduce the incidence of cerebrovascular accidents and that coronary and ischaemic cerebrovascular diseases share some pathological mechanisms,\textsuperscript{18,19} we repeated the analysis for ischaemic stroke. In addition, following other studies that employed diagnostic controls,\textsuperscript{19} we repeated our analysis for degenerative disc diseases and colon cancer. Finally, to address the possible confounding influence of air pollution, we performed an additional analysis that included the concentration of fine respirable particulates in the Santiago metropolitan area, where continuous data were available.

\textbf{Methods}

We conducted a population-based study of ST-elevation and non-ST elevation myocardial infarction in people aged 20 years or more in Chile who were treated before and after March 2013 at a public or private hospital or outpatient facility, including primary and urgent care centres. We excluded rural municipalities with a low population density and a small population. We employed the regression discontinuity method\textsuperscript{20,21} to
identify the near-immediate impact of smoking prohibition on the rates of myocardial infarction, ischaemic stroke and two conditions unaffected by exposure to second-hand smoke.

We obtained data from two Chilean Ministry of Health databases on all individual hospital discharges and deaths, respectively, recorded in the country during the period 2011 to 2014.\textsuperscript{22,23} We identified all patients with a primary or secondary diagnosis of acute myocardial infarction (i.e. codes I21 and I22 in the 10th revision of the \textit{International statistical classification of diseases and related health problems, ICD-10}), ischaemic stroke (i.e. codes I63, I64 and I67), degenerative disc disease (i.e. codes M50 and M51) and colon cancer (i.e. code C18).

Chile is divided into 346 administrative divisions called \textit{comunas}. Our study covered 123 \textit{comunas} with a 2012 population\textsuperscript{24} of at least 60 000 or a population density of at least 60 people per square kilometre.\textsuperscript{25} Together, these urban \textit{comunas} were home to 80\% of the Chilean population of 17.4 million in 2012. We determined the number of people in each urban \textit{comuna} diagnosed with a myocardial infarction or one of the comparison conditions in each month between January 2011 and December 2014. In the two databases, the variable \textit{comuna} referred to the individual’s residence. We obtained the total number of cases of myocardial infarction and of other conditions by summing the number of people with these conditions discharged from hospital alive, which was derived from the hospital discharge database, and the number of deaths occurring in health-care facilities, which was the greater of the two figures derived from the hospital discharge and mortality databases. For 76\% of \textit{comuna}–month combinations, mortality data on deaths from myocardial infarction at health-care facilities, which included primary care centres and hospital emergency departments, were more inclusive than discharge data on hospital inpatients whose death was attributed to myocardial infarction.

We included 37 833 patients who had a myocardial infarction between 2011 and 2014: 30 119 were discharged from hospital alive and 7714 died. We excluded 11 213 patients who died at home or at a site other than a health-care facility and whose deaths were attributed to, but could not reliably be confirmed as being due to, myocardial infarction. Among the patients included, 69\% were male and 65\% were aged between 20
and 69 years. Overall, 81% of all myocardial infarctions recorded in the country occurred among residents of urban comunas.

We calculated the rate of myocardial infarction and of other conditions in each month as the ratio of the number of cases to the number of residents aged 20 years or more in 2012, as derived from census data. For myocardial infarction, we consider these ratios to be approximate incidence rates. For the comparison conditions, we describe them simply as rates. We also analysed the rate of myocardial infarction stratified by sex and by age. We considered two age groups: 20 to 69 years and 70 years or more.

To take into account the possible confounding effect of air pollution, we obtained data on the daily concentration of particulate matter smaller than 2.5 micrometres ($PM_{2.5}$) in air in the Santiago metropolitan area between 2011 and 2014, which were available from 11 monitoring stations. We incorporated the mean monthly $PM_{2.5}$ concentration into an analysis of the 52 comunas in the Santiago metropolitan area, which was home to approximately 40% of the Chilean population in 2012. The study was exempt from ethical approval because data were obtained from only publicly available databases that contained no personal identifiers.

**Statistical analysis**

We used the regression discontinuity method to analyse trends in the monthly rate of myocardial infarction and of other diagnoses. To derive the regression discontinuity equation, let the index $t$ represent the number of months after March 2013. Thus, $t$ ranges from –26 for the month of January 2011 to +21 for December 2014, whereas March 2013 corresponds to $t = 0$. Let $y_t$ denote the rate of myocardial infarction (or of another condition) in month $t$. Let $X_t$ be a binary variable equal to 0 if $t < 0$ and equal to 1 if $t \geq 0$. Thus, $X_t$ switches from a value of 0 before the complete prohibition of smoking in enclosed public and private commercial spaces to a value of 1 once the prohibition comes into effect in March 2013. Let $Z_t$ denote a vector of other binary covariates corresponding to the calendar month of disease occurrence (i.e. February to December, with January as the reference category) and, in our restricted analysis of data from the Santiago metropolitan area, the monthly $PM_{2.5}$ concentration. Our regression discontinuity specification is:
\[ y_t = \alpha + \beta t + (\gamma + \delta t)X_t + \theta Z_t + \varepsilon_t, \quad (1) \]

where \( \alpha, \beta, \gamma, \delta \) and \( \theta \) are unknown parameters and \( \varepsilon_t \) are independently identically distributed error terms with a zero mean.

The parameters of interest in Equation 1 are \( \gamma \) and \( \delta \). The parameter \( \gamma \) captures the time-independent, discrete change in the disease rate once the smoking prohibition has become effective. In geometric terms, it corresponds to the discontinuity, or gap, between preprohibition and postprohibition trend lines. By contrast, the parameter \( \delta \) indicates the change in the temporal trend from before to after the prohibition has become effective. It corresponds to the difference between the slopes of the preprohibition and postprohibition trend lines. If smoke-free legislation resulted in a near-immediate reduction in the rate of myocardial infarction, we would expect the parameter \( \gamma \) to be negative and significantly different from zero. On the other hand, if the prohibition of smoking resulted in a gradual reduction in the rate of myocardial infarction over time, we would expect the parameter \( \delta \) to be negative and significantly different from zero.

In graphical presentations of our results, we display the estimated trend lines derived from Equation 1 and the seasonally adjusted rates of myocardial infarction for each month from January 2011 to December 2014. To calculate seasonally adjusted myocardial infarction rates, we estimated the regression model, \( y_t = \mu + \phi W_t + \eta_t \), where \( \mu \) and \( \phi \) are unknown parameters, \( W_t \) denotes the vector of binary covariates corresponding to the calendar month of disease occurrence (i.e. February to December, with January as the reference category) and \( \eta_t \) is an error term. Using estimates, \( \hat{\phi} \), from this regression model, we then calculated seasonally adjusted myocardial infarction rates as \( y_t - \hat{\phi} W_t \). For the Santiago metropolitan area, we used the same method to compute the seasonally adjusted \( PM_{2.5} \) concentration.

Results

The results of our regression discontinuity analysis of the incidence of myocardial infarction are shown in Fig. 1 and Table 1. The estimated discontinuity in March 2013 at month 0 (corresponding to the parameter \( \gamma \)) and the change in temporal trend (corresponding to the parameter \( \delta \)) were both statistically significant: \( \hat{\gamma} = -0.639 \).
(P = 0.002) and δ = −0.043 (P = 0.003). In relative terms, the near-immediate reduction in incidence was 7.8%, based upon the predicted incidence of 8.179 cases per 100 000 in March 2013 in the absence of smoke-free legislation. This reduction amounted to 64 fewer cases of myocardial infarction per month or 764 fewer cases per year in an adult population of 9.965 million in the urban comunas under study. Considering only data on hospital discharges did not significantly alter our findings: ŷ = −0.418 (P = 0.036) and δ = −0.049 (P = 0.001).

The results of our analysis of the change in the incidence of myocardial infarction stratified by sex are displayed in Fig. 2, Fig. 3 and Table 1. In males, both the estimated discontinuity and the change in temporal trend were statistically significant: ŷ = −0.778 (P = 0.027) and δ = −0.069 (P = 0.006). In females, the estimated discontinuity was statistically significant (ŷ = −0.514, P = 0.020) but the estimated change in temporal trend was not significantly different from zero (δ = −0.023, P = 0.121). The results of the corresponding analysis stratified by age group are shown in Fig. 4 (available at: http://www.who.int/bulletin/volumes/95/##/##-######), Fig. 5 and Table 1. The estimated discontinuities were statistically significant for both groups: P = 0.049 for individuals aged 20 to 69 years and P = 0.016 for those aged 70 years and older. In contrast, the estimated change in temporal trend was significant only for those aged 70 years and older: δ = −0.300 (P = 0.004).

Our corresponding results for other conditions are also shown in Table 1. For ischaemic stroke, the estimated discontinuity was not significant (ŷ = −0.188, P = 0.668), whereas the estimated change in temporal trend was negative and significantly different from zero (δ = −0.084, P = 0.009). Expansion of the definition of stroke to include nontraumatic, intracerebral haemorrhage (i.e. ICD-10 code I61) did not substantially alter our findings (ŷ = −0.218, P = 0.650; and δ = −0.094, P = 0.008). Our findings for degenerative disc disease are shown in Fig. 6. Neither the estimated discontinuity nor the change in trend was statistically significant (ŷ = 0.124, P = 0.648; and δ = −0.019, P = 0.306, respectively). For colon cancer, the estimated discontinuity was not significant (ŷ = −0.112, P = 0.467), whereas the estimated change in trend was positive and significantly different from zero (δ = 0.025, P = 0.023).
The estimated seasonally adjusted incidence of myocardial infarction in the Santiago metropolitan area is shown in Fig. 7 (available at: http://www.who.int/bulletin/volumes/95/##/##-#####) and the corresponding seasonally adjusted PM$_{2.5}$ concentration is shown in Fig. 8 (available at: http://www.who.int/bulletin/volumes/95/##/##-#####). In a regression discontinuity model that included the PM$_{2.5}$ concentration, both the estimated discontinuity in the incidence of myocardial infarction in March 2013 ($\hat{\phi} = -0.733$, $P = 0.009$) and the estimated change in trend ($\hat{\phi} = -0.053$, $P = 0.008$) remained significant (Table 1). The coefficient of the PM$_{2.5}$ term in the regression model was not significantly different from zero ($P = 0.771$).

Discussion

We observed a significant abrupt reduction in the incidence of myocardial infarction in urban municipalities in Chile in the same month that smoke-free legislation went into effect. This abrupt decline was observed in both sexes and in people aged 20 to 69 years and 70 years and older. There was no corresponding significant abrupt reduction in the rate of ischaemic stroke, degenerative disc disease or colon cancer. In an analysis restricted to the Santiago metropolitan area, inclusion of the concentration of fine respirable particulates had no detectable effect on our regression estimates.

Many prior studies have compared trends in the incidence of myocardial infarction during extended periods before and after the enforcement of public smoking bans. Our study follows the lead of a few others in assessing the near-immediate effect of a public smoking ban, as captured by the discontinuity in the estimated trend lines.\textsuperscript{16,19,27–29} The rationale for this approach is based on evidence that exposure to second-hand smoke has a near-immediate adverse effect on the risk of myocardial infarction and that enforcement of, and compliance with, smoke-free legislation is also near-immediate.

We also observed that the slope of the temporal trend line of myocardial infarction incidence was significantly smaller in the 20-month period after Chile’s smoke-free legislation went into effect than it was before. Although smoke-free legislation may have contributed to these longer-term trends, other factors, such as the additional tobacco control measures enacted as part of the 2013 law, could have been
For example, the real price of cigarettes increased by approximately 30% between 2011 and 2014. In addition, the increased use of troponin testing in Chilean hospitals to diagnose non-ST elevation myocardial infarction could also have influenced disease rates. Although the prevalence of all cardiovascular risk factors except diabetes remained stable between 2003 and 2010, no comparable data were available for the period 2011 to 2014. These potentially confounding factors could have influenced trends in disease incidence in the 2 years after the enforcement of smoke-free legislation but they are less likely to have contributed to the abrupt decline observed in the month immediately after the legislation went into effect.

Inclusion of the $PM_{2.5}$ concentration did not alter our finding of a significant abrupt decline in the incidence of myocardial infarction after March 2013. Nor did the temporal pattern of air pollution show any relation to incidence. In June 2011, before the enforcement of smoke-free legislation, the Puyehue–Cordón Caulle volcanic complex erupted in southern Chile. The resulting emission of particulates and toxic gases could have affected disease incidence. However, the dominant wind direction during the eruption was from west to east, which dispersed ash clouds into Argentina, Brazil and Uruguay.

We estimated that the relative decline in the incidence of myocardial infarction in the urban municipalities included in our analysis was 7.8%. This figure is towards the lower end of the 4 to 52% range reported in meta-analyses. However, our study focused solely on the near-immediate decline in incidence, whereas most other studies took into account longer-term effects.

Several studies of the impact of smoke-free legislation employed geographical controls. We could not use this study design because Chile’s 2013 law was adopted on a nationwide basis. Here, we hypothesized that people living in urban areas with a higher population or population density would have greater exposure to second-hand smoke and would thus experience a marked reduction in the likelihood of a myocardial infarction after the enforcement of smoke-free legislation. This hypothesis was reinforced by the substantially higher smoking prevalence in urban areas of Chile, as well as by the observed dose–response association between the extent of second-hand
smoke exposure and the risk of myocardial infarction. Following other studies, we employed diagnostic controls.

Although there is some evidence that smoke-free legislation can reduce the incidence of ischaemic cerebrovascular accidents, we detected a significant decline only in the slope of the trend line with the enforcement of legislation in Chile – there was no abrupt reduction in the rate of strokes. Our analysis may have been limited by the misclassification of cerebrovascular events. Among the three ICD-10 categories we employed, I64 (i.e. stroke, not specified as haemorrhage or infarction) and I67 (i.e. other cerebrovascular diseases) accounted for about 30 and 45% of events, respectively. Inclusion of I61 (i.e. nontraumatic, intracerebral haemorrhage) did not alter our findings substantially.

Most studies of the impact of smoke-free legislation on the incidence of myocardial infarction have relied solely upon data on hospitalizations, although some have analysed mortality data, either alone or with hospitalization data. Here, we employed a population-based approach, combining both hospitalization and mortality data. Still, we included only 37 833 cases of myocardial infarction diagnosed in a hospital or other health-care facility. Out of concern for diagnostic reliability, we excluded 11 213 deaths outside of health-care facilities that were attributed to, but not confirmed as, myocardial infarction.

Our study has two additional limitations. First, we lacked information on each individual’s smoking status and thus could not directly verify that the decrease in myocardial infarctions among nonsmokers resulted from reduced exposure to second-hand smoke. Second, our follow-up period ended in 2014. Longer follow-up may have improved the precision of our estimates of the post-ban trend line and of the immediate reduction in the incidence of myocardial infarction.

Our findings support the view that the smoke-free legislation enacted in 2013 in Chile had a significant favourable effect on the health of the population. These results will be useful in evaluating national policies for tobacco control and myocardial infarction prevention.
Acknowledgments

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Competing interest

None declared

References


Table 1. Regression discontinuity analysis of the change in incidence of medical conditions with enforcement of tobacco control legislation,\(^a\) Chile, 2011–2014

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Demographic group</th>
<th>Regression discontinuity model coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Discrete change in disease rate ((\gamma))(^b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value (95% CI)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Both sexes, aged (\geq) 20 years</td>
<td>(-0.639 (:-1.036) to (-0.242))</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Males, aged (\geq) 20 years</td>
<td>(-0.778 (:-1.462) to (-0.095))</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Females, aged (\geq) 20 years</td>
<td>(-0.514 (:-0.941) to (-0.086))</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Both sexes, aged 20–69 years</td>
<td>(-0.363 (:-0.725) to (-0.001))</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Both sexes, aged (\geq) 70 years</td>
<td>(-3.508 (:-6.317) to (-0.698))</td>
</tr>
<tr>
<td>Ischaemic stroke</td>
<td>Both sexes, aged (\geq) 20 years</td>
<td>(-0.188 (:-1.073) to (0.697))</td>
</tr>
<tr>
<td>Degenerative disc disease</td>
<td>Both sexes, aged (\geq) 20 years</td>
<td>(0.124 (:-0.422) to (0.669))</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>Both sexes, aged (\geq) 20 years</td>
<td>(-0.112 (:-0.421) to (0.197))</td>
</tr>
<tr>
<td>Myocardial infarction in the Santiago metropolitan area(^d)</td>
<td>Both sexes, aged (\geq) 20 years</td>
<td>(-0.733 (:-1.272) to (-0.195))</td>
</tr>
</tbody>
</table>

CI: confidence interval.

\(^a\) A second round of strengthened tobacco control legislation took effect on 1 March 2013.

\(^b\) The parameter \(\gamma\) indicates the discrete change in disease rate associated with the enforcement of smoking legislation in March 2013.

\(^c\) The parameter \(\delta\) indicates the change in the temporal trend of the disease rate associated with the enforcement of smoking legislation in March 2013.

\(^d\) An additional regression discontinuity model for the Santiago metropolitan area included the daily concentration of particulate matter in the air smaller than 2.5 micrometres (\(PM_{2.5}\)).
Fig. 1. Incidence of myocardial infarction before and after enforcement of tobacco control legislation, Chile, 2011–2014

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for people aged 20 years and older living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 2. Incidence of myocardial infarction in men before and after enforcement of tobacco control legislation, Chile, 2011–2014

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for men aged 20 years and older living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 3. Incidence of myocardial infarction in women before and after enforcement of tobacco control legislation, Chile, 2011–2014

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for women aged 20 years and older living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 4. Incidence of myocardial infarction in people aged 20 to 69 years before and after enforcement of tobacco control legislation, Chile, 2011–2014

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for people aged 20 to 69 years living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 5. **Incidence of myocardial infarction in people aged 70 years and older before and after enforcement of tobacco control legislation, Chile, 2011–2014**

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for people aged 70 years and older living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 6. **Rate of degenerative disc disease before and after enforcement of tobacco control legislation, Chile, 2011–2014**

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for people aged 20 years and older living in urban areas of Chile. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 7. *Incidence of myocardial infarction in the Santiago metropolitan area before and after enforcement of tobacco control legislation, Chile, 2011–2014*

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. The data shown are for people aged 20 years and older living in the Santiago metropolitan area. The circles show seasonally adjusted rates, as described in the text. Solid circles represent rates before March 2013 and open circles represent rates from March 2013 onward. The lines show the fitted values derived using the regression discontinuity model.
Fig. 8. Atmospheric $PM_{2.5}$ concentration in the Santiago metropolitan area before and after enforcement of tobacco control legislation, Chile, 2011–2014

$PM_{2.5}$: particulate matter smaller than 2.5 micrometres.

Notes: A second round of strengthened tobacco control legislation took effect on 1 March 2013. Particulate matter concentrations were available from 11 monitoring stations in Santiago.