Tobacco Smoking in Early Adulthood and Labor Market Performance: The Cardiovascular Risk in Young Finns Study

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ABSTRACT

Introduction: Tobacco smoking has long been associated with reduced success in the labor market. One possible explanation for this correlation is the negative impact smoking has on labor productivity, particularly in physically demanding jobs due to its detrimental effects on physical fitness and performance.

Methods: Using data from the Cardiovascular Risk in Young Finns Study (YFS) survey, which was linked to register information on labor market outcomes and education attainment, we examined the association between tobacco smoking and long-term labor market outcomes (earnings and employment, N = 1,953). Smoking levels were determined by cigarette pack-years in 2001, as reported in the survey. Annual earnings and employment status were tracked from 2001 to 2019.

Results: A one-unit increase in pack-years was associated with a 1.8% decrease in earnings (95% Confidence Interval [CI]: −2.6% to −0.9%) and 0.5% fewer years spent employed (95% CI: −0.6% to −0.3%). This association was more pronounced among participants with lower education levels. The earnings difference was evident among younger cohorts, whereas the negative correlation with employment was observed in older cohorts among individuals with limited education.

Conclusions: Our findings regarding earnings suggest that in younger generations, where smoking is less prevalent, it serves as a deterrent in the labor market. The results on employment align with the view that the detrimental health effects of smoking may take time to manifest. Once they do, these health impacts can hinder productivity, especially in physically demanding jobs typically held by individuals with lower education levels.

Implications: Because the adverse consequences of tobacco smoking, in terms of health and labor market losses, mainly do not fully appear until later in life, it is crucial to design policies that encourage individuals to consider the long-term consequences associated with smoking. Through such policies, we may promote the achievement of socially optimal outcomes.

INTRODUCTION

The adverse health effects of tobacco smoking are well documented.[1] Smoking elevates the risk of various cancers, respiratory issues, and cardiovascular diseases, with approximately 14% of all deaths in 2019 attributed to smoking.[2] Despite a decline since the 1990s, the age-standardized prevalence of smoking in high-income countries remained at 18% among females and 27% among males in 2019.[2]

Besides the well-documented health risks, tobacco smoking has been linked to decreased labor market performance, including lower earnings.[3,4,5,6,7] This may be due to severe health problems caused by smoking, resulting in an inability to work, increased sick absences, and premature retirement. However, not all smokers experience such severe health problems impeding their ability to work. Smoking may also lead to reduced physical fitness and performance, impacting workplace productivity. This decreased productivity may limit earning potential, particularly in physically demanding occupations. Moreover, the current stigma surrounding smoking may lead to discrimination against smokers by employers.[8]

This study investigated the relationship between smoking combustible cigarettes and labor market outcomes (earnings and employment). Our study contributes to previous research in three ways. First, we examined labor market outcomes over 18 years, comparing smokers and non-smokers using longitudinal data and register-based employment records. Second, because the physical demands of the occupation can affect how harmful smoking is to work

performance, we examined whether the results differ by the level of education. Third, we measured tobacco smoking using pack-years, indicating cumulative lifetime cigarette consumption.

METHODS

Data sources and the sample

The Cardiovascular Risk in Young Finns Study (YFS) is a longitudinal study of 3,596 participants from five Finnish university regions, born between 1962 and 1977, representing six age cohorts from urban and rural areas within those regions.[9] The YFS data was linked to labor market outcomes from Statistics Finland (the FOLK longitudinal data modules, FOLK) and parental background information from the Longitudinal Population Census (LPC) using personal identifiers. The observation period, starting in 2001, covered participants aged 24 to 39. For the study subjects' flowchart, refer to Supplemental Figure 1.

Measures

The logarithm of annual wage, salary earnings, and employment status (1 = employed; 0 otherwise) from FOLK data were used as outcome variables. We focused on long-term average measures of earnings and employment shares from 2001 to 2019, with additional analyses covering a shorter follow-up period from 2010 to 2019. Long-term averages were preferred due to their stability over short-term measures, which contain more random variation leading to larger standard errors and attenuation of parameter estimates.

We measured smoking using cigarette pack-years from the 2001 YFS survey, capturing cumulative lifetime smoking. Pack-years are calculated by multiplying the average daily cigarettes smoked by the person's age minus the age at smoking initiation. For instance, a person with a 10 pack-year history of smoking has smoked one pack daily for 10 years. We focused solely on combustible cigarettes, as they were the predominant form of tobacco consumption in Finland during the study period. Additionally, pack-years are typically calculated based on combustible cigarette use in research literature.

Using educational attainment information from FOLK, YFS participants were categorized as high-educated if they had completed the International Standard Classification of Education (ISCED) level 5 education or above in 2001, while those with lower qualifications were considered low-educated.

Sex (FOLK), birth cohort (6 indicators, YFS), region of residence in 1980 (4 indicators, YFS), and a parental background indicator (LPC) were considered as basic control variables. Parental background equaled one if at least one parent had completed university-level education by 1980. Additionally, baseline wage differences in 2001 were considered to address potential confounding factors. Models were constructed to include an indicator variable for high education in 2001 when pooling high and low educated individuals. Parental smoking status in 1980 (1 = regular daily smoking for at least one year; 0 = no

regular smoking) was also included as an additional control in robustness analyses due to evidence suggesting intergenerational correlation in smoking behavior.[10]

Statistical methods

We employed linear regressions (ordinary least squares, OLS) to analyze labor market differences between smokers and non-smokers, regressing the logarithm of average annual earnings and employment shares from 2001 to 2019 on cigarette pack-years, while accounting for basic controls. Analyses were conducted for all participants collectively, with separations for high and low education levels. Coefficient equality between education levels was assessed by computing the point estimates for the coefficients' linear combinations using the "lincom" command in the Stata software.

To illustrate labor market outcome differences over time, average earnings and employment rates were calculated by smoking status and year, segmented by younger (born in the 1970s) and older (born in the 1960s) cohorts. These trajectories were based on raw averages without controls.

To assess potential differences in labor market outcomes between individuals who were still smoking and those who had quit or currently abstaining from smoking in 2001, we estimated interaction models. These models incorporated pack-years, an indicator variable for quitters/abstainers, and their interaction. The interaction term indicates variations in subsequent labor market outcomes between these groups.

RESULTS

Supplemental Tables 1 and 2 present the descriptive statistics. In the OLS results (Table 1, Column 1), a one-unit increase in pack-years was associated with a 1.8% earnings decrease (95% CI: −2.6% to −0.9%, $p < 0.001$). This suggests that reducing smoking by an amount equivalent to five pack-years could lead to a 9% earnings increase (= 5×0.018), with effect sizes ranging from 4.5% to 13%. Employment status was not controlled, so the effect size encompasses both wage and employment effects. Additionally, a one-unit increase in pack-years was linked to a 0.5% decrease in years employed (95% CI: −0.6% to −0.9%, $p < 0.001$).

The results suggest that the negative relationship between smoking and labor market outcomes was more pronounced among low-educated individuals compared to those with higher education levels (Table 1: Columns 2–3). However, the education level difference was not statistically significant (Table 1: Column 4). The three categories for education revealed a stronger negative correlation between smoking and labor market outcomes for individuals with only 9-year comprehensive education compared to those with 12-year intermediate education or higher education (Supplemental Tabel 3). The inclusion of parental smoking indicators did not alter the main results (Supplemental Table 4). Furthermore, shortening the observation period to 2010–2019 accentuated the negative association between smoking and labor market outcomes (Supplemental Table 5).

Supplemental Figure 2 presents the earnings progression over time for smokers and non-smokers, based on raw averages. It highlights the similar earnings trajectories between highly educated smokers and non-smokers. Initially, there was no earnings disparity between low-educated smokers and non-smokers. However, over time, low-educated smokers earned less than their non-smoking counterparts. Supplemental Figure 3 demonstrates similar patterns in employment.

Supplemental Figure 4 reveals a significant earnings difference between smokers and non-smokers among young cohorts, particularly among the low-educated individuals, with no such distinction among older cohorts. Supplemental Figure 5 illustrates a growing employment gap between smokers and non-smokers among the low-educated, which appears to escalate with age.

Supplemental Table 6 reports labor market outcome disparities between smokers and individuals who quit or abstained from smoking in 2001. Among the low-educated population, the negative association between pack-years and employment was primarily attributed to continuing smokers. For those who had quit or abstained from smoking, such a negative relationship was not observed ($\beta = 0.002$, $p = 0.560$, not reported in the table). Moreover, the results suggested that the negative association between pack-years and earnings among less educated individuals was diminished for those who had quit or abstained from smoking, but this difference was deemed insignificant.

DISCUSSION

This study conducted in Finland unveiled a significant correlation between tobacco smoking and weakened labor market performance. Two key patterns emerged from the data. First, the earnings gap between smokers and non-smokers was observed among young cohorts, especially among the low-educated, possibly extending to higher education levels. This disparity was not apparent among older cohorts, suggesting that smoking among younger generations, where it is less prevalent, may negatively affect labor market prospects. Another explanation for the cohort differences is that pre-existing influences of smoking on labor market outcomes might reduce the likelihood of detecting subsequent effects among older cohorts. Second, the employment difference between smokers and non-smokers seemed more prominent among the low-educated and appeared to increase with age. Additionally, the adverse association between pack-years and employment among the less educated was driven by ongoing smoking, as this trend was not observed among quitters or abstainers. These findings support the idea that the health impacts of smoking become more evident with age and longer smoking histories, while cessation can reverse several of these effects. [11] The conclusion that smoking's adverse effects manifest over time was also supported by the finding that results focusing on the later part of the follow-up period (2010-2019) showed a stronger negative relationship between smoking and labor market outcomes compared to the results based on the initial time interval (2001-2019).

The adverse employment outcomes associated with smoking seemed more prevalent among individuals with lower education levels, which supports the notion that smoking’s

adverse health effects may impact productivity particularly in physically demanding occupations that are more common among this population. Smoking could impact labor market outcomes also beyond its health implications, potentially affecting employers' perceptions of productivity. While Finnish law prohibits discrimination, including against smokers, there are few reported cases of discriminatory behavior, making it challenging to assess the extent to which smokers' disadvantaged positions in the labor market may stem from discrimination.

The study's strength was in its use of longitudinal register-based employment and earnings data, enabling the longitudinal examination of labor market performance. This is important because the adverse health effects of smoking can accumulate over decades. However, a limitation could arise in the potential clustering of unhealthy behaviors, which could influence our results.[12] Moreover, unobserved confounders or reverse causality may affect the results. Differences in time preferences, [13] risk attitudes, [14,15] or self-control, [16] for instance, could affect both smoking behavior and earnings, potentially explaining the observed correlations.

This study's findings confirm the negative association between smoking and labor market outcomes. A recent study estimated that in the U.S. in 2018, productivity losses due to smoking-related presenteeism, absenteeism, home productivity, and inability to work amounted to $184.9 billion. [17] Consequently, the indirect monetary costs of smoking could be economically substantial. It remains unclear whether individuals initiating smoking consider these substantial indirect monetary losses. Previous findings suggest that smokers

tend to discount the future more heavily than non-smokers, [18] indicating a preference for immediate gains over long-term benefits. Given that adverse health and labor market effects of smoking often taken a long time to manifest, many individuals may not adequately consider the gradual accumulation of long-term income losses over their professional careers. Designing policy interventions that prompt individuals to consider the indirect health and productivity losses associated with tobacco smoking could help achieve socially optimal outcomes. Several policy tools, including smoking bans, taxes and pricing, and anti-smoking campaigns, have been implemented to reduce smoking. However, the effectiveness of these policies can vary depending on factors such as age and their impact smoking prevalence, whether through reducing initiation or increasing cessation rates.[19] Such heterogeneity may also stem from differences in time preferences and self-control, associated with tobacco smoking. Commitment devices have been proposed as a precommitment tool for individuals with self-control issues and present biases, potentially helping smoking cessation.[20] However, their effectiveness likely depends on individuals' awareness of their present bias and self-control challenges. For those unaware of these issues, more paternalistic interventions, such as higher cigarette prices, may be more effective.

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DECLARATION OF INTEREST: None

DATA AVAILABILITY STATEMENT: The dataset supporting the conclusions of this article were obtained from the Cardiovascular Risk in Young Finns Study (YFS) and Statistics Finland

register data after submission and approval of our study plan by the YFS coordinators. The YFS dataset comprises health related participant data and their use is therefore restricted under the regulations on professional secrecy (Act on the Openness of Government Activities, 612/1999) and on sensitive personal data (Personal Data Act, 523/1999, implementing the EU data protection directive 95/46/EC). Due to these legal restrictions, the data from this study cannot be stored in public repositories or otherwise made publicly available. However, data access may be permitted on a case-by-case basis upon request only. Data sharing outside the group is done in collaboration with YFS group and requires a data-sharing agreement with YFS representatives and appropriate contracts with Statistics Finland. The linked YFS-FLEED-LPC data can only be used in Statistics Finland remote access system (FIONA). Investigators can submit an expression of interest to the chairman of the publication committee (Prof. Mika Kähönen, Tampere University, Finland).

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REFERENCES

[1] The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. US Dept of Health and Human Services; 2014. https://stacks.cdc.gov/view/cdc/21569

[2] Reitsma MB, Kendrick PJ, Ababneh E, *et al.* Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990–2019: a systematic analysis from the Global Burden of Disease Study 2019. *Lancet* 2021;397:2337-2360. doi:10.1016/S0140-6736(21)01169-7

[3] Auld MC. Smoking, drinking, and income. *J Hum Resour* 2005;40(2):505-18. https://doi.org/10.3368/jhr.XL.2.505

[4] Darden ME, Hotchkiss JL, Pitts MM. The dynamics of the smoking wage penalty. *J Health Econ* 2021;*79*:102485. doi:10.1016/j.jhealeco.2021.102485

[5] Grafova IB, Stafford FP. The wage effects of personal smoking history. *ILR Review* 2009;62(3):381-93. doi:10.1177/001979390906200307

[6] Levine PB, Gustafson TA, Velenchik AD. More bad news for smokers? The effects of cigarette smoking on wages. *ILR Review* 1997;50(3):493-509. doi:10.1177/001979399705000307

[7] Van Ours JC. A pint a day raises a man's pay; but smoking blows that gain away. *J Health Econ* 2004;23(5):863-86. doi:10.1016/j.jhealeco.2003.12.005

[8] Roulin, N., Bhatnagar, N. Smoking as a Job Killer: Reactions to Smokers in Personnel Selection. *J Bus Ethics* 2018;149:959–972. doi:10.1007/s10551-016-3101-2

[9] Raitakari OT, Juonala M, Rönnemaa T. *et al.* Cohort profile: the cardiovascular risk in Young Finns Study. *Int J Epidemiol* 2008;37:1220-1226. doi:10.1093/ije/dym225

[10] Vandewater EA, Park SE, Carey FR *et al*. Intergenerational Transfer of Smoking Across Three Generations and Forty-five Years. *Nicotine Tob Res* 2014;16(1):11–17, doi:10.1093/ntr/ntt112

[11] Fagerström K. The epidemiology of smoking: health consequences and benefits of cessation. *Drugs* 2002;62:1-9. doi:10.2165/00003495-200262002-00001

[12] Böckerman P, Hyytinen A, Kaprio J, *et al.* If you drink, don't smoke: Joint associations between risky health behaviors and labor market outcomes. *Soc Sci Med* 2018;207:55-63. doi:10.1016/j.socscimed.2018.04.039

[13] Kang MI, Ikeda S. Time discounting and smoking behavior: evidence from a panel survey. *Health Econ* 2014;23(12):1443-64. doi:10.1002/hec.2998

[14] Anderson LR, Mellor JM. Predicting health behaviors with an experimental measure of risk preference. *J Health Econ* 2008;27(5):1260-74. doi:10.1016/j.jhealeco.2008.05.011

[15] Viscusi WK, Hersch J. Cigarette smokers as job risk takers. *Rev Econ Stat* 2001;83(2):269-80. doi:10.1162/00346530151143806

[16] Khwaja A, Silverman D, Sloan F. Time preference, time discounting, and smoking decisions. *J Health Econ* 2007;26(5):927-49. doi:10.1016/j.jhealeco.2007.02.004

[17] Shrestha SS, Ghimire R, Wang X, *et al.* Cost of Cigarette Smoking–Attributable Productivity Losses, US, 2018. *Am J Perv Med* 2022;63:478-485. doi:10.1016/j.amepre.2022.04.032

[18] Reynold B, Richards JB, Horn K *et al.* Delay discounting and probability discounting as related to cigarette smoking status in adults. *Behav Processes* 2004;65:35-42. doi:10.1016/S0376-6357(03)00109-8

[19] Wilson LM, Tang EA, Chander G *et al*. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *J Environ Public Health* 2012;Article ID 961724. doi:10.1155/2012/961724

[20] Giné X, Karlan D, Zinman J. Put your money where your butt is: a commitment contract for smoking cessation. *Am Econ J: Appl Econ* 2010;2(4):213-35. doi:10.1257/app.2.4.213

Table 1. Smoking and labor market outcomes, 2001–2019.

		Education		
	(1) All	(2) Low education	(3) High education	(4) Equality of coefficients between columns 2 and 3
Panel A: Log of average earnings, 2001-2019				
Pack years, 2001	-0.018*** [-0.026; -0.009] (p < 0.001)	-0.017*** [-0.029; -0.006] (p = 0.003)	-0.009* [-0.020; 0.001] (p = 0.090)	p = 0.464
Panel B: Share of years employed, 2001-2019				
Pack years, 2001	-0.005*** [-0.006; -0.003] (p < 0.001)	-0.005*** [-0.007; -0.003] (p < 0.001)	-0.003** [-0.006; -0.001] (p = 0.010)	p = 0.435
N	1,953	1,132	821	

Notes: Table reports OLS regression coefficients, 95% CI (in square brackets), and p-values (in parenthesis); additional controls in all models: (indicator for high education), sex, birth cohort (5 indicators), indicator for high family education background, and the region of residence in 1980 (3 indicators). The equality of the coefficients between columns 2 and 3 was tested by computing the point estimates for linear combinations of the coefficients using the “lincom” command in the Stata software. Statistically significant at * 10%, ** 5%, *** 1% levels.