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RESEARCH PAPER

Does smoking increase sick leave? Evidence using register data on Swedish workers

Petter Lundborg

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Objective: To examine the effect of smoking on sick leave.
Methods: Nationally representative data on 14 272 workers aged 16–65 years from the 1988–91 waves of the Swedish Survey of Living Conditions were used for the analyses. The data are linked to register-based data, on the annual number of absences due to sickness, from the National Board of Social Insurance. As outcome variable, the annual number of days of sick leave was used. This outcome was analysed as a function of smoking status and an extensive number of control variables, including occupational risk factors, work characteristics and health status.
Results: Smoking was found to increase the annual number of days of absence by 10.7 compared with never smoking. Controlling for risk factors at work, and thereby accounting for some of the selection of smokers into riskier jobs, reduced the effect to 9.7 days, corresponding to 38% of all annual absences due to sickness. Moreover, controlling for health status further reduced the effect of smoking to 7.7 days. The effect of smoking on sick leave was similar for men and women.
Conclusions: Smoking showed a large positive effect on the annual number of sick leaves. Hence, the results suggest that the gains to preventing and/or reducing smoking, in terms of reduced production losses, may be large. However, since the large effect of smoking persists when controlling for a range of health factors and occupational factors, the results also suggest that much of the higher number of absences among smokers may be explained by factors other than reduced health. The estimates should be viewed as upper bounds of the effect of smoking on sick leave, since smoking is potentially an endogenous variable.

The adverse health consequences of smoking are well established.[1] Moreover, the healthcare costs of smoking have been found to constitute a non-negligible part of the total healthcare costs in developed countries.[2] The indirect costs, in terms of productivity losses, however, typically constitute the major part of the economic burden. Estimates of the costs of smoking from different countries differ because of differences in the prevalence of smoking, of course, but also because of differences in the cost per smoker. Although smoking has been estimated to account for 8% of total healthcare costs in the US, 3.8% in Canada, and 3.7% in Germany, smoking accounts for only 1.5% of healthcare costs in Sweden according to recent estimates.[3–6] Several studies do not include lost productivity due to absence from sickness (hereafter sickness absence), because no sufficient data are available.[3–5]

Knowledge about the relationship between smoking and sickness absences is of importance from several perspectives. For employers, such knowledge is necessary for assessing the potential benefits of implementing smoking policies/practices at the workplace. At a higher societal level, such knowledge is necessary for policy makers to judge the potential benefits of societal interventions against smoking. Moreover, estimates of the costs of smoking depend on reliable estimates of the effect of smoking on sick leave.

The link between smoking and sick leave may be explained by several different mechanisms, though. Smokers differ from non-smokers in several respects that may be hard to measure. Studies have shown that smokers choose riskier jobs than non-smokers, which may partly reflect differences in attitudes towards risks.[7] Smokers have also been found to be more frequently involved in other risky activities, such as alcohol consumption and driving without a seat belt.[8 9] This means that a positive correlation between smoking and sickness absences may partly reflect smokers' tendency to choose riskier jobs and activities than non-smokers, which, in turn, may make them more likely to be absent. For policy purposes, it is crucial to distinguish between these "selection" effects and the causal effect that smoking has on sick leave.

Prior studies on smoking and sick leave have largely ignored potential selection effects. Moreover, non-representative, and in many cases small samples, have been used, making it difficult to draw any general conclusions from the findings. Halpern *et al*,[10] for instance, used data on 300 employees at a specific US air company. Robbins *et al*,[8] with a greater sample size, used data on 87 991 individuals serving in the US army. Both Yen *et al*[11] and Bertera[12] used data on workers from specific manufacturing companies, whereas Parkes[13] used data on 185 student nurses, and Van Tuinen and Land[14] used data on 406 health workers.

Among studies using representative samples, the outcome measure has typically been limited in several important respects. Typically, the outcome measure has been based on self-reported absences that have often concerned a limited time period. In Sindelar *et al*,[15] the outcome measure was a binary indicator of self-reported sickness absence in the previous week. Similarly, Bush and Wooden[16] and Wooden and Bush[17] used an outcome measure that concerned any sickness absence during the previous 2 weeks. Leigh[18] used self-reported information on the yearly number of hours of sickness absence. Obviously, measurement errors in such self-reports may bias the results in unknown directions. For Swedish conditions, Roberts[19] analysed the effect of smoking on the annual number of sick leaves in one of the few studies using register-based information on sick leave.

Abbreviations: BMI, body mass index; HILDA, Health and Individuals Longitudinal Data and Analysis

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Table 1 Descriptive statistics

Variable	All Mean (SD)*	Never smoker Mean (SD)	Current smoker Mean (SD)	Former smoker Mean (SD)
Dependent variable				
Annual days of sick leave	25.22 (60.72)	19.93 (52.41)	34.07 (70.43)	24.48 (61.28)
Key independent variables				
Socioeconomic and demographic				
Age, years	38.92 (12.33)	37.22 (13.14)	39.22 (11.62)	41.61 (11.07)
Female	0.51 (0.50)	0.53 (0.50)	0.54 (0.50)	0.44 (0.50)
Above upper secondary school education	0.26 (0.44)	0.31 (0.46)	0.18 (0.38)	0.29 (0.45)
Work characteristics				
Loud noise	0.37 (0.48)	0.36 (0.48)	0.39 (0.49)	0.38 (0.48)
Stress	0.63 (0.48)	0.62 (0.49)	0.64 (0.48)	0.64 (0.48)
Repetitive movements	0.38 (0.48)	0.35 (0.48)	0.44 (0.50)	0.35 (0.48)
Bad ergonomic positions	0.42 (0.49)	0.39 (0.49)	0.47 (0.50)	0.41 (0.49)
Heavy lifts	0.42 (0.49)	0.41 (0.49)	0.47 (0.50)	0.40 (0.49)
Lifestyle variables				
Smoker	0.29 (0.45)	na	na	na
Former smoker	0.26 (0.44)	na	na	na
Health				
Bad self-reported health	0.02 (0.15)	0.01 (0.12)	0.03 (0.18)	0.03 (0.16)
Activity limitation	0.05 (0.21)	0.04 (0.19)	0.06 (0.24)	0.05 (0.22)
Workplace accident	0.02 (0.12)	0.01 (0.11)	0.02 (0.14)	0.02 (0.12)
Number of chronic diseases	0.47 (0.82)	0.42 (0.77)	0.52 (0.85)	0.52 (0.86)

*Mean of dummy variables indicates the proportion of ones. na, not applicable.

In this paper, the relationship between smoking and sick leave was analysed using a nationally representative dataset, where survey data were linked to register-based data on annual sick leaves. In the analyses, we were able to control for a wide range of factors that may otherwise confound the relationship between smoking and sickness absence, such as occupational risk factors and various health-related behaviours.

METHODS

Sample

Data from Health and Individuals Longitudinal Data and Analysis (HILDA), a linked-register database developed at Lund University Centre for Health Economics, Lund, Sweden, were used for the analyses. HILDA contains all the waves of the Swedish biannual Survey of Living Conditions, starting in 1980–81 and includes a nationally representative sample of approximately 16 000 people, aged 16–84 years, in each wave. For all individuals who have ever been a respondent, survey data have been linked to the utilisation of inpatient care, sickness benefits and disability insurance.

In this study, pooled cross-sectional data on workers aged 16–65 years for the years 1988–91 were used. Data more recent than that were not included, since spells of sick leave shorter than 2 weeks are no longer paid for by social insurance (but by the employer) and, hence, have not been recorded in the register since 1992. For the years 1988 and 1989, the response rate was 80% and 79%, respectively, whereas for the years 1990 and 1991, the response rate was 78% and 79%, respectively.

Most variables of interest for the analyses were present for the whole period 1988–91. Body mass index (BMI), alcohol use and use of moist snuff were only available for the years 1988–89, though. A sensitivity analysis was therefore performed for the inclusion/exclusion of these variables. Table 1 shows descriptive statistics for some of the key variables.

Measurement

Dependent variable

The annual number of days of sick leave is used as the dependent variable in the analyses. The data were based on the administrative registers of the National Board of Social Insurance.

Smoking

HILDA contains information on whether the respondent is a current smoker, former smoker or a never smoker. Two separate dummy variables indicating current smoking and former smoking are created, with never smoking being the reference category. A current smoker was defined as a person reporting daily smoking. Former smokers were defined as persons reporting no current daily smoking, but who reported having smoked daily during some part of their life.

Control variables

Basic socioeconomic and demographic variables are included as control variables. In addition, an extensive set of binary variables indicating risk factors at work and work characteristics are included in the analyses. Regarding other health-related factors possibly affecting absences from work, the 1988–9 samples also included self-reported information on height and weight, alcohol use and use of moist snuff. BMI was used to create a binary indicator of obesity. BMI is measured by dividing weight (in kg) by height (in m^2). Obesity is defined as BMI $\geqslant$30 kg/m^2.[20]

Alcohol use is measured in grams of alcohol in the previous week. A binary indicator for snuff use was created. Information on physical exercise was available for the whole study period, and a binary indicator of weekly exercise was included. People who performed physical exercise at least once a week were assigned the value one whereas people who never performed physical exercise, or only performed it once in a while, were assigned the value zero. Finally, four indicators of the respondent's health status were included in the analyses. The first was a dummy variable indicating bad self-reported health. The omitted reference category was good or fair health. The question asked to the respondent was: ''how do you judge your general health?''. The second was a dummy variable indicating the presence of any activity limitation. The question asked to the respondent was: ''are you able to run a short

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Table 2 Ordinary least-squares regression on the annual number of days of sickness among Swedish adults during 1988–91

	Full sample	Males	Females
Current smoker	10.69 (8.17 to 13.20)	10.70 (7.24 to 14.15)	10.63 (6.99 to 14.27)
Former smoker	3.09 (0.69 to 5.49)	3.48 (0.34 to 6.63)	2.93 (−0.68 to 6.54)
Never smoker (reference category)	na	na	na
Observations	14 272	7020	7252

na, not applicable.

distance, say 100 m, if you are in a hurry?''. Those who answered no to the question were assigned the value one. Third, a variable indicating the number of chronic diseases of the respondent was included. Fourth, a dummy variable indicating if the respondent had experienced any work-related accidents during the previous 12 months was included (''have you experienced any work-related accident during the past 12 months?'').

Analyses

Ordinary least-squares regression was used for the analyses of annual number of days of absence.

RESULTS

The results are shown as follows. First, some descriptive results on the differences between smokers and non-smokers are shown. Second, the results of the baseline regressions on yearly sickness absences for the period 1988–91 are shown. Besides smoking, these regressions include the basic socioeconomic and demographic variables, but excludes the occupational variables and health variables. Third, regressions are performed adding (1) the occupational variables and (2) the health variables in order to examine the extent to which the effect of smoking works through smokers' choice of riskier jobs and worse health status.

Descriptive results

In the sample, 29% were current smokers, 26% were former smokers and 45% were never smokers. The mean number of days of absence in the sample was 25. Never smokers had 20 days on average, whereas smokers had 34 days on average. The average former smoker had 25 days.

Smokers and non-smokers differed along important dimensions, as table 1 shows. Smokers are older, less educated, have more chronic diseases, are more likely to report bad health and lift more at work compared with non-smokers.

Baseline model

Table 2 shows the results for the period 1988–91, with the ordinary least-squares estimates and the corresponding CIs in the columns. The first column shows the results of the regression for the full sample. Columns two and three show the effects for males and females separately.

The results in the first column show a large positive and statistically significant effect of smoking, as opposed to never smoking, on the number of days of absence. For the full sample, the effect of smoking is to increase the number of days of absence by 10.69. The effect is similar in magnitude for both men and women. Former smoking increases the number of absences by 3.09 days. Again, the pattern is similar for both men and women.

Model including occupational factors and health

Table 3 shows the results from the full model, including (1) the occupational variables and (2) the health variables. Including the occupational variables decreases the effect of smoking on sick leave by roughly 1 day, from 10.69 to 9.67 days, for the full sample. The effect is similar for both men and women. Including the occupational risk variables decreases the effect of former smoking from 3.09 to 2.52 days. Again, the pattern is similar for both men and women. When analysed separately by gender, the effect of former smoking is not statistically significant for either men or women, though. In summary, the phenomenon of smokers self-selecting into riskier jobs may account for roughly 1 of the approximately 10 additional days of sickness that smokers have compared with non-smokers. The corresponding figure for former smokers is 0.5 days.

Since measures of snuff use, obesity and alcohol use were available only for 1988–99, a sensitivity analysis was conducted, both when excluding and including the alcohol, snuff and obesity variables. The effect of current smoking was now reduced from 9.30 to 9.03, whereas the effect of former smoking increased from 0.66 to 0.80. To summarise, omission of the alcohol, snuff and obesity variables did not affect the

Table 3 Ordinary least-squares regression on the annual number of days of sickness among Swedish adults for the period 1988–91

	Full sample	Males	Females
Controlling for occupational factors			
Current smoker	9.67 (7.18 to 12.15)	9.67 (6.35 to 12.98)	9.50 (6.03 to 12.96)
Former smoker	2.52 (0.14 to 4.90)	2.83 (−0.42 to 6.08)	2.35 (−1.40 to 6.10)
Never smoker (reference category)	na	na	na
Observations	14 272	7020	7252
Controlling for health factors			
Current smoker	7.67 (5.43 to 9.90)	7.26 (4.22 to 10.31)	7.55 (4.30 to 10.81)
Former smoker	0.58 (−1.60 to 2.76)	−0.19 (−3.01 to 2.63)	1.05 (−2.27 to 4.37)
Never smoker (reference category)			
Observations	14 272	7020	7252

na, not applicable.

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estimated effects of smoking to any great extent. These results are available on request.

Finally, the four health variables were also added to the regressions, in addition to the occupational variables. Controlling for health status, smoking still showed a substantial effect on the number of days of absence. For the full sample, the effect was reduced from 9.67 to 7.67, but was still significant at the 1% level. The effect was roughly similar in size for both men and women. Former smoking no longer showed any significant effect on days of absence, however.

SUMMARY AND DISCUSSION

The results in this paper provide some of the strongest evidence to date of the relationship between smoking and sick leave. First, and in contrast with most previous studies, it makes use of nationally representative data, which allow for more general conclusions to be drawn from the results. Second, it makes use of register-based data on days of sickness absence, which should normally reduce the risk of measurement errors. Third, it concerns the annual number of sickness absences, instead of the limited time periods used in most previous studies. Finally, by using information on a wide range of risk factors at work, and various health-related behaviours, it was possible to control for some important factors that may otherwise confound the relationship between smoking and sickness absence.

In summary, the results show a strong effect of smoking on the annual number of days of absence. Smoking was found to increase the annual number of days of absence by 10.7 compared with never smoking. This figure corresponded to 42% of the average number of days of sickness for the whole sample. The effect was roughly equal for men and women. The corresponding effect of former smoking was to increase the annual number of days of absence by 3.

To account for the fact that smokers may choose riskier jobs than non-smokers, and for that reason are absent from work more often, an extensive set of variables indicating risk factors at work was included in the regressions. In this manner, some of the potential selection of smokers into riskier jobs may be accounted for. Controlling for risk factors at work reduced the effect of smoking on sick leave by roughly 1 day (10%) annually. Still, smoking caused 38% of the sample mean of 25 days of sickness absences.

The use of the HILDA database allows controls for both self-reported and more objective measures of health, such as the number of chronic conditions. This was an improvement in comparison with most prior studies, where only self-reported health or no health measures had been included.[8 10 15 19] When controlling for health status, in addition to socioeconomic, demographic and occupational factors, smoking still increased the annual number of days of absence by 7.7. Since the causal link between smoking and sick leave can be expected to work through the adverse health effects of smoking, these results suggested either that inadequate controls for health status are included in the regressions or that the link between smoking and sick leave must be explained by factors other than health-related ones.

Most prior studies have used outcome measures other than annual days of absence and, therefore, comparisons of results were not straightforward. A direct comparison with Roberts[19] may be made, however, since partly the same data sources were used. Using data from HILDA for the years 1988–9, Roberts[19] finds that smoking increased absences by 7.6 days annually, compared with never smoking. This estimate is close to the one obtained in this paper for the period 1988–91—that is, 7.7 days—when controlling for health status and occupational risk factors and occupational characteristics. The results in this paper show that the relatively large effect obtained by Roberts seems to be robust to the use of other time periods and to the inclusion of a more extensive set of control measures.

The mean annual number of days of absence was 25.2 in the sample. This figure is most reliable, since the data are based on the administrative registers of the National Board of Social Insurance. The sickness-absence rate in Sweden, along with Norway and The Netherlands, has traditionally been high in comparison to other European countries, such as Germany, the UK and Denmark.[21] In a recent report by the Organisation for Economic Cooperation & Development, it was shown that Sweden has the highest number of lost working days due to sickness among the OECD countries; >25 days per employee compared with 9 days in the US.[22]

Limitations

Following the tradition in the literature, smoking was treated as an exogenous variable.[10–19] Even though a wider range of control variables was included than in most previous studies, there may still be factors affecting both smoking and sick leave that went unobserved by the analyst. In that case, the error term will be correlated with the smoking variable, thus violating one of the necessary assumptions for obtaining consistent estimates. Smoking will, in that case, be an endogenous variable and the coefficient of smoking may overstate the true effect of smoking on sick leave. Therefore, the results should be interpreted with some caution. Owing to the ethical and practical barriers of conducting controlled trials, where people could be randomly assigned to smoking and non-smoking status, the literature will always, more or less, have this drawback. There are ways in which future studies could be improved, however. For instance, one could try to identify events acting as ''natural experiments'', where the event affects the smoking behaviour of various groups in a seemingly random manner, and then follow the outcomes in terms of sick leave. Also, the use of longitudinal data would, under certain circumstances, improve the possibility of dealing with

What this paper adds

- Studies have linked smoking to absence from work. The literature, however, still has a number of important drawbacks such as inadequate outcome measures, the use of self-reported absences, small and non-representative samples, and lack of adequate control for factors that may confound the relationship between smoking and sick leaves. Unsurprisingly, the estimated impact of smoking varies to a great extent between studies.
- This paper makes several contributions to the literature. First, it makes use of register-based data on absences due to sickness, which reduces the risk of measurement errors.
- Second, it makes use of nationally representative data, which allow for more general conclusions to be drawn from the results.
- Third, it concerns the annual number of absences due to sickness, instead of the limited time periods used in most previous studies.
- Finally, by using information on a wide range of occupational risk factors, and health factors, it is possible to control for some important factors that may otherwise confound the relationship between smoking and absence due to sickness.

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the endogeneity. By using fixed-effects models, where unobserved individual factors that do not change over time could be controlled for, consistent estimates of the effects of smoking on sick leave could be obtained.[23] However, it should be noted that the fixed-effects strategy will only work if there is variation in the smoking status within individuals over time. Since most people do not start smoking until after their teens, this strategy will only work when looking at the effect of quitting smoking on sick leave. Although the HILDA database does contain longitudinal data, changes over time in the way that sick leaves are recorded currently prevent the possibility of conducting longitudinal analyses.

Our measure of smoking is based on self-reported smoking behaviour, which cannot be validated by, for instance, biochemical measures. Prior results have suggested, however, that self-reported smoking is reliable, and consistent with biological indicators, when measurements are carried out under optimised measurement conditions, ensuring anonymity.[24 25]

Policy implications and conclusion

The results suggest that policies that reduce and/or prevent smoking may also reduce the number of days of sick-leave. However, the results also suggest that much of the higher number of days of sick leave among smokers may be explained by factors other than reduced smoking-related health. This latter result suggests that policies aimed at reducing and/or preventing smoking may have a limited effect on sick leave among smokers. Further research should aim at improving our understanding of the mechanisms by which smoking correlates with sick leave. This is crucial to assess the cost effectiveness of various smoking cessation policies and the societal costs of smoking.

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