ORIGINAL ARTICLE

Associations of perceived work strain with nicotine dependence in a community sample

U John, J Riedel, H-J Rumpf, U Hapke, C Meyer

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See end of article for authors' affiliations

Correspondence to:
Professor Dr U John,
Director of the Institute of
Epidemiology and Social
Medicine, University of
Greifswald, Walter-
Rathenau-Str 48,
D-17487 Greifswald,
Germany; ujohn@
uni-greifswald.de

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Background: Little is known about work strain and smoking, and even less about work strain and nicotine dependence.

Aim: To investigate the relations of perceived work strain with nicotine dependence among an adult general population sample.

Method: Cross sectional survey with a probability sample of residents of a northern German area with 4075 participants, aged 18–64 years (participation rate 70.2%). The current study is based on 2549 participants who were working 15 or more hours per week. Face to face at-home computer aided interviews (World Health Organization Composite International Diagnostic Interview) were carried out. Work strain, defined as high work demand and low work control, was assessed with a questionnaire. Nicotine dependence was diagnosed according to the Diagnostic and Statistical Manual (DSM-IV) of the American Psychiatric Association. In addition, the Fagerström Test for Nicotine Dependence (FTND) was used.

Results: Subjects with work strain had an odds ratio of 1.6 (95% CI 1.2 to 2.3) for nicotine dependence compared to those who had no work strain. In a general linear model, higher work strain was associated with a stronger relation between work demand and work control and the FTND. The findings were adjusted for alcohol use disorders, occupational status, age, and sex.

Conclusion: Perceived work strain is related to nicotine dependence in this general adult population.

The workplace is a suitable setting for interventions that are designed to encourage smoking cessation and thus is an important field of public health efforts.¹ Large groups of smokers can be reached and non-smokers can be protected against second hand smoke. Smokers may experience withdrawal symptoms when they are not allowed to smoke during working hours and may therefore be motivated to live tobacco-free. A meta-analysis of 26 studies revealed that making workplaces smoke-free was associated with a decrease of smoking and an overall relative reduction in cigarettes per day per employee of 29%.¹ According to one study smokers who had worked in environments that changed to smoke-free policies between 1993 and 2001 were 1.9 times more likely to have quit by the year 2001 than smokers not working in such environments. Furthermore, continuing smokers reported a decrease of 2.6 cigarettes per day by 2001.² Even a reduction in the rate of hospital admissions among patients with acute myocardial infarction has been shown for the time in which a legislation of smoke-free workplaces was in effect.³ Interventions aimed at the individual worker to support smoking cessation increased smoking cessation rates⁴ while the evidence about interventions aimed at the workplace as a whole was less clear according to smoking outside the workplace setting.⁴

Evidence is inconsistent about associations between smoking status or cigarettes per day and job strain as defined in the Karasek model.⁵ Although some studies revealed more current smokers among those with high strain than among those with low strain^{6–9} slightly more studies showed that smoking status was unrelated to job strain.^{10–14} Heavy smoking, which was defined as 20 or more cigarettes per day, turned out to be related to job strain in a number of studies, but this relation was not always consistent in women and men.^{10–15–17} Only a few studies used random samples of the general adult population,^{8–9–12–13} and most of these studies were restricted by age or a participation rate of less than 60%.^{9–12–13}

No evidence about relations between nicotine dependence and work strain could be found. Nicotine dependent subjects according to the ICD-10 or the Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-IV)¹⁸ or the Fagerström Test for Nicotine Dependence (FTND)¹⁹ might tend to report more work strain in their working conditions than non-nicotine dependent subjects. Nicotine withdrawal criteria such as craving for smoking might add to the experience of work strain, particularly in cases of high work demand. Additionally, work strain might be related with nicotine dependence by its assumed arousal provoking effect that could increase the need for relief or for minimising negative feelings from work strain such as tenseness. Tension reduction is assumed to be one of the reasons why smokers smoke.²⁰ Furthermore, nicotine dependence is related to alcohol risk drinking and alcohol dependence and abuse,²¹ thus potentially contributing to a relation with work strain, and work strain is dependent on confounders such as occupational status or education.⁹

Altogether, the evidence is limited according to relations of work strain and details of smoking behaviour. No evidence could be found from general population studies between work strain and nicotine dependence and the urge to smoke. The goal of the present study is to analyse whether work strain is related to nicotine dependence adjusting for confounders such as risky alcohol drinking, alcohol dependence or abuse, and occupational status. We hypothesised, firstly, that among smokers who experience work strain higher proportions are nicotine dependent and show an urge to smoke than among smokers who do not experience work strain. Secondly, we assumed a positive association between strain and the urge to smoke.

Abbreviations: CIDI, Composite International Diagnostic Interview; DSM-IV, Diagnostic and Statistical Manual (of the American Psychiatric Association); FTND, Fagerström Test for Nicotine Dependence

METHODS

Study population

Individuals aged 18–64 years living in the northern German (217 000 inhabitant) city of Lübeck and 46 surrounding communities were eligible for the present study (Transitions in Alcohol Consumption and Smoking, TACOS).²² A random sample was drawn from the communities' resident registration files, in which the address and further personal data of everybody have to be included. Of the eligible subjects, 4093 completed the baseline interview (participation rate: 70.2%), and the data of 4075 subjects could be analysed. Reasons for non-participation were refusal, no contact with the individual, or severe disease.²² The individuals were representative of the defined population with respect to demographic characteristics.²³ Finally, our study population included 2549 current, former, or never smokers who worked 15 or more hours per week. The study was approved by the ethics committee of the University of Lübeck.

Assessments

Data were collected by face to face, computer aided personal interviews, in 91.5% of the participants at their home. The study followed the ethical principles of the American Psychological Association.²⁴ Individuals received written information about the study and were informed that they were free to participate and could withdraw at any time.

Perceived work strain was measured with a work strain questionnaire to be filled in by the respondent as part of the interview. The questionnaire had been developed (1) to measure perceived high work strain being defined by high work demand and at the same time low work control based on the Karasek model of job strain²⁵ and (2) to measure the perceived physical working conditions. Only the items referring to the Karasek model were included into our analysis. The questionnaire originally included 19 item pairs with a five point Likert scale response format.²⁶ A principal component analysis, a confirmatory factor analysis, and an analysis of internal consistency revealed the subscales "work demand", "work control", and "physical working conditions". The work demand subscale included the five item pairs: "agitated – calm", "slow – fast", "a lot – a little", "easy – difficult", "distressing – relaxed". The work control subscale included six item pairs: "inspiring – tedious", "responsible – irresponsible", "interesting – boring", "meaningful – meaningless", "communicative – isolated", "monotonous – varied". Principal component analysis revealed factor loadings of 0.53 to 0.81 for the work demand subscale and 0.60 to 0.84 for the work control subscale, and a confirmatory factor analysis revealed a χ^2 1682.0 (df = 116; comparative fit index = 0.87; mean standardised residuals 0.06).²⁷ For the work demand subscale the part-whole corrected item total correlations were $r = 0.39$ to $r = 0.62$, and Cronbach's alpha was 0.72. For the work control subscale the part-whole corrected item total correlations were $r = 0.44$ to $r = 0.72$, and Cronbach's alpha was 0.78. Each of the two subscales was dichotomised using the median.

According to work strain based on the Karasek model²⁵ four groups of individuals were defined according to the perceived characterisation of work: low demand + high control, low demand + low control, high demand + high control, high demand + low control. These groups were used for the data analysis comparing low demand plus high control indicating no work strain, to high demand plus low control indicating the high work strain group. The two groups with low demand plus low control and high demand plus high control were included as indicating medium work strain.

Nicotine dependence according to DSM-IV was assessed with the computer based German version of the Composite

International Diagnostic Interview (CIDI).^{28–29} Nicotine dependence according to DSM-IV is defined as a cluster of three or more symptoms occurring at any time in the same 12 month period: tolerance to the substance, withdrawal symptoms, use of the substance to relieve or to avoid withdrawal symptoms, taking the substance in larger amounts or over a longer period than intended, unsuccessful efforts to decrease or discontinue its use, a great deal of time spent in obtaining or consuming the substance or recovering from its effects, important activities given up or reduced because of substance use, continued use despite recognising that the use of the substance contributes to problems for the individual.³⁰ For the data analysis we chose the current diagnosis of nicotine dependence—that is, the criteria for a diagnosis of nicotine dependence must have been fulfilled during the last 12 months before the interview.

We included another frequently used concept of nicotine dependence as a continuous measure, the FTND.¹⁹ It consists of six questions that may be considered measuring the urge to smoke: time to first cigarette in the morning (≤ 5 , 6–30, 31–60, >60 minutes), difficulty in refraining from smoking where prohibited, which cigarette would be the most hated to give up (the first in the morning or other), the number of cigarettes smoked per day (≤ 10 , 11–20, 21–30, >30), whether the individual smokes more in the morning or the rest of the day, and whether the individual smokes when ill and in bed. The sum score of the FTND ranges from 0 to 10. In addition to the FTND as a continuous measure, we defined two categories for the FTND: a score of 0 versus a score of 1 or more to differentiate smokers who had no symptoms from those who had symptoms according to this measure. The FTND was applied to current smokers only. Smoking status included current, former, and never daily smoking and was assessed according to the algorithm of the CIDI. Current daily smokers were those who smoked daily during the four weeks before the interview; former daily smokers were those who had smoked more than four weeks daily in their life, but not during the last four weeks before the interview. Never daily smokers were those who had never smoked daily for longer than four weeks in their life.

As confounders we assessed alcohol risk drinking and alcohol abuse and dependence according to DSM-IV, occupational status, age, and sex. Alcohol risk drinking was defined as drinking 20 g or more pure alcohol per day among women and 30 g or more among men with respect to criteria of the British Medical Association.³¹ Alcohol dependence was diagnosed equivalent to nicotine dependence according to DSM-IV. Alcohol abuse according to DSM-IV was defined as a maladaptive pattern of alcohol consumption leading to clinically significant impairment or distress, manifested by recurrent alcohol use resulting in a failure to fulfil major role obligations—for example, repeated absences from work. The symptoms have never met the criteria for alcohol dependence.³⁰ Occupational status was categorised into six groups based on the nine main groups of ISCO-88³² with main groups 3 and 4, 6 and 7, and 8 and 9, merged into three of the six groups.

Data analysis

The bivariate data analyses included proportions and means with confidence intervals and χ^2 tests and univariate analysis of variance. For the effect size estimate for χ^2 tests we used Cohen's w with 0.10 or higher indicating an effect and for univariate analysis of variance we used Ω^2 and interpreted values of 0.01 or higher as indicating an effect.³³ As multivariate data analyses, logistic regression analysis and regression analysis according to the general model were applied. For the confidence intervals of proportions we used

Table 1 Work strain and nicotine dependence

	Nicotine dependence*			Fagerström Test for Nicotine Dependence†				
	n	%	CI	n	% >0	CI	Mean (SD)	CI
Total								
Low demand + high control	602	9.8	7.7 to 12.4	212	82.1	76.4 to 86.7	2.8 (2.0)	2.5 to 3.0
Low demand + low control	745	10.1	8.1 to 12.4	292	91.1	87.3 to 93.9	3.2 (2.0)	3.0 to 3.4
High demand + high control	715	11.5	9.3 to 14.0	267	89.1	84.8 to 92.3	3.3 (2.0)	3.1 to 3.5
High demand + low control	480	16.5	13.4 to 20.0	191	94.2	90.0 to 96.8	3.7 (1.9)	3.4 to 4.0
	$\chi^2 = 13.7$; $p < 0.01$; $w = 0.08$			$\chi^2 = 16.6$; $p \leq 0.001$; $w = 0.13$			$F = 6.8$; $df = 3$; $p < 0.001$; $\Omega^2 = 0.02$	
Men								
Low demand + high control	339	8.8	6.3 to 12.4	121	85.1	77.7 to 90.4	3.0 (2.1)	2.6 to 3.4
Low demand + low control	424	10.4	7.8 to 13.6	170	92.9	88.1 to 95.9	3.6 (2.0)	3.3 to 3.9
High demand + high control	442	12.4	9.7 to 15.8	172	90.7	85.4 to 94.2	3.5 (2.1)	3.2 to 3.8
High demand + low control	305	15.4	11.8 to 19.9	112	94.6	88.8 to 97.5	4.0 (2.0)	3.6 to 4.4
	$\chi^2 = 7.6$; NS; $w = 0.07$			$\chi^2 = 7.3$; NS; $w = 0.12$			$F = 4.9$; $df = 3$; $p < 0.01$; $\Omega^2 = 0.02$	
Women								
Low demand + high control	263	11.0	7.8 to 15.4	91	78.0	68.5 to 85.3	2.5 (2.0)	2.1 to 2.9
Low demand + low control	321	9.7	6.9 to 13.4	122	88.5	81.7 to 93.0	2.7 (2.0)	2.3 to 3.1
High demand + high control	273	9.9	6.9 to 14.0	95	86.3	78.0 to 91.8	2.9 (1.9)	2.5 to 3.3
High demand + low control	175	18.3	13.3 to 24.7	79	93.7	86.0 to 97.3	3.2 (1.8)	2.8 to 3.6
	$\chi^2 = 8.8$; $p < 0.05$; $w = 0.10$			$\chi^2 = 9.5$; $p < 0.05$; $w = 0.16$			$F = 2.1$; $df = 3$; NS; $\Omega^2 = 0.01$	
Occupational main groups								
Senior officials	155	4.5	2.2 to 9.0	45	82.2	68.7 to 90.7	2.8 (2.0)	2.2 to 3.4
Professionals	607	11.7	9.4 to 14.5	173	85.0	78.9 to 89.5	2.9 (2.0)	2.6 to 3.2
Technicians, clerks	521	11.9	9.4 to 15.0	171	91.8	86.7 to 95.1	3.3 (2.0)	3.0 to 3.6
Service, sales	234	12.0	8.4 to 16.8	89	88.8	80.5 to 93.8	3.3 (2.1)	2.9 to 3.7
Agricultural, craft	424	12.5	9.7 to 16.0	204	94.1	90.0 to 96.6	3.7 (2.1)	3.4 to 4.0
Elementary	598	12.2	9.8 to 15.1	277	87.7	83.3 to 91.1	3.1 (1.9)	2.9 to 3.3
	$\chi^2 = 10.2$; $df = 5$; NS; $w = 0.06$			$\chi^2 = 12.8$; $df = 5$; $p < 0.05$; $w = 0.11$			$F = 3.6$; $df = 5$; $p < 0.01$; $\Omega^2 = 0.02$	

*According to DSM-IV.³⁰

†Current smokers.

Current, former, or never smokers; $n = 2549$.

Confidence Interval Analysis,³⁴ and for all other data analyses we used SPSS 12.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

In the final sample there were 2128 (83.5%) who worked 35 or more hours per week and 421 (16.5%) who worked 15–34 hours per week. According to smoking status, 934 (36.6%) were never, 599 (23.5%) former, and 998 (39.2%)

current daily smokers. Among the current daily smokers, 259 (26.0%) were currently nicotine dependent, and 738 (74.0%) did not have a diagnosis of a current nicotine dependence. The data revealed that there was no relation between the four work strain groups and smoking status (likelihood χ^2 test 8.0; 6 degrees of freedom; $p = 0.24$, not significant; $w = 0.06$). Current smokers did not differ in work strain from never smokers (unadjusted OR 1.1; CI 0.99 to 1.2) and former smokers (unadjusted OR 1.0; CI 0.9 to 1.1).

Table 2 Work strain and nicotine dependence

	Nicotine dependence*		FTND†	
	Odds ratio	CI	Odds ratio	CI
Work strain				
Low demand + high control	Ref		Ref	
Low demand + low control	1.0	0.7–1.4	2.2	1.3–3.8
High demand + high control	1.2	0.8–1.7	1.9	1.1–3.3
High demand + low control	1.6	1.1–2.4	3.4	1.7–7.0
Alcohol use				
No heavy drinking, dependence, abuse	Ref		Ref	
Heavy drinking‡	2.1	1.3–3.4	0.6	0.3–1.3
Dependence or abuse	2.8	1.9–4.2	1.2	0.5–2.8
Occupational main groups				
Senior officials	Ref		Ref	
Professionals	2.8	1.2–6.2	1.3	0.5–3.1
Technicians, clerks	2.9	1.3–6.6	2.6	1.0–7.0
Service, sales	2.8	1.2–6.7	1.8	0.6–5.1
Agricultural, craft	2.8	1.2–6.5	2.9	1.1–7.9
Elementary	3.0	1.3–6.7	1.7	0.7–4.2
Hours worked per week				
15–34	Ref		Ref	
≥35	0.9	0.6–1.3	1.1	0.6–2.1

Logistic regression analysis. All variables in table 2 were entered into the regression model in addition to age (18–33, 34–49, 50–64) and sex.

*According to DSM-IV.³⁰

†Current smokers.

‡≥20 g pure alcohol per day among women, ≥30 g pure alcohol per day among men.

FTND Fagerström Test for Nicotine Dependence¹⁹ sum score ≥1.Current, former, or never smokers; $n = 2549$.

Table 3 Work strain and Fagerström Test for Nicotine Dependence

	Mean squares	F	p Value
Work strain	20.3	5.4	0.001
Alcohol use disorders	25.0	6.6	<0.001
Occupational status	9.0	2.4	<0.05
Age	4.4	1.2	NS
Sex	47.1	12.5	<0.001
Hours worked per week	0.6	0.2	NS
Error	3.8		

$r^2 = 0.14$.

General linear model.

Fagerström Test for Nicotine Dependence sum score.¹⁹

Current daily smokers; n = 998

In the bivariate data analysis, the proportion of nicotine dependent individuals differed among the four work strain groups of individuals; the highest proportion of nicotine dependent subjects was found among those with high work demand plus low control (table 1). There was an effect for work strain among smokers with FTND ≥ 1 , and those with high demand plus low control in their work had the highest mean FTND sum score. Among women, those with high work demand and low work control were most likely to be nicotine dependent and to have an FTND ≥ 1 . Men showed a trend in the same direction.

After adjustment for occupational status, work hours per week, age, and sex in a logistic regression analysis, those with work strain revealed an OR of 1.6 (CI 1.1 to 2.4) to be nicotine dependent and an OR of 3.4 (CI 1.7 to 7.0) to have an FTND ≥ 1 in comparison to those with low work demand and high work control (table 2). Subjects with alcohol risk drinking, alcohol dependence, or alcohol abuse were more likely to be nicotine dependent than individuals without alcohol risk drinking, alcohol dependence, or alcohol abuse. The general linear model revealed that work strain was related to the FTND as a continuous measure after controlling for alcohol risk drinking, alcohol dependence or abuse, occupational status, age, and sex (table 3).

DISCUSSION

Our findings extend existing knowledge that among individuals with work strain the proportion of nicotine dependence is higher than among subjects without work strain. Both hypotheses were confirmed by the data. The result may be explained by the criteria of nicotine dependence. Upcoming withdrawal—for example, restlessness, urge to smoke, or delay in work after the break that is needed for smoking might support the individual perception of work conditions as high demand. This is expressed in the work strain items “agitated”, “fast”, “a lot”, “difficult”, and “distressing”. However, low work control—for example characterised by little responsibility, boredom, meaninglessness—may be perceived as an attitude triggered by nicotine dependence criteria. This suggests that the nicotine dependence criteria only partly explain the relation.

A second explanation is that work strain might support the development of dependence among vulnerable individuals. Among them, work strain could contribute to a smoking pattern that is characterised by relief from an arousal that may have been produced or supported by work strain. This seems plausible in the light of evidence that one of the reasons for smoking reported by smokers is tension reduction.²⁰ Dependence criteria such as withdrawal and craving are particularly plausible for determining these relations, which is also expressed by the urge to smoke according to the FTND. In line with this finding, the relations of work strain

with the FTND tend to be higher than the relations of work strain with nicotine dependence.

A third explanation of the findings might be that both work strain and nicotine dependence are assumed to have the same effect: to provoke physical arousal. In that case, nicotine may be used for its sedating effects. Both work strain and nicotine dependence may be quantified, and future research might analyse this in further detail.

A fourth explanation could be that the relation between nicotine dependence and work strain is confounded by social inequality. Among workers of lower occupational status there are more smokers than among those with higher occupational status. However, occupational status was controlled, and the members of all occupational status groups were more likely to be nicotine dependent compared to the highest one with similar odds ratios.

The findings are in accordance with the Karasek model of work strain²⁵ because they show that high demand plus low control reveal higher proportions of nicotine dependence than low demand plus high control. The relation with nicotine dependence exists despite alcohol use disorders that are known to be highly comorbid with nicotine dependence.²¹ The finding that alcohol dependence or abuse does not discard the relation of work strain with nicotine dependence strongly supports the work strain nicotine dependence relation.

Other studies have found more subjects with work strain among smokers than among non-smokers.^{8,9,35,36} Our results did not confirm this finding. A reason may be the high proportion of current daily smokers (39.4%) among those working 15 hours per week or more in our sample compared to the proportions of current smokers in the Swedish general population samples. In the sample with the same age range as ours, the proportion of current daily smokers (15.6% to 21.2% dependent on the work strain) was about half of the proportion in our sample.⁸ In the Swedish sample of residents aged 25–64, there were 22% to 30% current smokers dependent on gender and work strain.⁹ In Sweden, a country with more tobacco control activities than Germany³⁷ those individuals in particular who are nicotine dependent might have maintained smoking.

A strength of the present study is its random adult population sample. However, several limitations of the results must be taken into account. Firstly, the sample is representative for only one region of Germany. Secondly, this was a cross sectional study only, and the data do not allow any conclusions about causal relations. Former smokers may have had other working conditions when they stopped smoking than at the time of the interview. Thirdly, all data including those about smoking were based on self statements only. However, recent evidence shows that the proportion of smokers who deny or minimise smoking in survey studies may be negligible because they do not significantly change the results according to smoking status.³⁸

We conclude that nicotine dependence is related to work strain, although no causal relations could be determined because of the limitations of the study design. One of the most plausible reasons for the relation may be that both work strain and nicotine dependence provoke physical arousal which the individual seeks to sedate by smoking. Nicotine dependence might function as an effect modifier in the relation between stress and somatic disease—for example, in cardiovascular disease. In this process, nicotine dependence and work strain may function as mutually reinforcing factors. Nicotine dependence plus work strain might be a risk factor particularly predictive of cardiovascular and other diseases. Consequently, workplace smoking bans should help to avoid such diseases. This confirms the finding that the enactment of a law against smoking in workplaces coincided with a

Main messages

- Subjects with work strain were 1.6 times more likely to be nicotine dependent than subjects without work strain.
- Current daily smoking was unrelated to work strain.

significant reduction of hospital admissions of acute myocardial infarction.³ Public health interventions at the workplace should consider the work strain-nicotine dependence relation—for example, by including alternative ways to cope with arousal or by adequate smoking cessation aids in addition to more general approaches, particularly workplace smoking bans. Workplace smoking bans may add to giving nicotine dependent smokers the opportunity to detect nicotine withdrawal. Our results show that this subpopulation of smokers may constitute a substantial part of the workforce.

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Authors' affiliations

U John, J Riedel, U Hapke, C Meyer, University of Greifswald, Institute of Epidemiology and Social Medicine, Greifswald, Germany
H-J Rumpf, University of Lübeck, Department for Psychiatry and Psychotherapy, Lübeck, Germany

Institution to which the work should be attributed: University of Greifswald, Institute of Epidemiology and Social Medicine

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