

**Better air but not for all? Changes in secondhand smoke exposure at workplaces in 29 European countries over 10 years**

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For Review Only

## ABSTRACT

Background: As the largest study of its kind to date, this paper aims to describe the scope, trends over time, socio-demographic risk groups and the association with different progressive regulations relating to workplace SHS exposure in 29 European countries during a period of high regulatory action.

Methods: Three waves of the European Working Conditions Surveys (2005, 2010, 2015) were evaluated, including a total of 95,718 workers. The samples are representative for all employed residents of the 29 countries included. All interviews were conducted face-to-face at respondents' homes (Computer Assisted Personal Interviews). SHS exposure among the overall working population of 29 countries - including smokers - was examined. Workplace regimes were grouped corresponding to the sub-scale 'workplace' as used in the Tobacco Control Scale.

Results: Between 2005 and 2015, SHS exposure in the European countries declined from around 19.0% [95% CI 16.1-22.0] to 9.9% [8.3-11.5]. High SHS-exposure was reported by workers with the lowest level of education (11.5% [9.7-13.2]), among high-skilled manual laborers (14.3% [12.1-16.4]) and among those without a standard employment contract (11.2% [9.3-13.1]). The highest exposure was reported by workers in the food service industry (19.7% [16.8-22.6]). Countries with less workplace-related smoking prevention regulations were found to have the highest overall levels of exposure.

Conclusion: This multinational series of cross-sectional surveys on the trends in passive smoking in the workplace has shown that countries with more comprehensive workplace smoking bans overall report lower levels of SHS exposure among their work force as compared to slow progressing countries.

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3 Keywords: prevention, tobacco control, health inequality, tobacco, second hand smoke,  
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## INTRODUCTION

Secondhand smoke (SHS) is a complex mixture of thousands of gases and particulate matter emitted by the combustion of tobacco products and from smoke exhaled by smokers.<sup>1</sup>

Exposure to SHS is still a major risk factor for disease and premature mortality worldwide.<sup>2</sup>

SHS is also an important driver of the persisting socioeconomic inequalities in health; because exposure to SHS is significantly more frequent among individuals with a lower socioeconomic position compared to their more privileged counterparts.<sup>3,4</sup> This is why smoke-free policies are a cornerstone of the World Health Organization's Framework Convention on Tobacco Control (FCTC)<sup>5</sup>, which demands a coordinated international policy and program response to the overall tobacco epidemic and measures to curb the effects of passive smoking in particular.<sup>6</sup>

In addition to a person's own home, the workplace is a major source of SHS exposure among adults and therefore one of the most important settings for smoke-free policies to target.<sup>7</sup>

Without any form of protection, those affected in the workplace are facing long-term exposure to tobacco smoke – lasting for years or even decades in the worst cases. Because there is no safe level of exposure to SHS, comprehensive smoking bans are the only way to completely protect employees from SHS harm.<sup>8,9</sup>

As a matter of fact, all European countries have ratified the FCTC and, in accordance with Article 8, have committed themselves to implementing complete workplace smoking bans. However, the degree to which European countries have succeeded in introducing these smoking bans in the workplace vary greatly.<sup>10</sup> It is rare that a “smoking ban” really means that smoking is not allowed at all anywhere on the company premises. Within specific national legislations, universal workplace smoking bans are often watered down or undermined with numerous exceptions. Common exceptions include designated ventilated or unventilated smoking rooms or separated smoking areas.<sup>9</sup> The public health consequences of the varying success of the smoking bans are largely unknown, and we suspect that the

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3 exposure to SHS is more severe in countries that have been less successful with their public  
4 health policy interventions. We also suspect that vulnerable groups are even more exposed to  
5 SHS in countries that experience a slow progress in implementing the smoking bans. Both of  
6 these questions are possible to address using data from the European Working Conditions  
7 Surveys, and we expect that our results will be of high policy relevance.<sup>6</sup>

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10 Thus, the main aim of this study is to examine whether more successful countries in terms of  
11 SHS smoking ban implementation have (1) a smaller prevalence of SHS at the workplace as  
12 compared to slow progressing countries and (2) lower exposure in the vulnerable group of  
13 workers with low education, specifically. This will be done by a comparison of SHS within  
14 three country clusters (pioneers, fast progressing, and slow progressing countries) within the  
15 workplace, between socioeconomic groups, and over time.

16  
17 For this, we evaluated a comprehensive data set of as yet unused, representative and  
18 methodologically comparable samples from a total of 29 European countries, covering a  
19 period of 10 years. Governments wishing to fulfil their obligations as stipulated by Article 8  
20 of the FCTC can use the following analysis to see what levels of SHS exposure were reported  
21 according to the specific smoke-free legislation in place and to identify which groups of  
22 workers have the greatest deficits in terms of smoking prevention.

## 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 **METHODS**

### 45 46 **Study population**

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48 Data was obtained from the European Working Conditions Surveys.<sup>11</sup> These comparative,  
49 representative, periodical surveys are conducted every five years by the European Foundation  
50 for the Improvement of Living and Working Conditions, an autonomous European Union  
51 (EU) agency. Each questionnaire includes a wide range of topics regarding employment and  
52 working conditions.

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3 We used the most recent three waves from 2005, 2010 and 2015 for our analyses. The survey  
4 samples are representative for all employed residents of the 29 countries included in the  
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6 study. In addition to the 25 EU member states (in 2005), our dataset also includes Bulgaria,  
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8 Romania (EU member states from 2007 on), Norway and Turkey. In each country, a multi-  
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10 stage, stratified random sampling method was used. The survey interviews were conducted  
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12 face-to-face at respondents' homes. The overall response rates were 48% (2005), 44% (2010)  
13  
14 and 43% (2015). People with missing data on exposure, determinants or covariates were  
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16 excluded. Using these criteria, a total of 95,718 participants were available for the final  
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18 analysis. Details of the sample are provided in the online supplementary material (Table A).  
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20 Further details on the survey design, sampling framework, bias control and quality assurance  
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22 measures are available elsewhere.<sup>12</sup>  
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## 30 **Measures**

### 31 **Determinants at the micro level**

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33 The following individual level variables were included in order to explore if exposure to  
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35 workplace SHS varied between different groups: sex and age data were recorded as  
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37 individual-level demographic variables. Educational level was classified according to the  
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39 International Standard Classification of Education system (ISCED-97) and categorized into  
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41 the ordinal categories low, middle and high education level. We also included variables to  
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43 measure occupational status, coded with the International Standard Classification of  
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45 Occupations (ISCO). Economic activity of the employer or business was measured using the  
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47 NACE standard industrial classification (Nomenclature statistique des activités économiques  
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49 dans la Communauté européenne; <sup>12</sup>). In addition to this, we also recorded whether the person  
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51 worked in the private, public or another sector, the type of contract (standard or non-standard)  
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53 and the size of the company.  
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### Determinants at the macro level

At the contextual level, countries were grouped according to the country-specific implementation of tobacco control policies. To operationalize this, we used the internationally established Tobacco Control Scale (TCS; <sup>13</sup>). The TCS quantifies the implementation of tobacco control policies at country level within Europe at three year intervals.<sup>14</sup> The dimensions of the scale are operationalized by a panel of national and international experts and data is collected by a board of national correspondents from government agencies, public health officials or relevant public health institutes. The sub-scale “workplace” indicates how comprehensive tobacco control policies are in the workplace, ranging from 2 to 10 points. In grouping the 29 countries, we identified a group of five countries that introduced some form of smoking ban at the workplace very early on, namely, at the beginning of the EWCS data analysis period in 2005.<sup>14</sup> We classified these countries as “pioneers”. Another eight countries scored at the second wave of the EWCS data analysis period in 2010 on the TCS sub-scale “workplace”  $\geq 6$  points and were classified as countries with “fast progress”. All other countries were labeled as countries with “slow progress”. Fig. A illustrates the operationalization process (Figure A see online supplementary material)

Dependent variable: workplace second-hand smoke exposure

Workplace SHS exposure was assessed with the question: “From now onwards all the questions are about your main paid job. Please tell me, using the following scale, are you exposed at work to tobacco smoke from other people?” Similar to the process for the official reporting of the European Foundation for the Improvement of Living and Working Conditions <sup>15</sup>, in the following analysis, participants who reported being “never” or “almost never” exposed were dummy-coded as ‘non-exposed to workplace second-hand smoke’ (=0) while employees reporting an exposure of “around 1/4 of their working time” and more were

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3 classified as exposed (=1). As the EWCS does not include an assessment of individual  
4 smoking status, all data refer to the overall population, including current smokers.  
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## 11 **Statistical analysis**

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14 Weighted sampling was used to obtain representative estimates according to EWCS data  
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16 handbooks.<sup>11</sup> After an initial sample description, the first task was to calculate prevalence  
17 estimates and the corresponding 95% confidence intervals of SHS exposure at the workplace  
18  
19 for each of the three survey waves. Analyses were conducted for the whole of Europe and for  
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21 each country individually. Following this, exposure to SHS was determined according to  
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23 individual socio-demographic characteristics for specific groups of employees over the course  
24  
25 of time. Given the multi-level structure of the data, we also applied multi-level logistic  
26  
27 regression models with individuals (Level 1) nested within countries (Level 2) to account for  
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29 variation between countries. In addition to odds ratios and [95% confidence intervals] we also  
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31 calculated prevalence estimates (i.e. predicted prevalence rates<sup>16</sup>). In the final multi-level  
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33 logistic regression models, a three-way interaction of education, year and country groups was  
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35 applied and then adjusted according to other socio-demographic and work-related  
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37 characteristics at an individual level. All analyses were conducted using STATA 15 statistical  
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39 package (STATA, College Station, Texas, USA). To calculate prevalence estimates and  
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41 prevalence differences we used STATA's margins command. Ethics approval was not  
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43 required as this study dealt exclusively with freely available data.  
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## RESULTS

Within the examined collective of 95,718 European employees, around 50% were female.

Between 2005 and 2015, the average age of participants increased by 2.3 years to 43.4 +/-12.5 years old. Economic transformation in Europe is – among other things – reflected in the increase seen over the whole observation period in the proportion of well-educated participants (+8% points) and highly-skilled clerical workers (+4% points) as well as the clear decrease seen over the same period in the proportion of people working in the public sector (-5% points; Table A, Appendix).

### Overall exposure to SHS

In the total sample, one in ten employees reported that they had recently been exposed to SHS at the workplace in 2015 (9.9% [8.3-11.5]). Ten years earlier, in 2005, this proportion was almost 1 in 5 (19.0% [16.1-22.0]) and 1 in 9 (11.7% [9.8-13.7]) in 2010.

There was a widespread reduction of secondhand smoke exposure in all socio-demographic groups investigated (Table 1).

Table 1 here

### Socio-economic Inequalities in Exposure to SHS

However, inequalities in exposure can still be observed. For example, no reduction is seen in the odds ratio regarding secondhand smoke exposure at the workplace for low educated participants in comparison with high educated participants between 2005 and 2015 (2005: 1.52 [1.34-1.71] vs. 2015: 1.58 [1.39-1.80]; Table 1). The same is true for workers without an employment contract compared with those with a permanent employment contract (2005: 1.21 [1.06-1.38] vs. 2015: 1.23 [1.07-1.41]; Table 1). Using the ISCO classifications suggests that social inequalities have actually increased. For all manual activities, whether for high-

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3 skilled manual workers (2005: 1.55 [1.36-1.77] vs. 2015: 2.81 [2.40-3.29]) or for low-skilled  
4 manual workers (2005: 1.29 [1.14-1.46] vs. 2015: 2.15 [1.85-2.50]), compared to high-skilled  
5 clerical workers, the odds ratios have actually increased considerably over the observation  
6 period (Table 1).  
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#### 14 **Differences in Exposure to SHS by Industry**

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16 Workers in the food service industry represent an exceptional case (Table 1): Workers in  
17 hotels, restaurants, bars and pubs have always suffered from SHS exposure – in terms of a  
18 higher intensity of exposure (more hours per day, higher indoor air pollution) and of a higher  
19 proportion of workers exposed (SHS prevalence). Although the prevalence has more than  
20 halved between 2005 and 2015, when compared with all the other industries, they still present  
21 by far the highest level of SHS prevalence.  
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#### 33 **Differences in Exposure to SHS by Country and Regulation Levels**

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35 An analysis of individual countries shows that many of the countries with the lowest  
36 prevalence of secondhand smoke exposure are in Northern and Western Europe, while the  
37 highest prevalence of workplace-specific secondhand smoke exposure was reported in Eastern  
38 Europe. Figure 1 shows the country specific [prevalence estimates](#) for the last survey wave  
39 from 2015.  
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49 Figure 1 here  
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54 The status-specific social inequalities in secondhand smoke exposure already found at an  
55 individual level are also reflected in the country-specific analyses (Fig. 2).  
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Figure 2 here

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5 When national tobacco control efforts, worker education level and survey year are all taken  
6 into consideration in the context of a multi-level regression analysis, the first thing that is  
7 shown is that exposure is declining across all subgroups. Only within the pioneer countries  
8 did the already low level of SHS exposure fail to fall further. Secondly, considerable socio-  
9 economic inequalities can still be seen in 2015; better educated workers are consistently less  
10 likely exposed to SHS at the workplace in all countries (Table 2). Thirdly, it can also be seen  
11 that countries with lower levels of workplace-related smoking prevention regulations are  
12 found to have the highest overall levels of exposure.  
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## 30 **DISCUSSION**

### 31 **Key findings**

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33 Between 2005 and 2015, workplace SHS exposure in the 29 European countries included in  
34 this epidemiological study fell from around 19% [16 - 22] to 10% [8 - 12]. However, socio-  
35 economic inequalities in terms of exposure still continue to exist. The highest exposure to  
36 SHS in the workplace continues to be reported by workers with the lowest level of education,  
37 manual laborers and those without an employment contract. Workers in the food service  
38 industry continue to be those with the highest prevalence. These inequalities in secondhand  
39 smoke exposure are also reflected in the country-specific analysis. According to the  
40 measurements of the Tobacco Control Scale, countries with deficits in terms of workplace-  
41 related smoking prevention regulations are found to have the highest overall levels of  
42 exposure.  
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### **Placing this study in the context of current research**

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3 First of all, it is of no surprise that legislative smoking bans are closely linked to a reduction  
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5 in exposure to SHS. This is also shown in a Cochrane Review from 2010 which looked at 50  
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7 relevant studies. What is more interesting is the finding that the stricter and more  
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9 comprehensive the protection measures are, the greater the reduction is in secondhand smoke  
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11 exposure. Relatedly, research into partial smoking bans has suggested only limited  
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13 effectiveness and the potential of increasing health inequalities.<sup>17</sup> Very early on, an  
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15 international working group investigated the relationship between the TCS and self-reported  
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17 exposure to SHS at work using the "Eurobarometer" dataset (Flash Eurobarometer survey  
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19 253). Data from 2008 already showed a negative association between tobacco control  
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21 measures (high TCS score) and SHS prevalence estimates. However, the fact that in that study  
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23 workplace-related measures were considered together with measures in public places may  
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25 explain why the correlation found at that time remained below the significance threshold.<sup>18</sup>  
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27 Another analysis of the Eurobarometer data was conducted in 2012 (Special Eurobarometer  
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29 survey 385).<sup>3</sup> It also found higher SHS exposure for countries with lower levels of smoking  
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31 regulation. The authors conclude by saying that “smoke-free policies prohibiting smoking in  
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33 all public areas are ineffective when poorly enforced. (...) Measures such as ventilating  
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35 buildings or separating smokers from non-smokers are not effective in eliminating  
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37 involuntary exposure to SHS”.<sup>3</sup> The Eurobarometer survey wave conducted two years later  
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39 (Special Eurobarometer 429; 2014) has not yet been analyzed in such depth. However, the  
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41 official data report shows a very similar pattern as in Figure 1 presented here. Also in the  
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43 Eurobarometer, the lowest values of SHS exposure at the workplace are reported from the  
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45 Northern European nations and the highest values from the Eastern European nations.<sup>19</sup>  
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47 Another large European study on this topic to date was conducted in 2014 and covered 11,000  
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49 employed participants from 13 European countries. Using data from the European  
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51 Community Respiratory Health Survey, workplace-related secondhand smoke exposure in the  
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53 countries surveyed fell between 1990 and 2014. Likewise the study found that employees  
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3 working in companies with only a partial smoking ban and with a lower level of education  
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5 faced the highest levels of exposure.<sup>4</sup> A similar social gradient with regard to workplace-  
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7 related SHS exposure has also been identified in the USA: of the 16,000 participants in the  
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9 National Health Interview Survey from 2015, those in the lowest income and education  
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11 categories were exposed almost twice as much as those in the highest income and education  
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13 categories.<sup>7</sup>  
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17 In addition to this, there is also a number of – mostly – considerably smaller studies from  
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19 individual countries that explored the link between workplace-related smoking bans and SHS  
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21 exposure. These also attest to a similar decrease in overall exposure over the years (for Japan:  
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23 <sup>10</sup>) as well as an inverse relationship between social status (for China: <sup>20</sup>; for California: <sup>21</sup>; for  
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25 Myanmar: <sup>22</sup>, for the Philippines: <sup>23</sup>; for Romania: <sup>24</sup>) or workplace smoking bans (for China:  
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27 <sup>20</sup>; for Japan: <sup>10</sup>; for Myanmar: <sup>22</sup>; for the Philippines: <sup>23</sup>; for South Korea: <sup>25</sup>) on the one hand  
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29 and SHS exposure on the other. No status-specific differences in exposure were found in  
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31 studies from Greece <sup>26</sup>, Uruguay <sup>6</sup>, Mexico <sup>6</sup> and China <sup>27</sup>.  
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35 International longitudinal observational studies examining length of workplace bans and  
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37 exposure reductions have been rare. Two similar studies have been conducted in regions in  
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39 China, where it is reported that SHS exposure at the workplace fell by around 10 percentage  
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41 points between 2009 and 2011.<sup>28,29</sup> A third study from Taiwan demonstrated a significant,  
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43 widespread reduction in workplace-related exposure, but barely any reduction in social  
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45 inequalities.<sup>30</sup> It is evident that our multi-country study helps close a research gap that is – due  
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47 to the widespread inequalities in exposure – highly relevant.  
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### 52 53 **Limitations and strengths**

54  
55 The following limitations should be taken into consideration when interpreting our results.  
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57 Firstly, like most comparable epidemiological studies, this study is based on self-reported  
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59 data. Although biomarkers such as cotinine are considered the gold standard research  
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3 economy makes questionnaire-based surveys to assess SHS exposure in comprehensive  
4 epidemiological science necessary.<sup>3</sup> In general, self-reported data of SHS at the workplace  
5 should be used with caution. A recent Cochrane Review demonstrated otherwise identical  
6 findings for both biomarker-based and self-reported data-based studies. Nevertheless, a social  
7 desirability bias in particular cannot be ruled out in our data source. However, it is our belief  
8 that SHS exposure is less associated with feelings of shame than active tobacco consumption  
9 or other behaviors which are more likely to lead to a social desirability bias (e.g. consumption  
10 of illegal drugs, alcohol etc.).

11  
12 Secondly, response rates for this survey were between 40% and 50%. Although this value is  
13 above average when viewed in relation to other comparable studies, a selection or  
14 participation bias cannot be ruled out.

15  
16 Thirdly, the EWCS does not include an assessment of individual smoking status. This meant  
17 that it was not possible to conduct stratified analyses separated according to the smoker status  
18 of the participant.

19  
20 Lastly, smoking ban legislation is often preceded or followed by public awareness activities,  
21 as well as other population-based interventions (e.g. tax increases) to promote smoking  
22 cessation<sup>1</sup>. In addition to the concurrent implementation of these measures, secular trends in  
23 the population's smoking behavior should also be taken into consideration when interpreting  
24 the data.

25  
26 The strengths of our study are the large geographic coverage with unique information about  
27 employees at individual level that, at the time of conducting our survey, had not been used in  
28 this context before. Therefore, to the best of our knowledge, this study currently represents  
29 the largest study on SHS exposure ever carried out in the world and especially in Europe.  
30 With over 95,000 participants, it covers representative data from 29 countries and enables  
31 comparisons using harmonized data. Furthermore, the convenient sample size allows for  
32 multi-variate statistical analyses with appropriate confounder control to be carried out. The  
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3 validity of the results of this major European study is strengthened not least thanks to using  
4 the same study protocol, questionnaire and methods in all countries and by implementing a  
5 comprehensive quality assurance system.  
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## 10 11 12 **Conclusion**

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14 Long term enactment of smoke-free legislation is inversely associated with workplace SHS  
15 exposure. For policy makers tasked with healthcare and other relevant decision-makers, this  
16 study highlights that smoking bans have the potential to affect a large number of individuals  
17 in a population at minimal cost. This may be because legal restrictions create a supportive  
18 environment for those who want to quit, thereby helping employees who continue to smoke to  
19 reduce their tobacco consumption.<sup>1</sup> A comparison of the successes and experiences of 29  
20 countries clearly shows that especially those countries with a strict and comprehensive  
21 workplace smoking ban can reduce SHS at the workplace. In contrast, fragmentary legal  
22 regulations (potentially resulting in loopholes that are readily used), are less successful and  
23 lead to an avoidable exposure to a toxic, carcinogenic mixture in the air at the workplace.  
24 Occupational health data from France shows that lax implementation and a lack of monitoring  
25 can lead to the continuation of smoking in many offices, staff canteens, cafeterias and  
26 restrooms.<sup>31</sup> Lastly, our data makes it quite clear that workers in lower status groups in  
27 particular should be the priority group for future workplace SHS prevention.  
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**Key points:**

- The workplace is a major source of secondhand smoke (SHS) exposure.
- We do not know whether there is an association between workplace smoking bans and secondhand smoke (SHS) exposure at the workplace.
- Although absolute rates of workers regularly exposed to SHS decreased substantially over time (2005-2015), relative social inequalities in SHS exposure persisted.
- Across Europe, secondhand smoke exposure at the workplace was more common among workers with a lower socio-economic position.
- Highest overall SHS exposure rates were observed in countries with insufficient legal frameworks to implement complete workplace smoking bans.

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## Legends

### Tables

Table A (see online supplementary material): Description of the analytical sample of 29 European Countries (European Working Conditions Surveys: EWCS 2005, the EWCS 2010 and the EWCS 2015; unweighted)

Table 1: Associations between individual level variables and exposure at work to secondhand tobacco smoke across 29 countries (European Working Conditions Surveys: EWCS 2005, EWCS 2010 and EWCS 2015, [prevalence estimates](#) and odds ratios OR [95 % CI] from hierarchical logistic regression modelling with country as level 2 unit)

Table 2: [Prevalence estimates](#) and prevalence differences (p-values) of exposure at work to SHS sorted by educational group in different country groups across 29 countries (European Working Conditions Survey: EWCS 2005, EWCS 2010 and EWCS 2015, based on multi-level logistic regression models with three-way interaction of education, year and country group)

### Figures

Figure A (Figure A see online supplementary material): Country-specific implementation of tobacco control policies according to the Tobacco Control Scale (sub-scale “workplace” from 2010)

Figure 1: Proportion of employees with workplace secondhand tobacco smoke exposure ( $\geq \frac{1}{4}$  of working time) [2015, by country](#)

Figure 2: Proportion of employees with workplace secondhand tobacco smoke exposure ( $\geq \frac{1}{4}$  of working time) 2015, by country and implementation of tobacco control policies according



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3 to the Tobacco Control Scale (sub-scale “workplace” from 2010): dark grey: pioneer  
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5 countries, light grey: countries with fast progress, white: countries with slow progress  
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**Table 1: Associations between individual level variables and exposure at work to secondhand tobacco smoke across 29 countries (European Working Conditions Surveys: EWCS 2005, EWCS 2010 and EWCS 2015, prevalences and odds ratios OR [95 % CI] from hierarchical logistic regression modelling with country as level 2 unit)**

	2005 (n=24,891)		2010 (n=35,262)		2015 (n=35,565)	
	SHS exposure	OR [95% CI]	SHS exposure	OR [95% CI]	SHS exposure	OR [95% CI]
Total	19.0		11.7		9.9	
Sex						
Male	23.6	ref.	14.9	ref.	12.5	ref.
Female	13.9	0.50 [0.46-0.53]	7.9	0.47 [0.43-0.51]	7.0	0.51 [0.47-0.55]
Age		0.99 [0.98-0.99]		0.99 [0.99-0.99]		0.98 [0.98-0.99]
Education						
High	14.9	ref.	8.6	ref.	7.8	ref.
Medium	20.0	1.48 [1.34-1.64]	12.0	1.50 [1.35-1.66]	10.3	1.40 [1.26-1.56]
Low	20.3	1.52 [1.34-1.71]	14.1	1.82 [1.61-2.05]	11.5	1.58 [1.39-1.80]
Standard classification of skills (ISCO)						
High-skilled clerical	16.3	ref.	9.4	ref.	5.9	ref.
Low-skilled clerical	18.0	1.14 [1.02-1.27]	10.4	1.14 [1.01-1.28]	9.3	1.68 [1.48-1.92]
High-skilled manual	22.4	1.55 [1.36-1.77]	15.4	1.84 [1.61-2.10]	14.3	2.81 [2.40-3.29]
Low-skilled manual	19.7	1.29 [1.14-1.46]	13.2	1.51 [1.33-1.72]	11.5	2.15 [1.85-2.50]
Economic activity (NACE)						
Agriculture, hunting, forestry and fishing	10.4	ref.	5.9	ref.	6.0	ref.
Industry	19.1	2.15 [1.80-2.57]	13.4	2.60 [2.16-3.12]	10.9	1.98 [1.66-2.36]
Services	17.3	1.89 [1.57-2.27]	10.1	1.83 [1.51-2.21]	8.3	1.43 [1.19-1.72]
Public administration and defense, compulsory social security	21.7	2.56 [2.04-3.22]	13.4	2.59 [2.03-3.31]	9.9	1.75 [1.35-2.26]
Others	17.9	1.98 [1.63-2.41]	10.7	1.97 [1.60-2.42]	9.9	1.76 [1.43-2.15]
Hotels and Restaurants	43.1	7.86 [6.30-9.80]	23.2	5.41 [4.34-6.74]	19.7	4.18 [3.38-5.17]
Sector						
Private	18.6	ref.	11.9	ref.	9.7	ref.
Public	19.3	1.05 [0.95-1.16]	11.0	0.91 [0.81-1.02]	10.8	1.15 [1.01-1.30]
Other	20.5	1.14 [0.99-1.31]	12.4	1.05 [0.90-1.22]	10.3	1.07 [0.92-1.25]
Type of contract						
Indefinite	17.9	ref.	11.0	ref.	9.4	ref.
Temporary	18.1	1.01 [0.91-1.14]	12.4	1.16 [1.04-1.30]	10.4	1.12 [0.99-1.26]
Apprenticeship	20.5	1.20 [0.83-1.74]	10.0	0.89 [0.54-1.47]	8.2	0.85 [0.53-1.38]
No Contract	20.6	1.21 [1.06-1.38]	12.9	1.21 [1.06-1.39]	11.2	1.23 [1.07-1.41]
Self-employed	22.7	1.39 [1.23-1.58]	13.7	1.32 [1.16-1.49]	10.8	1.17 [1.02-1.34]
Other	21.1	1.25 [0.81-1.94]	11.5	1.06 [0.68-1.64]	10.6	1.15 [0.75-1.78]
Company size						
1 employee	13.2	ref.	9.3	ref.	8.8	ref.
2-9 employees	19.7	1.69 [1.47-1.95]	12.9	1.49 [1.30-1.71]	11.2	1.34 [1.16-1.54]
10-249 employees	19.5	1.66 [1.43-1.93]	12.3	1.40 [1.21-1.62]	9.8	1.13 [0.97-1.32]
250+ employees	20.2	1.75 [1.47-2.08]	8.9	0.95 [0.78-1.15]	8.3	0.94 [0.77-1.13]

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**Table 2: Prevalences and prevalence differences (p-values) of exposure at work to SHS sorted by educational group in different country groups across 29 countries (European Working Conditions Survey: EWCS 2005, EWCS 2010 and EWCS 2015, based on multi-level logistic regression models with three-way interaction of education, year and country group)**

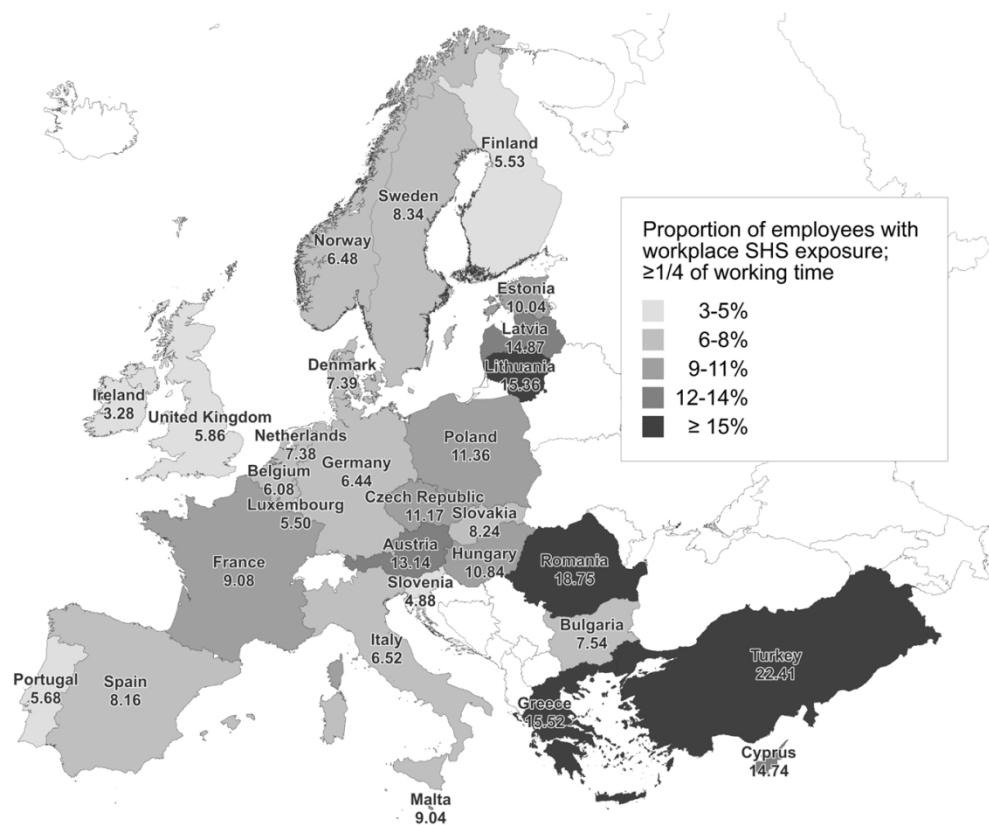
		Pioneer				Fast progress				Slow progress			
		2005	2010	2015	Diff15/05	2005	2010	2015	Diff15/05	2005	2010	2015	Diff15/05
Education	Low	9.61	9.56	9.68	0.07 (.957)	17.60	10.55	10.24	-7.36 (<.001)	23.60	16.75	12.94	-10.66 (<.001)
	Medium	9.10	6.73	7.64	-1.46 (.072)	18.21	9.61	8.37	-9.84 (<.001)	22.50	15.19	12.62	-9.88 (<.001)
	High	3.78	6.11	5.15	1.37 (.106)	17.06	6.72	6.28	-10.78 (<.001)	18.59	9.61	8.43	-10.17 (<.001)
	Diff Edu	-5.83	-3.45	-4.53		-0.54	-3.83	-3.96		-5.01	-7.14	-4.51	
	high/low	(<.001)	(.001)	(<.001)		(.648)	(<.001)	(<.001)		(<.001)	(<.001)	(<.001)	

Notes: Analyses are adjusted for the following covariates: sex, age, NACE, ISCO, sector, type of contract and company size.

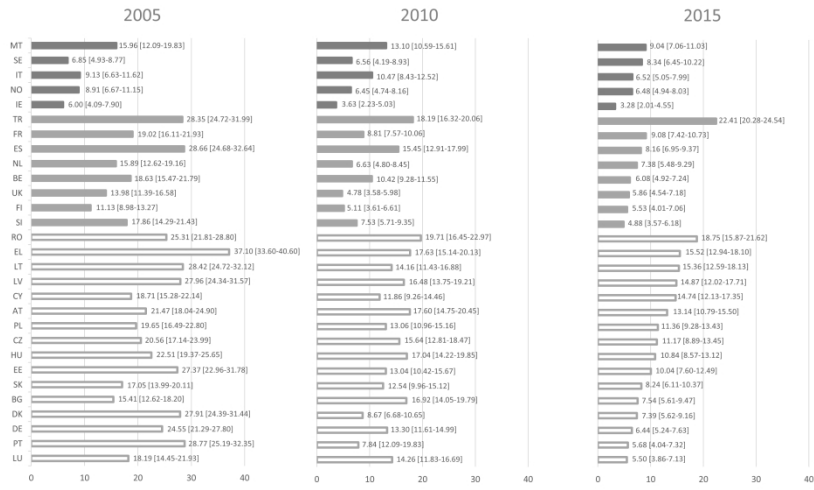
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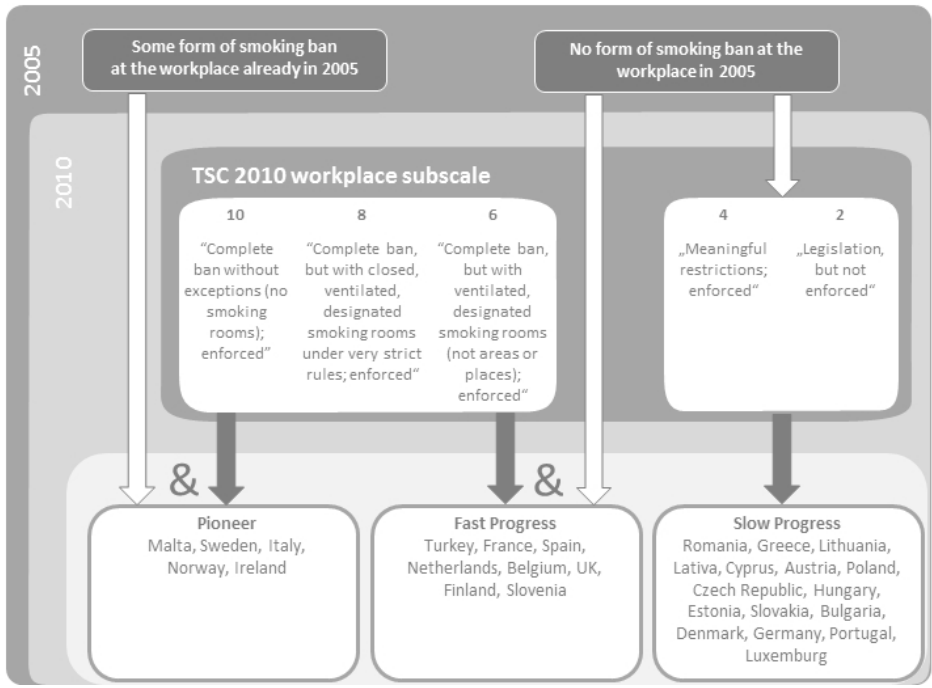


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**Table A (electronic supplementary material): Description of the analytical sample of 29 European Countries (European Working Conditions Surveys: EWCS 2005, the EWCS 2010 and the EWCS 2015; unweighted)**

	2005		2010		2015	
	% / AM±SD	n	% / AM±SD	n	% / AM±SD	n
<b>Total</b>	<b>100%</b>	<b>24,891</b>	<b>100%</b>	<b>35,262</b>	<b>100%</b>	<b>35,565</b>
<b>Sex</b>						
Male	50.2%	(12,506)	50.9%	(17,932)	50.4%	(17,928)
Female	49.8%	(12,385)	49.1%	(17,330)	49.6%	(17,637)
<b>Age in years</b>						
	41.10±11.93		41.79±11.92		43.37±12.54	
<b>Education</b>						
Low education	22.5%	(5,612)	25.2%	(8,877)	18.6%	(6,632)
Medium education	51.4%	(12,805)	44.1%	(15,565)	47.6%	(16,919)
High education	26.0%	(6,474)	30.7%	(10,820)	33.8%	(12,014)
<b>Standard classification of skills (ISCO)</b>						
High-skilled clerical	21.8%	(5,427)	24.0%	(8,468)	25.3%	(8,985)
Low-skilled clerical	39.3%	(9,794)	42.5%	(15,002)	41.9%	(14,900)
High-skilled manual	17.5%	(4,361)	15.2%	(5,363)	15.6%	(5,534)
Low-skilled manual	21.3%	(5,309)	18.2%	(6,429)	17.3%	(6,146)
<b>Economic activity (NACE)</b>						
Agriculture, hunting, forestry and fishing	5.5%	(1,369)	4.6%	(1,619)	5.3%	(1,901)
Industry	25.5%	(6,341)	22.9%	(8,058)	21.6%	(7,666)
Services	30.1%	(7,499)	33.8%	(11,934)	36.0%	(12,796)
Public administration and defense, compulsory social security	6.7%	(1,657)	6.6%	(2,329)	5.8%	(2,074)
Others	28.2%	(7,011)	27.3%	(9,621)	25.8%	(9,185)
Hotels and restaurants	4.1%	(1,014)	4.8%	(1,701)	5.5%	(1,943)
<b>Sector</b>						
Private	65.1%	(16,195)	67.8%	(23,891)	69.5%	(24,703)
Public	27.9%	(6,936)	25.8%	(9,109)	23.3%	(8,296)
Other	7.1%	(1,760)	6.4%	(2,262)	7.2%	(2,566)
<b>Type of contract</b>						
Indefinite contract	64.3%	(16,003)	65.8%	(23,186)	65.1%	(23,136)
Temporary	10.5%	(2,615)	10.0%	(3,534)	10.4%	(3,681)
Apprenticeship	0.8%	(187)	0.4%	(150)	0.5%	(189)
No contract	7.5%	(1,861)	7.1%	(2,500)	6.5%	(2,325)
Self-employed	16.4%	(4,085)	16.1%	(5,664)	16.9%	(5,995)
Other	0.6%	(140)	0.6%	(228)	0.7%	(239)
<b>Company size</b>						
1 employee	11.0%	(2,737)	11.8%	(4,149)	13.1%	(4,668)
2-9 employees	28.2%	(7,015)	29.8%	(10,522)	27.9%	(9,919)
10-249 employees	48.6%	(12,109)	47.5%	(16,751)	46.0%	(16,345)
250+ employees	12.2%	(3,030)	10.9%	(3,840)	13.0%	(4,633)

Notes: AM = arithmetic mean / SD = standard deviation

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