

ORIGINAL PAPER

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

Christine L. Baker¹ | Natalia M. Flores² | Kelly H. Zou¹ | Marianna Bruno¹ |
Vannessa J. Harrison¹

¹Pfizer Inc, New York, NY, USA

²Kantar Health, Foster City, CA, USA

Correspondence

Natalia M. Flores, Kantar Health, Foster City CA, USA.

Email: natalia.flores@kantarhealth.com

Funding information

Pfizer Inc

Summary

Background: Smoking has important health and economic consequences for individuals and society. This study expands the understanding of work-related burden associated with smoking and benefit of smoking cessation across the US, European Union (EU) and China using large-scale, representative survey methodology.

Methods: Data utilised the 2013 National Health and Wellness Survey in United States (US), EU5 (UK, France, Germany, Italy, and Spain) and China. Working-aged respondents 18-64 were used in the analyses (US N=58 500; EU5 N=50 417; China N=17 987) and were categorised into: current smokers, trying to quit, former smokers and never smokers. Generalised linear models controlling for demographics and health characteristics examined the relationship of smoking status with work productivity and activity impairment (WPAI-GH). The WPAI-GH measures were: absenteeism, presenteeism, overall work impairment, and activity impairment. Separately, current smokers were compared with those who quit 0-4, 5-10 and 11 or more years ago on WPAI-GH end-points.

Results: Current smokers reported greater absenteeism in the US and China and greater presenteeism, overall work impairment, and activity impairment than former and never smokers across the three regions. Those who quit even 0-4 years ago demonstrated lower absenteeism, presenteeism, and activity impairment in China and lower presenteeism, overall work impairment, and activity impairment in the US and EU5.

Conclusions: Smoking was associated with significant work productivity loss in the US, EU5 and China. The results suggest that quitting benefits extend to work productivity rapidly after cessation, serving to further encourage and promote the implementation of workplace cessation programs.

1 | 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.¹ 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.²

Approximately 21% of the global adult population are current smokers.³ Smoking prevalence is dependent, in part, on societal acceptance of smoking, with lower prevalence in areas with greater public policy efforts [eg, 16.8% of adults in the United States (US), 19.2% in Great Britain, 19.5% in Italy] and higher prevalence in areas without

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

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.² 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,

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 work 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.

the European Union (EU), and China using large-scale representative survey methodology.

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)²³].

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.html²⁴), 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 (ANOVAs) 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,²⁵ 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).²⁴

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

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

	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.

TABLE 2 Demographics and health characteristics by smoking status for US

	Smoking status										P-value
	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	
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
	N	%	N	%	N	%	N	%	N	%	
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.

magnitude of differences, US current smokers had 28% more absenteeism, 28% more presenteeism, 24% more overall work impairment, and 22% more activity impairment than former smokers. In EU5, current smokers had 18% more absenteeism, 18% more presenteeism, 15% more overall work impairment and 12% more activity impairment than former smokers. In China, current smokers had 61% more absenteeism, 16% more presenteeism, 17% more overall work impairment and 13% more activity impairment than former smokers.

In contrast, across all three regions, current smokers had lower impairment on all WPAL-GH variables than individuals trying to quit ($P<.01$ for all), 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 across all three regions ($P<.001$ for all).

The pattern is less clear when comparing former smokers to never smokers. In the US, former smokers had greater presenteeism, overall work impairment, and activity impairment than never smokers ($P<.001$ for all); however, there was no statistically significant difference between former smokers and never smokers on absenteeism. For EU5, former smokers had lower presenteeism than never smokers ($P<.01$), but there were no statistically significant differences between 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.

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 ($P<.017$ 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

TABLE 3 Demographics and health characteristics by smoking status for EU5

	Smoking Status										P-value
	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	
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	%	N	%	N	%	N	%	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										P-value
	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	
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	%	N	%	N	%	N	%	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	120	7.6	146	6.6	777	6.8	1322	7.3	
Unknown	29	1.0	10	.6	17	.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 WPAL-GH after controlling for demographic and health characteristics^a

	Current smoker (A)			Trying to quit (B)			Former smoker (C)			Never smoker (D)				
	Mean	SE	95% CI	P-value A vs B	P-value A vs C	P-value A vs D	Mean	SE	95% CI	P-value C vs B	P-value C vs D	Mean	SE	95% CI
US														
Absenteeism % ^b	4.06	0.27	3.57-4.61	.02	.003	<.001	5.24	0.47	4.40-6.24	<.001	<.001	2.90	0.09	2.73-3.08
Presenteeism % ^b	16.78	0.43	15.95-17.66	.006	<.001	<.001	18.89	0.66	17.63-20.24	<.001	<.001	12.15	0.14	11.87-12.43
Overall work impairment % ^b	18.82	0.48	17.91-19.78	.003	<.001	<.001	21.40	0.74	20.00-22.90	<.001	<.001	13.94	0.16	13.63-14.26
Activity impairment %	25.47	0.39	24.71-26.25	.010	<.001	<.001	27.23	0.57	26.13-28.38	<.001	<.001	18.87	0.14	18.60-19.15
EU5														
Absenteeism % ^b	5.68	0.24	5.23-6.16	<.001	.003	.035	7.56	0.55	6.56-8.72	<.001	<.001	5.10	0.15	4.81-5.40
Presenteeism % ^b	17.58	0.30	17.00-18.19	<.001	<.001	<.001	21.17	0.64	19.96-22.45	<.001	<.001	15.86	0.19	15.49-16.24
Overall work impairment % ^b	20.97	0.35	20.29-21.67	<.001	<.001	<.001	25.49	0.74	24.07-26.99	<.001	<.001	19.14	0.23	18.70-19.59
Activity impairment %	24.91	0.29	24.34-25.49	<.001	<.001	<.001	28.51	0.57	27.42-29.64	<.001	<.001	22.16	0.18	21.81-22.52
China														
Absenteeism % ^b	8.35	0.38	7.64-9.12	.001	<.001	<.001	10.62	0.63	9.45-11.92	<.001	<.001	5.21	0.12	4.97-5.46
Presenteeism % ^b	26.93	0.54	25.89-28.02	<.001	<.001	<.001	32.92	0.86	31.29-34.65	<.001	<.001	23.30	0.25	22.83-23.79
Overall work impairment % ^b	30.88	0.61	29.71-32.09	<.001	<.001	<.001	37.95	0.97	36.09-39.91	<.001	<.001	26.07	0.27	25.56-26.60
Activity impairment %	27.06	0.50	26.09-28.06	<.001	<.001	<.001	32.77	0.79	31.25-34.36	<.001	<.001	23.97	0.22	23.54-24.41

SE, standard error; CI, confidence interval. ^aCovariates included: age, ethnicity (for US only), education, BMI category and CCI. ^bAsked 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.^{1,2} 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 employees.

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.^{2,26}

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.²⁷ This suggests a role for employers in providing support to employees currently in the process of quitting smoking to enhance the chance 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 (eg, 10-20 years) for maximum risk reduction.²⁸⁻³⁰

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,^{31,32} 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^a

	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	Mean	SE	95% CI	Mean	SE	95% CI	
US																
Absenteeism % ^b	4.61	0.23	4.17-5.09	.040	<.001	<.001	3.82	0.29	3.3-4.44	3.00	0.28	2.5-3.6	3.11	0.22	2.71-3.56	
Presenteeism % ^b	17.67	0.35	17-18.36	<.001	<.001	<.001	14.39	0.43	13.57-15.27	13.62	0.49	12.68-14.62	13.03	0.35	12.35-13.73	
Overall work impairment % ^b	19.98	0.39	19.23-20.75	<.001	<.001	<.001	16.78	0.49	15.84-17.78	15.49	0.55	14.44-16.62	14.90	0.40	14.14-15.69	
Activity impairment %	27.54	0.32	26.93-28.17	<.001	<.001	<.001	24.09	0.42	23.28-24.93	21.72	0.48	20.79-22.68	21.28	0.34	20.61-21.96	
EU5																
Absenteeism % ^b	6.15	0.22	5.72-6.6	.194	.087	<.001	5.59	0.36	4.93-6.34	5.33	0.40	4.6-6.17	4.47	0.26	3.99-5.01	
Presenteeism % ^b	18.47	0.28	17.93-19.02	<.001	<.001	<.001	16.24	0.43	15.42-17.11	14.65	0.46	13.77-15.57	14.98	0.36	14.3-15.7	
Overall work impairment % ^b	22.08	0.32	21.46-22.72	0.001	<.0001	<.001	20.06	0.52	19.07-21.1	18.33	0.56	17.27-19.45	18.09	0.42	17.28-18.93	
Activity impairment %	26.29	0.26	25.78-26.81	.004	<.001	<.001	24.83	0.43	24.01-25.68	22.94	0.47	22.04-23.88	21.82	0.34	21.16-22.49	
China																
Absenteeism % ^b	8.63	0.28	8.1-9.21	<.001	<.001	<.001	6.74	0.40	6-7.56	5.60	0.49	4.72-6.66	4.46	0.38	3.78-5.26	
Presenteeism % ^b	28.55	0.44	27.7-29.42	.016	<.001	<.001	26.45	0.73	25.06-27.93	22.95	0.94	21.18-24.87	22.04	0.87	20.39-23.83	
Overall work impairment % ^b	32.52	0.49	31.57-33.49	0.029	<.0001	<.0001	30.39	0.82	28.81-32.05	26.25	1.06	24.26-28.41	24.54	0.95	22.76-26.47	
Activity impairment %	28.68	0.41	27.89-29.5	.006	<.001	<.001	26.46	0.68	25.16-27.82	23.69	0.89	22.01-25.5	23.49	0.85	21.88-25.21	

SE, standard error; CI, confidence interval. ^a Covariates included: age, ethnicity (for US only), education, BMI category, and CCI. ^b 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=3016), 5-10 years (N=9262), 0-4 years (N=3016), 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, EU5 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.

ACKNOWLEDGEMENTS

This study was sponsored by Pfizer Inc, a pharmaceutical company that has a prescription medication indicated as an aid to smoking cessation in adults 18 and over. Kantar Health received funding from Pfizer for study design, data access, data analysis and for the development of this manuscript. Errol J. Philip provided editorial support for manuscript preparation as a paid consultant to Kantar Health.

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.

REFERENCES

- World Health Organization. Tobacco 2015. <http://www.who.int/mediacentre/factsheets/fs339/en/>. Accessed November 14, 2015.
- US Department of Health and Human Services (USDHHS). The health consequences of smoking—50 years of progress. A report of the surgeon general. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014. <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/>
- World Health Organization. Tobacco Control Country Profiles 2014. http://www.who.int/tobacco/surveillance/policy/country_profile/en/
- Jamal A, Homa DM, O'Connor E, et al. Current cigarette smoking among adults — United States, 2005–2014. Centers for Disease Control and Prevention, 2015.
- Halpern MT, Shikar R, Rentz AM, Khan ZM. Impact of smoking status on workplace absenteeism and productivity. *Tobacco Control*. 2001;10:233–238.
- Berman M, Crane R, Seiber E, Munur M. Estimating the cost of a smoking employee. *Tobacco Control*. 2014;23:428–433.
- Bunn WB 3rd, Stave GM, Downs KE, Alvir JM, Dirani R. Effect of smoking status on productivity loss. *J Occup Environ Med*. 2006;48:1099–1108.
- Robroek SJ, van den Berg TI, Plat JF, Burdorf A. The role of obesity and lifestyle behaviours in a productive workforce. *Occup Environ Med*. 2011;68:134–139.
- Wegner C, Gutsch A, Hessel F, Wasem J. Smoking-attributable productivity loss in Germany—a partial sickness cost study based on the human capital potential method. *Gesundheitswesen*. 2004;66:423–432.
- Prenzler A, Mittendorf T, devron Schulenburg JM. Modelling of the costs of productivity losses due to smoking in Germany for the year 2005. *Gesundheitswesen*. 2007;69:635–643.
- Yu J, Wang S, Yu X. Health risk factors associated with presenteeism in a Chinese enterprise. *Occup Med* 2015;65:732–738.
- How tobacco smoke causes disease: the biology and behavioral basis for smoking-attributable disease: a report of the surgeon general. Publications and Reports of the Surgeon General. Atlanta, GA, 2010.
- Rasmussen SR, Prescott E, Sorensen TI, Sogaard J. The total lifetime health cost savings of smoking cessation to society. *Eur J Public Health*. 2005;15:601–606.
- American Cancer Society. Guide to quitting smoking, 2014. <http://www.cancer.org/healthy/stayawayfromtobacco/guide-toquittingsmoking/guide-to-quitting-smoking-toc>. Accessed November 14, 2015.
- Centers for Disease Control and Prevention. Tobacco-use cessation. Workplace health promotion, 2013.
- Fitch K, Iwasaki K, Pyenson B. Covering smoking cessation as a health benefit: a case for employers, 2006. <http://www.dfwbgh.org/events07/9-27-2007.pdf>. Accessed November 14, 2015.
- Jackson KC 2nd, Nahoopii R, Said Q, Dirani R, Brixner D. An employer-based cost-benefit analysis of a novel pharmacotherapy agent for smoking cessation. *J Occup Environ Med*. 2007;49:453–460.
- Health Research & Education Trust. Employer Health Benefits 2013 Annual Survey. Kaiser Family Foundation, 2013.
- World Health Organization. WHO Report on the Global Tobacco Epidemic, The MPOWER package. Geneva: 2008.
- Finkelstein EA, Allaire BT, Dibonaventura MD, Burgess SM. Direct and indirect costs and potential cost savings of laparoscopic adjustable gastric banding among obese patients with diabetes. *J Occup Environ Med*. 2011;53:1025–1029.
- Bolge SC, Doan JF, Kannan H, Baran RW. Association of insomnia with quality of life, work productivity, and activity impairment. *Qual Life Res*. 2009;18:415–422.
- DiBonaventura MD, Wagner JS, Yuan Y, L'Italien G, Langley P, Ray Kim W. Humanistic and economic impacts of hepatitis C infection in the United States. *J Med Econ*. 2010;13:709–718.
- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373–383.
- Reilly MC, Zbrozek AS, Dukes EM. The validity and reproducibility of a work productivity and activity impairment instrument. *Pharmacoeconomics*. 1993;4:353–365.
- Wickens TD, Keppel G. *Design and Analysis: A Researcher's Handbook*. Englewood Cliffs, NJ: Pearson; 2004.
- Ekpu VU, Brown AK. The economic impact of smoking and of reducing smoking prevalence: review of evidence. *Tob Use Insights*. 2015;8:1–35.
- Fiore MC, Smith SS, Jorenby DE, Baker TB. The effectiveness of the nicotine patch for smoking cessation: a meta-analysis. *JAMA*. 1994;271:1940–1947.
- American Cancer Society. Guide to Quitting Smoking. American Cancer Society; February 6, 2014.

29. Will JC, Galuska DA, Ford ES, Mokdad A, Calle EE. Cigarette smoking and diabetes mellitus: evidence of a positive association from a large prospective cohort study. *Int J Epidemiol*. 2001;30:540-546.
30. Kenfield SA, Stampfer MJ, Rosner BA, Colditz GA. Smoking and smoking cessation in relation to mortality in women. *JAMA*. 2008;299:2037-2047.
31. Hilton MF, Scuffham PA, Sheridan J, Cleary CM, Vecchio N, Whiteford HA. The association between mental disorders and productivity in treated and untreated employees. *J Occup Environ Med*. 2009;51:996-1003.
32. Lasser K, Boyd JW, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: a population-based prevalence study. *JAMA* 2000;284:2606-2610.