Benefits of quitting smoking on work productivity and activity impairment in the United States, the European Union and China

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INTRODUCTION

Smoking and tobacco use exert a tremendous global health and economic burden. As of 2015, direct tobacco use is associated with over 5 million deaths annually among the estimated 1 billion smokers worldwide, as well as an additional over 600,000 deaths caused by exposure to second-hand smoke. The use of tobacco products is associated with increased risk of some of the leading global causes of mortality, including heart disease, cancer, respiratory diseases, and cerebrovascular disease.

Approximately 21% of the global adult population are current smokers. Smoking prevalence is dependent, in part, on societal acceptance of smoking, with lower prevalence in areas with greater public policy efforts [e.g. 16.8% of adults in the United States (US), 19.2% in Great Britain, 19.5% in Italy] and higher prevalence in areas without...
strong policy environments (eg, 34.1% in France, 27% in Spain, 24.5% in Germany, 27.7% in China).3,4 Smoking also causes significant societal consequences globally in the form of work productivity impairment. Working smokers in the US are estimated to miss an average of 2.3 more workdays annually than those who have never smoked and be less productive while at work.5–7

In addition to health and work-related impairment, smoking is also associated with substantial direct and indirect costs. The estimated cost attributable to the burden of smoking is between $289 and $333 billion annually in the US alone.2 These costs are because of both medical care for smoking-related illnesses and the substantial work-related loss attributable to early mortality. Further costs for non-smokers have been reported at an estimated $6 billion in productivity loss caused by second-hand exposure; however, this is much lower than the substantially higher estimates of $151 billion for smokers.2

Further studies outside the US have reported similar findings regarding work loss and associated costs. An EU study of over 10 000 workers in the Netherlands found that smoking status was associated with an increased use of sick leave and lost productivity while at work.8 Similarly, two German-based studies have reported significant costs as a result of smoking-related productivity loss,9 including one in which annual productivity costs as a result of smoking were estimated to be in excess of €9.6 billion.10 Finally, in China, smoking was associated with significantly higher rates of presenteeism in a cross-sectional survey of workers at one large corporation.11 These authors concluded that health-promoting programs should be made available to all workers to limit the impact of smoking and other risk factors for poor health and impaired work productivity.

Importantly, evidence suggests that a number of benefits are associated with smoking cessation, with the risk of cancer and heart disease reduced after approximately 12 months of non-smoking.12 Quitting smoking has also been found to drastically reduce direct and indirect costs, which can benefit payers, employers, employees and society as a whole.13 Those who have quit smoking not only save money from no longer purchasing cigarettes but may also gain from reduced health and life insurance expenses, as well as lower healthcare costs caused by smoking-related illnesses.14

The increase in work productivity when smokers quit has led some employers to invest in smoking cessation programs, often including pharmacotherapy and behavioural interventions.5,15,16 Although a cost exists for employers to implement smoking cessation programs, employers still save money per employee who quits smoking when the indirect savings from smoking cessation are considered, thus making it both health conscious and cost-effective to implement such programs.16,17 Despite such positive findings, however, many employers globally fail to cover quit programs in the workplace18 and smoking rates continue to rise in many regions.20

In order to demonstrate the tangible value to employers and society as a whole of successful smoking cessation in the employee population, it is important to investigate the effect of years since quitting and the impact of smoking on workplace productivity. As a result, this study seeks to expand the understanding of the work-related burden associated with smoking and quitting across the US, the European Union (EU), and China using large-scale representative survey methodology.

What’s known
The clinical and economic burdens of smoking have been demonstrated in various geographies, particularly in the US and EU, with the cost attributed to smoking reaching in the billions of dollars annually. Additionally, work productivity has been shown to suffer for those who are smoking. Despite the health benefits resulting from smoking cessation, many employers do not support smoking cessation programs.

What’s new
This study examines the impact of smoking on productivity in multiple geographies using the same methodology: US, EU and China. Additionally, the time to improvement in workplace productivity following cessation is investigated. This study provides evidence that those who have quit smoking have substantially greater work productivity in examined geographies.

2 | MATERIALS AND METHODS

2.1 | Sample

This analysis includes data from the 2013 National Health and Wellness Survey (NHWS) from the US (N=75 000), EU5 (N=62 000; including UK, France, Germany, Italy and Spain), and China (N=19 987). The NHWS is a self-administered, Internet-based questionnaire from a sample of adults aged 18 or older.

A stratified random sample (with strata by gender and age in EU5 and China, and race/ethnicity added in the US) was implemented to ensure that the demographic composition is representative of the corresponding adult population based on: data from the International Data Base of the US Census Bureau for the EU and China, and data from the US Census for the US. For regions outside the US, online recruitment was supplemented by offline recruitment to reach elderly people who may not have Internet access. Several peer-reviewed publications have previously favourably compared the NHWS with other governmental sources.20–22 The NHWS sample for the current study includes only working-age respondents aged 18-64: 2013 US NHWS (N=58 500), 2013 EU5 NHWS (N=50 417), and 2013 China NHWS (N=17 987).

2.2 | Measures

2.2.1 | Independent variables: smoking status and years since quit

Respondents were broken into four groups based on self-reported smoking behaviour in each region: current smoker (those currently
smoking), those trying to quit (those in the process of quitting or using cessation products), former smokers (those who previously but no longer smoke), and never smokers (those who have never smoked).

Additional analyses compared current smokers to former smokers by further examining how years since quitting smoking, 0-4 years ago, 5-10 years ago and 11 or more years ago, was related to outcomes.

### 2.2.2 | Demographics and health characteristic variables

The following demographic and health characteristic variables were examined for differences between groups: age, sex, race/ethnicity (for US only) and education. The following health characteristics were also examined: body mass index (BMI) category and comorbidity burden [measured via the Charlson Comorbidity Index (CCI)]

### 2.2.3 | Outcome variables

Work productivity loss and activity impairment were measured via the validated Work Productivity and Activity Impairment-General Health questionnaire (WPAI-GH; [http://www.reillyassociates.net/ WPAI_GH.html](http://www.reillyassociates.net/WPAI_GH.html)), included in the NHWS. The WPAI measures four constructs: absenteeism (the percentage of work time missed because of one’s health problems in the past 7 days), presenteeism (the percentage of impairment experienced while at work in the past 7 days because of one’s health problems), overall impairment (an overall impairment estimate that is a combination of absenteeism and presenteeism) and activity impairment (the percentage of impairment in daily activities because of one’s health problems in the past 7 days). Only respondents who reported being full-time or part-time employed (via the labour force participation question) provided data for absenteeism, presenteeism and overall work impairment. All respondents provided data for activity impairment.

### 2.3 | Analyses

All analyses were conducted using SPSS version 20, Armonk, NY, USA. Demographic and health characteristic differences were examined by smoking status. For categorical variables, chi-square tests were used to determine significant differences while one-way analyses of variance (ANOVA) were used for continuous variables when comparing the smoking groups. Frequencies (N) and percentages (%) are reported for categorical variables and means, and standard deviations are reported for continuous variables.

Two-sided P-value, P<.05, indicated statistical significance. To account for multiple comparisons, a Bonferroni correction was implemented such that the critical P-value (P<.05) was divided by number of comparisons (eg, five) to yield a new critical P-value, P<.01.

Following initial comparisons, generalised linear models were used to assess benefits of smoking cessation on work productivity and activity impairment after controlling for covariates. Covariates included: age, sex, race/ethnicity (in US only), education, BMI category and CCI. Estimated means, standard errors, and 95% confidence intervals are reported. Two-sided P-value, P<.01, indicated statistical significance for pairwise comparisons assessing smoking status (ie, five comparisons) and a P<.017 indicated statistical significance for pairwise comparisons assessing years since quit (ie, three comparisons).

### 3 | RESULTS

#### 3.1 | Initial group comparisons

The percentages of current smokers were 13.4% in the US, 15.6% in China and 21.2% in EU5 (see Table 1 for smoking group sample sizes for all three regions). Analyses examining demographic and health characteristics demonstrated that there were significant differences for each of these variables across smoking groups for US, EU5 and China (P<.001 for all; see Tables 2-4). These variables were retained as covariates in the multivariable analyses.

#### 3.2 | Multivariable analyses

#### 3.2.1 | Smoking status

To examine the unique burden of smoking status on work productivity, current smokers and former smokers were compared with each other and were each also compared with those trying to quit and never smokers while controlling for covariates. Covariates included age, gender, race/ethnicity (for US respondents only), education, BMI category and CCI.

In the US, EU5, and China, the workplace burden associated with smoking was clear (see Table 5 for means, standard errors and 95% confidence intervals). Those currently smoking had greater mean presenteeism, overall work impairment and activity impairment than former smokers and never smokers across all three regions (P<.01 for all). Current smokers also had greater absenteeism compared with former and never smokers in US and China and greater absenteeism compared with former smokers in EU5 (P<.01 for all). To illustrate the

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**TABLE 1** Sample sizes for each region for according to smoking status

| Region | Current smoker | Trying to quit | Former smoker | Never smoker | Total |
|--------|----------------|----------------|---------------|--------------|-------|
| US     | 7813 (13.4)    | 4121 (7.0)     | 13 445 (23.0) | 33 121 (56.6) | 58 500 |
| EU5    | 10 713 (21.2)  | 3710 (7.4)     | 13 647 (27.1) | 22 347 (44.3) | 50 417 |
| China  | 2804 (15.6)    | 1584 (8.8)     | 2208 (12.3)   | 11 391 (63.3) | 17 987 |

Values within parenthesis are expressed as percentage.

EU5=UK, Germany, Italy, France and Spain.
but there were no statistically significant differences between former smokers and never smokers (P < .01), except for absenteeism and activity impairment in US. Similarly, former smokers had lower absenteeism, presenteeism, overall work impairment and activity impairment than those trying to quit 0-4 years ago. However, those who quit while controlling for covariates had lower absenteeism, presenteeism, overall work impairment or activity impairment.

3.2.2 | Years since quit

Follow-up analyses examined the unique burden of current smokers compared with those who quit while controlling for covariates. Covariates included age, gender, race/ethnicity (for US subjects only), education, BMI category and CCI. Those who have not quit smoking were compared with those who quit within the last 0-4 years, 5-10 years and 11 or more years.

Those who quit smoking 0-4 years ago had lower presenteeism and activity impairment across the US, EU5 and China, and lower overall work impairment in the US and EU5, than current smokers (P < .0001 for all). The reduction in impairment resulting from quitting smoking ranged from 7%-19% for presenteeism, 9%-16% for overall work impairment and 6%-13% for activity impairment. For China, those who quit 0-4 years ago also had lower absenteeism than those still smoking (P < .001); there was a 22% reduction in absenteeism when comparing former smokers and never smokers on absenteeism, overall work impairment and activity impairment. In China, there were no statistically significant differences between former smokers and never smokers on absenteeism, presenteeism, overall work impairment or activity impairment.

### TABLE 2  Demographics and health characteristics by smoking status for US

| Smoking status | Current smoker (N=7813) | Trying to quit (N=4121) | Former smoker (N=13 445) | Never smoker (N=33 121) | Total (N=58 500) |
|----------------|-------------------------|-------------------------|--------------------------|-------------------------|------------------|
|                | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | P-value |
| Age            | 43.26 | 12.18 | 41.46 | 12.65 | 44.68 | 13.20 | 40.68 | 12.84 | 42.00 | 12.93 | <.001 |
| CCI            | 0.49 | 1.24 | 0.59 | 1.33 | 0.45 | 1.05 | 0.24 | 0.78 | 0.35 | 0.97 | <.001 |
| Sex            |          |          |          |          |          |          |          |          |          |          |
| Female         | 3639 | 46.6 | 2004 | 48.6 | 6837 | 50.9 | 19279 | 58.2 | 31759 | 54.3 | <.001 |
| Male           | 4174 | 53.4 | 2117 | 51.4 | 6608 | 49.1 | 13842 | 41.8 | 26741 | 45.7 |          |
| Ethnicity      |          |          |          |          |          |          |          |          |          |          |
| Non-Hispanic White | 5607 | 71.8 | 2651 | 64.3 | 9697 | 72.1 | 21156 | 63.9 | 39111 | 66.9 | <.001 |
| Non-Hispanic Black | 885 | 11.3 | 622 | 15.1 | 1323 | 9.8 | 4897 | 14.8 | 7727 | 13.2 |
| Hispanic       | 716 | 9.2 | 455 | 11.0 | 1350 | 10.0 | 3324 | 10.0 | 5845 | 10.0 |
| Other ethnicity | 605 | 7.7 | 393 | 9.5 | 1075 | 8.0 | 3744 | 11.3 | 5817 | 9.9 |
| Education      |          |          |          |          |          |          |          |          |          |          |
| Less than 4-year degree | 6151 | 78.7 | 3016 | 73.2 | 8661 | 64.4 | 16613 | 50.2 | 34441 | 58.9 | <.001 |
| 4-year degree or more | 1662 | 21.3 | 1105 | 26.8 | 4784 | 35.6 | 16508 | 49.8 | 24059 | 41.1 |
| BMI category   |          |          |          |          |          |          |          |          |          |          |
| Underweight (<18.5) | 244 | 3.1 | 103 | 2.5 | 187 | 1.4 | 841 | 2.5 | 1375 | 2.4 | <.001 |
| Normal weight (18.5 to <25) | 2829 | 36.2 | 1416 | 34.4 | 3746 | 27.9 | 11876 | 35.9 | 19867 | 34.0 |
| Overweight (25 to <30) | 2418 | 30.9 | 1334 | 32.4 | 4228 | 31.4 | 9562 | 28.9 | 17542 | 30.0 |
| Obese (≥30)    | 2189 | 28.0 | 1203 | 29.2 | 4979 | 37.0 | 9700 | 29.3 | 18071 | 30.9 |
| Unknown        | 133 | 1.7 | 65 | 1.6 | 305 | 2.3 | 1142 | 3.4 | 1645 | 2.8 |

SD, standard deviation; CCI, Charlson Comorbidity Index; BMI, body mass index. P-values represent the omnibus comparisons noting significant differences across the smoking groups and are derived from one-way ANOVAs (for continuous measures) or chi-squared tests (for categorical measures) and are two-sided.
### TABLE 3  Demographics and health characteristics by smoking status for EU5

| Smoking Status          | Current smoker (N=10 713) | Trying to quit (N=3710) | Former smoker (N=13 647) | Never smoker (N=22 347) | Total (N=50 417) |
|-------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-------------------|
|                         | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | P-value |
| Age                     | 41.81 | 11.77 | 41.17 | 12.19 | 44.25 | 12.66 | 39.81 | 12.40 | 41.54 | 12.46 | <.001 |
| CCI                     | 0.33  | 0.98  | 0.45  | 1.29  | 0.31  | 0.80  | 0.18  | 0.62  | 0.26  | 0.82  | <.001 |
| N %                     |      |      |      |      |      |      |      |      |      |      |      |      |
| Sex                     |      |      |      |      |      |      |      |      |      |      |      |      |
| Female                  | 5950 | 55.5  | 1883 | 50.8  | 7426 | 54.4  | 12986 | 58.1  | 28245 | 56.0  | <.001 |
| Male                    | 4763 | 44.5  | 1827 | 49.2  | 6221 | 45.6  | 9361  | 41.9  | 22172 | 44.0  |      |
| Education               |      |      |      |      |      |      |      |      |      |      |      |      |
| Less than university    | 7298 | 68.1  | 2264 | 61.0  | 8233 | 60.3  | 12137 | 54.3  | 29932 | 59.4  | <.001 |
| University degree or more | 3415 | 31.9  | 1446 | 39.0  | 5414 | 39.7  | 10210 | 45.7  | 20485 | 40.6  |      |
| BMI category            |      |      |      |      |      |      |      |      |      |      |      |      |
| Underweight (<18.5)     | 447  | 4.2   | 128  | 3.5   | 332  | 2.4   | 837   | 3.7   | 1744  | 3.5   | <.001 |
| Normal weight (18.5 to <25) | 5241 | 48.9  | 1766 | 47.6  | 5628 | 41.2  | 10809 | 48.4  | 23444 | 46.5  |      |
| Overweight (25 to <30)  | 3112 | 29.0  | 1137 | 30.6  | 4467 | 32.7  | 6401  | 28.6  | 15117 | 30.0  |      |
| Obese (≥30)             | 1670 | 15.6  | 605  | 16.3  | 2871 | 21.0  | 3383  | 15.1  | 8529  | 16.9  |      |
| Unknown                 | 243  | 2.3   | 74   | 2.0   | 349  | 2.6   | 917   | 4.1   | 1583  | 3.1   |      |

SD, standard deviation; CCI, Charlson Comorbidity Index; BMI, body mass index. P-values represent the omnibus comparisons noting significant differences across the smoking groups and are derived from one-way ANOVAs (for continuous measures) or chi-squared tests (for categorical measures) and are two-sided.

### TABLE 4  Demographics and health characteristics by smoking status for China

| Smoking Status          | Current smoker (N=2804) | Trying to quit (N=1584) | Former smoker (N=2208) | Never smoker (N=11 391) | Total (N=17 987) |
|-------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------|
|                         | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | Mean | SD   | P-value |
| Age                     | 39.54 | 11.07 | 37.32 | 11.01 | 36.76 | 11.37 | 38.54 | 11.96 | 38.37 | 11.70 | <.001 |
| CCI                     | 0.35  | 1.06  | 0.53  | 1.36  | 0.27  | 0.75  | 0.19  | 0.56  | 0.25  | 0.79  | <.001 |
| N %                     |      |      |      |      |      |      |      |      |      |      |      |      |
| Sex                     |      |      |      |      |      |      |      |      |      |      |      |      |
| Female                  | 243  | 8.7   | 212  | 13.4  | 398  | 18.0  | 6106  | 53.6  | 6959  | 38.7  | <.001 |
| Male                    | 2561 | 91.3  | 1372 | 86.6  | 1810 | 82.0  | 5285  | 46.4  | 11028 | 61.3  |      |
| Education               |      |      |      |      |      |      |      |      |      |      |      |      |
| College or lower        | 1117 | 39.8  | 499  | 31.5  | 758  | 34.3  | 4148  | 36.4  | 6522  | 36.3  | <.001 |
| University or over      | 1687 | 60.2  | 1085 | 68.5  | 1450 | 65.7  | 7243  | 63.6  | 11465 | 63.7  |      |
| BMI category            |      |      |      |      |      |      |      |      |      |      |      |      |
| Underweight (<18.5)     | 126  | 4.5   | 67   | 4.2   | 140  | 6.3   | 947   | 8.3   | 1280  | 7.1   | <.001 |
| Normal weight (18.5 to <25) | 1736 | 61.9  | 1026 | 64.8  | 1459 | 66.1  | 7781  | 68.3  | 12002 | 66.7  |      |
| Overweight (25 to <30)  | 634  | 22.6  | 361  | 22.8  | 446  | 20.2  | 1749  | 15.4  | 3190  | 17.7  |      |
| Obese (≥30)             | 279  | 10.0  | 102  | 7.6   | 146  | 6.6   | 777   | 6.8   | 1322  | 7.3   |      |
| Unknown                 | 29   | 1.0   | 10   | 0.6   | 17   | 0.8   | 137   | 1.2   | 193   | 1.1   |      |

SD, standard deviation; CCI, Charlson Comorbidity Index; BMI, body mass index. P-values represent the omnibus comparisons noting significant differences across the smoking groups and are derived from one-way ANOVAs (for continuous measures) or chi-squared tests (for categorical measures) and are two-sided.
### TABLE 5

Adjusted means examining effect of smoking status on WPAI-GH after controlling for demographic and health characteristics

|                  | Current smoker (A) | Trying to quit (B) | Former smoker (C) | Never smoker (D) |
|------------------|--------------------|--------------------|-------------------|-----------------|
|                  | Mean | SE  | 95% CI       | P-value | Mean | SE  | 95% CI       | P-value | Mean | SE  | 95% CI       | P-value |
| US               |      |     |              |         |      |     |              |         |      |     |              |         |
| Absenteeism %    | 4.06 | 0.27 | 3.57-4.61   | .02     | 5.24 | 0.47 | 4.40-6.24   | .003    | 3.18 | 0.16 | 2.88-3.50   | .001    |
| P-value A vs B   |      |     |              |         |      |     |              |         |      |     |              |         |
| P-value A vs C   | .003 |     |              | .001    |      |     |              | .001    |      |     |              | .001    |
| P-value A vs D   | .001 |     |              | .001    |      |     |              | .001    |      |     |              | .001    |
| P-value C vs B   | .003 |     |              | .001    |      |     |              | .001    |      |     |              | .001    |
| P-value C vs D   | .001 |     |              | .001    |      |     |              | .001    |      |     |              | .001    |
| Presenteeism %   | 16.78 | 0.43 | 15.95-17.66 | .006    | 18.89 | 0.66 | 17.63-20.24 | .002    | 13.16 | 0.25 | 12.67-15.73 | .001    |
| Overall work impairment % | 18.82 | 0.48 | 17.91-19.78 | .003    | 21.40 | 0.74 | 20.00-22.90 | .001    | 15.16 | 0.29 | 14.60-16.67 | .001    |
| Activity impairment % | 25.47 | 0.39 | 24.71-26.25 | .010    | 27.23 | 0.57 | 26.13-28.38 | .001    | 20.84 | 0.25 | 20.36-21.32 | .001    |
| EU5              | 5.68 | 0.24 | 5.23-6.16   | <.001   | 7.56 | 0.55 | 6.56-8.72   | <.001   | 4.80 | 0.18 | 4.46-5.18   | <.001   |
| Absenteeism %    | 17.58 | 0.30 | 17.00-18.19 | <.001   | 21.17 | 0.64 | 19.96-22.45 | <.001   | 14.95 | 0.24 | 14.49-15.42 | <.001   |
| Overall work impairment % | 20.97 | 0.35 | 20.29-21.67 | <.001   | 25.49 | 0.74 | 24.07-26.99 | <.001   | 18.27 | 0.28 | 17.72-18.83 | <.001   |
| Activity impairment % | 24.91 | 0.29 | 24.34-25.49 | <.001   | 28.51 | 0.57 | 27.42-29.64 | <.001   | 22.23 | 0.23 | 21.78-22.69 | <.001   |
| China            | 8.35 | 0.38 | 7.64-9.12   | <.001   | 10.62 | 0.63 | 9.45-11.92  | <.001   | 5.20 | 0.27 | 4.71-5.76   | <.001   |
| Absenteeism %    | 26.93 | 0.54 | 25.89-28.02 | <.001   | 32.92 | 0.86 | 31.29-34.56 | <.001   | 23.20 | 0.53 | 22.19-24.25 | <.001   |
| Overall work impairment % | 30.88 | 0.61 | 29.71-32.09 | <.001   | 37.95 | 0.97 | 36.09-39.91 | <.001   | 26.30 | 0.58 | 25.18-27.46 | <.001   |
| Activity impairment % | 27.06 | 0.50 | 26.09-28.06 | <.001   | 32.77 | 0.79 | 31.25-34.36 | <.001   | 23.87 | 0.49 | 22.92-24.85 | <.001   |

SE, standard error; CI, confidence interval. Covariates included: age, ethnicity (for US only), education, BMI category and CCI. Asked only of the employed population. For US: Yes, I smoke (N=4382), Trying to quit (N=2329), No, I quit (N=7900), and Never smoked (N=20 713). For EU5: Yes, I smoke (N=7230), Trying to quit (N=2414), No, I quit (N=8665) and Never smoked (N=14 850). For China: Yes, I smoke (N=2488), Trying to quit (N=1423), No, I quit (N=1904) and Never smoked (N=9238).
current smokers to those who quit 0-4 years ago in China. When comparing those who have not quit to those who quit 5-10 years ago, current smokers had greater presenteeism, overall work impairment, and activity impairment in all three regions and greater absenteeism in US and China (P<.001 for all). Lastly, current smokers had greater absenteeism, presenteeism, overall work impairment and activity impairment than those who quit 11+ years ago in all three regions (P<.001 for all; see Table 6 for means, standard errors and 95% confidence intervals).

4 | DISCUSSION

Smoking is associated with significant societal and individual consequences across a variety of health and economic outcomes. Importantly, the results of the current study suggest that quitting smoking serves to reduce the burden to workplace productivity and activity impairment. This is most exemplified by recent quitters, between 0 and 4 years postcessation, having significantly lower impact on absenteeism, presenteeism and activity impairment compared with current smokers. Additionally, this burden was so reduced that former smokers appeared mostly indistinguishable from never smokers. These findings suggest that in addition to the health and economic benefits experienced by employees who quit, employers themselves benefit economically from tobacco cessation in the workplace by the increase in work productivity experienced by their employers.

This study provides important simultaneous documentation of the work-related burden of smoking in the US, EU5 and China using large-scale representative survey sampling methodology. While there was some variation among regions, after controlling for demographic and health characteristics, comparisons revealed that overall, employees who smoked reported significant impairments across multiple domains of work productivity as well as activity impairment compared with former and never smokers. These results are consistent with previous work establishing the detrimental impact of smoking and tobacco use on work-related outcomes in the US and EU.

Interestingly, those who are trying to quit had greater impairment than current smokers and former smokers, suggesting that the act of quitting can be a challenging process and previous research has shown that smokers can benefit from support during the quitting process. This suggests a role for employers in providing support to employees currently in the process of quitting smoking to enhance the change of successful quitting given the rapid benefits that were identified. The overall pattern of results across all regions thus suggests that former smokers and never smokers have the lowest impairment compared with other groups.

Quitting smoking has been shown not only to reverse many of the detrimental health effects of tobacco use over time but also to reduce impairments in work productivity in a cost-effective manner. Of note in this study, former smokers were statistically indistinguishable from never smokers in some work productivity outcomes across a number of regions sampled, although this result warrants further replication and investigation. This may suggest that in a period of 4 years or less, the burden of smoking is lessened to such a degree that former smokers begin to appear similar to those who have never smoked in terms of work productivity loss and activity impairment. This timeline is contrasted with some medical and health-related benefits from quitting smoking, which may take substantially longer (e.g., 10-20 years) for maximum risk reduction.

To the authors’ knowledge, no previous findings examining the impact of quitting on work productivity and impairment across both time and geographic region simultaneously exist. The novel findings of this study support the need for increased investment in employer-based smoking cessation programs irrespective of geography as well as identifying system wide approaches to help smokers during the quit process. This provides further evidence that employers should seek to implement and promote tobacco cessation programs in the workplace, as well as to provide ongoing support for their employees who are seeking to quit or have successfully quit.

4.1 | Strengths and limitations

This study possesses a number of strengths, including its methodological approach and ability to provide unique insight into the impact of quitting on work-related outcomes. Similar large-scale representative survey methodology was utilised in order to gain information from individuals across three global regions, providing exclusive insight into the impact of smoking on work-related outcomes among a diverse population of tobacco users. Importantly, this methodological approach enabled two study objectives to be examined, the impact of smoking behaviour on workplace productivity and the improvement over time provided by cessation. Although the results presented provide insight into the potential consequences of smoking in the workplace, it is important to consider them in the context of study limitations. The results of this study were based on self-reported data and thus smoking status was not independently verified. Additionally, the percentage of smokers in China was lower than identified in China by other sources, potentially indicating a healthier population. Further, the cross-sectional nature of this survey precludes causal inferences from being drawn regarding the primary study variables.

More specifically, we cannot infer whether smoking makes people less productive or whether more productive people are less likely to smoke. While we controlled for some potentially confounding variables, it is still possible that not all confounders were captured. There may be other variables, such as mental illness, related to smoking and work productivity that were not controlled for in this study. As those with mental illness are both more likely to smoke and exhibit decreased employee productivity, quitting smoking may not alleviate the work productivity burden within the mentally ill population. Future research could examine how smoking affects work productivity loss in the mentally ill population.

4.2 | Conclusions

Smoking is associated with important health and economic consequences for individuals and society at large. This study provides important insight into burden exerted by smoking on work productivity
**TABLE 6** Adjusted means examining effect of years since quitting on WPAI-GH after controlling for demographic and health characteristics

|                      | Have not quit (A) | 0-4 years (B) | 5-10 years (C) | 11+ years (D) |
|----------------------|------------------|---------------|----------------|---------------|
|                      | Mean  | SE   | 95% CI       | P-value A vs B | P-value A vs C | P-value A vs D | Mean  | SE   | 95% CI       |
| US                   |       |      |              |                |                |                |       |      |              |
| Absenteeism % 🟢      | 4.61  | 0.23 | 4.17-5.09    | .040           | <.001          | <.001          | 3.82  | 0.29 | 3.3-4.44     |
| Presenteeism % 🟢     | 17.67 | 0.35 | 17-18.36     | <.001          | <.001          | <.001          | 14.39 | 0.43 | 13.57-15.27  |
| Overall work impairment % 🟢 | 19.98 | 0.39 | 19.23-20.75  | <.001          | <.001          | <.001          | 16.78 | 0.49 | 15.84-17.78  |
| Activity impairment % | 27.54 | 0.23 | 26.93-28.17  | <.001          | <.001          | <.001          | 24.09 | 0.42 | 23.28-24.93  |
| EU5                  |       |      |              |                |                |                |       |      |              |
| Absenteeism % 🟢      | 6.15  | 0.22 | 5.72-6.66    | .194           | .087           | <.001          | 5.59  | 0.36 | 4.93-6.34    |
| Presenteeism % 🟢     | 18.47 | 0.28 | 17.93-19.02  | <.001          | <.001          | <.001          | 16.24 | 0.43 | 15.42-17.11  |
| Overall work impairment % 🟢 | 22.08 | 0.32 | 21.46-22.72  | <.001          | <.001          | <.001          | 20.06 | 0.52 | 19.07-21.11  |
| Activity impairment % | 26.29 | 0.26 | 25.78-26.81  | <.001          | <.001          | <.001          | 24.83 | 0.43 | 24.01-25.68  |
| China                |       |      |              |                |                |                |       |      |              |
| Absenteeism % 🟢      | 8.63  | 0.28 | 8.1-9.21     | <.001          | <.001          | <.001          | 6.74  | 0.40 | 6.3-7.14     |
| Presenteeism % 🟢     | 28.55 | 0.44 | 27.79-29.24  | .016           | <.001          | <.001          | 26.45 | 0.73 | 25.06-27.93  |
| Overall work impairment % 🟢 | 32.52 | 0.49 | 31.57-33.49  | 0.029          | <.001          | <.001          | 30.39 | 0.82 | 28.81-32.05  |
| Activity impairment % | 28.68 | 0.41 | 27.89-29.5   | <.001          | <.001          | <.001          | 26.46 | 0.68 | 25.16-27.82  |

SE, standard error; CI, confidence interval. *Covariates included: age, ethnicity (for US only), education, BMI category, and CCI. 🟢 Asked only of the employed population. For US: Have not quit (N=6319), 0-4 years (N=2780), 5-10 years (N=1837) and 11+ years (N=3675). For EU5: Have not quit (N=9262), 0-4 years (N=3016), 5-10 years (N=2148), and 11+ years (N=3883). For China: Have not quit (N=3616), 0-4 years (N=1132), 5-10 years (N=508) and 11+ years (N=559).
in the US, EUS and China. Among former smokers, improved work productivity outcomes were evident even among those who had quit relatively recently. This finding further reinforces the immediate benefits that can emerge for both individuals and employers. These novel findings provide further support for the widespread implementation of workplace smoking cessation programs.

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DISCLOSURE

This study was sponsored by Pfizer Inc. CL Baker, KH Zou and M Bruno are employees and stockholders of Pfizer Inc, a pharmaceutical company that has a prescription medication indicated as an aid to smoking cessation in adults aged 18 and over. VJ Harrison is an employee of Atrium Staffing, who were paid contractors to Pfizer in the development of this manuscript. NM Flores is an employee of Kantar Health. Kantar Health received funding from Pfizer for conducting this study and for the development of this manuscript.

AUTHOR CONTRIBUTIONS

CLB, KHZ, MB and VJH were involved in the study design, interpretation of results, critical revision of the manuscript, and approval of the manuscript. NMF was involved in the study design, analyses and interpretation of results, drafting the manuscript, critical revision of the manuscript and approval of the manuscript.

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