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Low schoolwork engagement and schoolwork difficulties predict smoking in adolescence?

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Background: Low academic achievement has been associated with smoking but factors behind this association are poorly known. Such factors could include schoolwork disengagement and schoolwork difficulties. To assess the extent to which they contribute to the explanation of how health inequalities emerge, we study in a longitudinal design whether these have an independent effect on smoking or whether their effect is mediated through academic achievement. **Methods:** Longitudinal data were collected in the Helsinki metropolitan area, Finland in 2011 and 2014. Participants were seventh-graders (12 − 13 years, N=9497). In the follow-up, 6534 students reported their smoking status in the ninth grade (15 − 16 years). Smoking, schoolwork behavioural engagement, i.e. participation in academic activities, and disengagement, schoolwork difficulties and cognitive competence were self-reported by adolescents. Academic achievement was obtained from the Finnish national application register on upper secondary education. A mediation analysis was executed with bootstrapped confidence intervals. **Results:** Higher schoolwork behavioural engagement and cognitive competence in the seventh grade predicted that adolescents were more likely not to smoke in the ninth grade (all *P*<0.001) while higher schoolwork disengagement and schoolwork difficulties predicted adolescents' smoking (all *P*<0.001). The effects were mediated through academic achievement. **Conclusions:** Students' behavioural disengagement with schoolwork and schoolwork difficulties are risks for smoking initiation. Their effect is mediated through poor school achievement. As smoking often continues in adulthood and poor school performance typically leads to lower education, schoolwork disengagement and difficulties in adolescence constitute potential pathways to inequalities in health.

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Introduction

Socio-economic health differences in adulthood are well-established. People with lower education and socio-economic position have higher mortality and morbidity compared to those with higher education and socio-economic position.[1] The origin of these health differences can be detected, at least partly, in adolescence where low academic achievement is related to health-compromising behaviours, like smoking. Students who achieve better grades at school are less likely to smoke, while those whose performance at school is poor tend to smoke more often.[2–6] On the other hand, smoking adolescents complete fewer years of education compared to non-smokers,[2,7] and students with poor academic performance have a higher probability of ending up with a lower level of education in adulthood.[8,9] Added up, this implies that adolescents with health-compromising behaviours are more likely to end up with a low socio-economic position in adulthood than those with healthy behaviours. Even though the association between educational achievement and smoking in young people has been shown in several studies, factors behind it are poorly known, with the exception of low socio-economic background of the family. Students from lower socioeconomic background tend to smoke more than those from higher socio-economic background,[10] and a low socio-economic background predicts lower academic achievement in school.[11]

Education and health have mainly been separate fields in the scientific literature, which is why factors behind academic achievement and risk factors for smoking have been studied separately. In this paper, we combine these two fields by assessing whether smoking can be better understood with concepts derived from education research, namely, schoolwork engagement and cognitive competence from learning-to-learn studies.[12] We suggest that these factors may explain the association between smoking and academic achievement and, consequently, contribute to the explanation of how health inequalities emerge.

The concept of schoolwork engagement comprises behavioural, emotional and cognitive dimensions.[13–15] Behavioural engagement has been the dimension that best predicts academic achievement[16] why this is our interest here. It refers to involvement in learning and academic tasks, adhering to classroom norms and participation in academic and extracurricular activities.[15] Previous smoking research has studied schoolwork engagement in general but the specific contribution of behavioural engagement to schoolwork has been neglected. In those studies, schoolwork engagement has been positively associated with academic achievement[6,13,17] but negatively with health-compromising behaviours, like smoking.[6]

Students' engagement to school builds a motivational context for schoolwork,[18] and enables students to deal with difficulties and failures in school.[19] Schoolwork difficulties refer to difficulties in basic tasks, e.g. tasks demanding reading, writing or independent work. Difficulties in these fundamental skills may worsen academic achievement, and through deterioration of academic achievement, schoolwork difficulties may contribute to smoking initiation. Additionally, cognitive skills predict academic achievement, but a recent longitudinal study of early adolescence also showed that students with poor

cognitive skills tend to engage more in health-compromising behaviours, like smoking, than students with good cognitive skills.[20]

We aim to study whether schoolwork behavioural engagement (involvement in learning and academic tasks), schoolwork difficulties and cognitive competence in the seventh grade (age 12−13 years) predict initiation of smoking and academic achievement by the end of the ninth grade (age 15−16 years). Further, we study whether the associations between smoking and schoolwork behavioural engagement, schoolwork difficulties and cognitive competence are mediated through academic achievement. Figure 1 presents our study design and model.
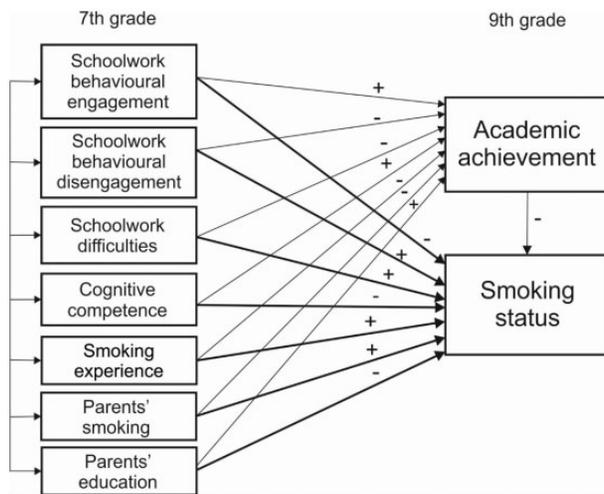

Figure 1 The conceptual model of smoking status, academic achievement, school-related predictors and covariates. The stronger arrows from the variables in seventh grade refer to the hypothesized total effects through the mediator of academic achievement in ninth grade on smoking status in ninth grade. A plus sign refers to the hypothesized positive association and a minus sign refers to hypothesized negative association between variables

Methods

Data

The longitudinal data were collected in 2011 and 2014 from all students in the Helsinki Metropolitan area. Participants in the baseline data (seventh-graders, 12−13 years) had just started lower secondary school ($N = 9497$; response rate 73%; 50.4% girls). Of the original cohort 6880 students (15−16 years) participated in the follow-up in the ninth grade at the end of compulsory school (response rate 72%; 53% of the original sample). Educational authorities of 14 municipalities gave permission for the study. The protocol was approved by the Ethics Committee of the National Institute for Health and Welfare. The baseline and follow-up surveys included two questionnaires (Health Survey and Learning-to-Learn Assessment). The final sample included only students who reported their smoking status in the ninth grade ($N = 6534$; 50.4% girls, table 1). Students' grades in the school-leaving certificate were obtained from the national joint application register on upper secondary education, 2014.

We compared the final sample to those students who completed the questionnaire in the seventh grade using t-test. The longitudinal sample included less students who had tried smoking in seventh grade ($P < 0.01$), whose parents have been smokers ($P < 0.05$), and who had schoolwork difficulties ($P < 0.01$), and more students with higher ninth grade academic achievement ($P < 0.001$) and behavioural engagement in schoolwork ($P < 0.05$), than the whole sample of students, who completed the questionnaire in 2011. No significant difference was found in other analysis variables.

Measures

Smoking status was asked: 'Which option best describes your smoking nowadays?' Response scale was 'I do not smoke at all', 'Less than once a week', 'Once a week or more often, but not daily', 'Once a day or more often'. No smoking was encoded as 0, other options as 1. In the ninth grade, 20% smoked at least sometimes ($N = 1309$).

Academic achievement was a sum of mother tongue, mathematics, and foreign language in the school-leaving certificate. The scale was 4–10 (4= fail, 10= excellent).

Table 1 Sample characteristics (N_{boys} =3255, N_{girls} =3279)

	Boys	Girls	Boys		Girls		Scale	T-test
	%	%	Mean	SD	Mean	SD		
Dichotomous variables								
Smoking (ninth grade)							0/1	3.27**
Non-smokers	78.3	81.6						
Occasional or daily smokers	21.7	18.4						
Smoking experience (seventh grade)							0/1	6.68***
No	78.1	85.2						
Yes	21.9	14.8						
Parents' smoking							0/1	0.34
No	58.2	58.7						
Yes	41.8	41.3						
Parents' education							0/1	−0.52
Other	63.7	63.1						
University degree	36.3	36.9						
Continuous variables[a]								
Academic achievement (ninth grade)			7.82	1.06	8.29	1.03	4–10	7.47***
Schoolwork behavioural engagement (seventh grade)			30.78	6.59	32.36	6.27	6–42	10.06***
Schoolwork behavioural disengagement (seventh grade)			13.45	4.08	11.62	4.00	3–21	0.393***
Schoolwork difficulties (seventh grade)			9.61	3.18	9.13	2.54	8–24	108.25***
Cognitive competence (seventh grade)			38.55	25.34	41.19	25.22	0–100	0.164***

a: Higher scores reflect higher quantity of the attribute.
**: $P < 0.01$, two-tailed.
***: $P < 0.001$, two-tailed.

Schoolwork behavioural engagement is typically described as including student's positive conduct, effort on schoolwork, pay attention in class and prepare for class.[14, 21–22] It was measured by six items regarding student's homework and behaviour during lessons ('I always carefully do the homework we have been given', 'I often leave my homework undone', 'If the teacher gives us homework I always do it in time', 'I always listen carefully when the teacher teaches in class', 'In lessons, I always listen carefully when the teacher gives instructions and new tasks', 'I always listen carefully when the teacher gives homework'). The scale was 1–7 (1 = Not true, 7 = Very true). Item scores were summed to a total score after turning the scale of the second item. Higher scores reflected student's stronger adherence to schoolwork. The internal reliability of the composite variable was good (Cronbach's α = 0.875).

Schoolwork behavioural disengagement

The students were asked their opinion in three statements: 'I try to get away with doing as little homework as possible', 'I have no interest in doing anything extra for school', 'I only do the compulsory work for school, nothing more'. The scale was 1–7 (1 = Not true, 7 = Very true). The operability and validity of the measure has been validated in educational research.[23] Item scores were summed to a total score (Cronbach's α = 0.732). Higher scores reflected student's stronger schoolwork behavioural disengagement.

Schoolwork difficulties, the seventh grade, were measured using an eight-item indicator which has been used in the Finnish School Health Promotion studies.[24] The question was 'How are you doing at school? Do you have difficulties in the following areas': paying attention to the teaching during class hours, working in groups, doing homework or similar tasks, preparing for exams, finding the right study method for you, doing assignments that require you to work independently, doing assignments that require writing, doing assignments that require reading (e.g. a book). The options were on a four-point scale: No, Some, Quite a lot, Very much. The options 'No' and 'Some' were coded as 1, 'Quite a lot' as 2 and 'Very much' as 3. The items were combined to form a composite variable with a higher value indicating more schoolwork difficulties (Cronbach's α = 0.927).

Cognitive competence was constructed by the mean of two cognitive tasks, taken from the Finnish Learning-to-Learn-Assessment battery.[24] Both introduced cognitive scales have been recently used in different research projects using SEM, evidencing their operability and validity.[23,25,26] The Control of Variables task consisted of eight items, each including a comparison pair of variables in the world of Formula 1 races: Driver, Car, Tires and Track. One item included three or four subsections where the adolescents had to decide whether the comparison pair gave information to decide the single effect of the variables. The options in each subsection were: 'No', 'Maybe', and 'Yes'. All subsections had to be answered correctly to get points from the item. The task scores were percent of correctly answered items (1 item = 12.50, 2 items = 25.00 etc.). The maximum score was 100. The reliability was adequate (Cronbach's α = 0.790). The other cognitive task was the Invented Mathematical Concepts task, which was a modified version of Sternberg and colleagues'[27] Triarchic Test Creative Number scale.[23] In the task, two imaginary mathematical concepts were introduced to adolescents, who were then asked to solve seven arithmetic tasks (multiple choice alternatives) based on the new concepts. The scores were the percentage of correct answers (1 correct answer = 14.29, 2 correct answers = 28.57 etc.). The maximum score was 100. The reliability was adequate (Cronbach's α = 0.750).

Covariates

Student's smoking experience, parents' smoking and parents' education were background variables. Smoking experience in the seventh grade was measured; 'Have you ever smoked? If you have, how many cigarettes have you smoked thus far?' with options 'I have

never tried to smoke', '1', 'About 2 − 50', 'More than 50'. 'Never tried' was coded as 0, the others were coded as 1. Mothers' and fathers' smoking was asked separately: 'Have your parents smoked during your lifetime?' with options 'He/she has never smoked', 'He/she has smoked but quit', 'He/she smokes nowadays', 'I have no father/mother'. *Parents' smoking* was coded as 1, if either parent smokes nowadays or had smoked but quit. 'Never smoked' and 'No mother/father' were coded as 0. *Parents' education* was asked separately for mothers and fathers: 'What kind of education do your parents have?' with option 'Basic education only', 'Vocational upper secondary education or vocational college', 'Matriculation examination and vocational college' 'University degree', 'No mother/father'. The highest level of either parent's education was used. Parental education was dichotomized for the technical reasons as covariates should be dichotomic or continuous in the mediation analysis using the Mplus statistical package.[28] University degree was encoded as 1, other options as 0. 'No mother and father' was coded as missing. Of students, 37% had at least one parent with university-level education which equates the high education level in the population of the Helsinki Metropolitan area.[29]

Statistical analysis

Descriptive and preliminary analyses were performed with IBM SPSS statistics 23 and the path analysis was executed using the Mplus (version 8) applying the WLSMV estimator.[28] The path analysis was accomplished in order to explore the mediated effects of the variables measured in the seventh grade on smoking status (the ninth grade) through academic achievement (the ninth grade; figure 1). The mediation model analyses were conducted separately for boys and girls, as the preliminary analyses showed that boys and girls differed significantly in the most of dependent variables (table 1). All variables measured in the seventh grade were allowed to correlate with each other. Bootstrapped confidence intervals were conducted to determine reliable confidence intervals of indirect effects, which are not normally distributed in nature.[30] Total, indirect and direct effects were based on counterfactuals, which takes into account that the outcome is binary and the mediator is continuous.[30] Odds ratios for smoking in the ninth grade were reported. Two-tailed significance testing was applied at the criterion level of P = 0.05. Missing data ranged from 1.4 to 28.7%. Missing data were handled in Mplus using a full information maximum likelihood estimation.[28]

Results

The causally-defined direct and total effects of the analyzed variables were all significant on the smoking status among both genders (all $P < 0.001$; table 2). The direct and total effects showed that higher schoolwork behavioural engagement in the seventh grade predicted less smoking in both genders in the ninth grade (direct effect boys OR = 0.717, girls OR = 0.710; total effect boys OR = 0.670; girls OR = 0.655). Conversely, higher schoolwork behavioural disengagement predicted more smoking in the ninth grade (direct effect boys OR= 1.099, girls OR = 1.072; total effect boys OR = 1.113, girls OR = 1.108). Additionally, schoolwork difficulties predicted more smoking (direct effect boys OR = 1.004, girls OR = 1.102; total effect boys OR = 1.030, OR = 1.141). Higher cognitive competence in the seventh grade predicted less smoking in the ninth grade among boys and girls according to the total effect (respectively, OR = 0.784, OR = 0.903). In sum, the hypothesized longitudinal associations were confirmed according to the total effects. That is, the effects of students' schoolwork behavioural engagement, schoolwork behavioural disengagement, schoolwork difficulties and cognitive competence on smoking were mediated through academic achievement.

All controlling variables, adolescent's smoking experience, parents' smoking and parents' education had significant direct and total effects on boys' and girls' smoking (all $P < 0.001$; table 2). All the variables measured in the seventh grade significantly

Table 2 Predicting smoking status in the ninth grade through academic achievement (*N*=6534)

	Boys		Girls	
	OR	SE	OR	SE
Variables in seventh grade				
Schoolwork behavioural engagement				
Total natural indirect effect[a]	0.934***	0.012	0.922***	0.014
Pure natural direct effect[a]	0.717***	0.044	0.710***	0.046
Total effect[a]	0.670***	0.042	0.655***	0.044
Schoolwork behavioural disengagement				
Total natural indirect effect	1.013***	0.008	1.034***	0.013
Pure natural direct effect	1.099***	0.069	1.072***	0.068
Total effect	1.113***	0.070	1.108***	0.071
Schoolwork difficulties				
Total natural indirect effect	1.026***	0.008	1.036***	0.012
Pure natural direct effect	1.004***	0.052	1.102***	0.056
Total effect	1.030***	0.052	1.141***	0.059
Cognitive competence				
Total natural indirect effect	0.822***	0.024	0.759***	0.022
Pure natural direct effect	0.954***	0.062	1.189***	0.073
Total effect	0.784***	0.045	0.903***	0.051
Covariates				
Smoking experience				
Total natural indirect effect	1.057***	0.011	1.079***	0.015
Pure natural direct effect	1.519***	0.069	1.701***	0.083
Total effect	1.606***	0.072	1.835***	0.089
Parents' smoking				
Total natural indirect effect	1.027***	0.008	1.023***	0.010
Pure natural direct effect	1.240***	0.065	1.246***	0.067
Total effect	1.273***	0.067	1.274***	0.069
Parents' education				
Total natural indirect effect	0.945***	0.010	0.913***	0.011
Pure natural direct effect	0.971***	0.048	1.101***	0.057
Total effect	0.918***	0.045	1.005***	0.052

	Boys		Girls	
	b	SE	B	SE
Effect of academic achievement in ninth grade to smoking in ninth grade	−0.245***	0.037	−0.364***	0.040
Effects of variables in seventh grade to academic achievement in ninth grade				
Schoolwork behavioural engagement	0.150***	0.017	0.122***	0.020
Schoolwork behavioural disengagement	−0.030	0.017	−0.054**	0.018
Schoolwork difficulties	−0.059***	0.016	−0.056**	0.018
Cognitive competence	0.444***	0.015	0.439***	0.015
Covariates				
Smoking experience	−0.136***	0.016	−0.129***	0.019
Parents' smoking	−0.063***	0.017	−0.036*	0.015
Parents' education	0.130***	0.016	0.146***	0.014
R^2				
Smoking status in ninth grade	0.401		0.401	
Academic achievement in ninth grade	0.252		0.289	
Model fit				
Number of free parameters	53		53	
RMSEA	0.000		0.000	
CFI/TLI	1.000/1.000		1.000/1.000	
N	3255		3279	

a: Total, indirect, and direct effects based on counterfactuals. OR = odds ratio. Higher scores reflect higher quantity of the attribute.
Note: b=unstandardized coefficient; SE = standard error. Higher scores reflect higher quantity of the attribute. The correlations between the variables in seventh grade significantly correlated with each other but they are not displayed in the table to conserve space.
∗: *P* < 0.05, two-tailed.
∗∗: *P* < 0.01, two-tailed.
∗∗∗: *P* < 0.001, two-tailed.

correlated with each other in boys (*P* < 0.01) and girls (*P* < 0.001). R^2 for smoking status was 0.252 in boys and 0.289 in girls, and for academic achievement 0.401 for both genders.

Discussion

We investigated the longitudinal associations between students' initiation of smoking and their behavioural engagement in schoolwork and schoolwork difficulties. Our results go beyond the known relationship between poor academic achievement and smoking by showing that low engagement in schoolwork and schoolwork difficulties predict smoking and that their effects mediate partly through academic achievement. Given that adolescent smoking often persists to adulthood and that poor academic achievement predicts short education, we find that low schoolwork engagement and

schoolwork difficulties constitute a potential pathway to health inequalities.

Early negative attitudes to schoolwork represent markers of an increased risk for smoking initiation during the later phases of adolescence. Previously, the association between lower schoolwork engagement and adolescent smoking has been found in a cross-sectional setting.[6] Our study shows that the association can also be established in a longitudinal design, so that both low schoolwork behavioural engagement and schoolwork difficulties predict later adolescent smoking. Previous studies have not been able to detect that this association is mediated through academic achievement. Our study also confirmed previous findings that students with lower cognitive competence tend to engage more in health-compromising behaviours than students with higher cognitive competence.[20] The longitudinal association of high schoolwork behavioural engagement and academic achievement was also detected in our study consistently with previous studies, which have shown that especially higher engagement in schoolwork predicts subsequent academic achievement.[16]

Our study provides new insight into the well-reported connection between poor academic achievement and smoking. The following theoretical interpretations offer explanations to the association. The first is inherently a psychological theory that rests on the notion of conservation of resources (COR).[31] The COR theory suggests that stress is the reaction to the threat to, or loss of, valuable psychological, material and social resources, and that to relieve or eject negative stress responses, people are intuitively motivated to protect, conserve and recover these valuable resources.[31] For schoolchildren, poor academic achievement is definitely a stressor. Actually, it is an increasing number of stressors through cyclic assessments at school in which a poorly performing student frequently finds him/herself to be worse compared to his/her peers. Thus, poor academic achievement may generate plenty of feelings of loss in students, e.g. loss of pleasure by competency or loss of teachers' and parents' appreciation. It also may lead to material loss, as poor academic achievement predicts low-pay employment in adulthood. According to COR, poorly performing students tend to protect, conserve, and recover their loss of psychological and social resources.[31] As nicotine induces pleasure and reduces stress and anxiety, improves concentration and performance of certain tasks,[32] for poorly performing students smoking may become a way to control mood and a way to achieve recovery from the psychological and social stress caused by poor academic achievement.

Another possible explanation for the association between low schoolwork behavioural disengagement and smoking could derive from the self-system model, based on self-determination theory.[18] This suggests that the extent to which students are engaged or disengaged in school constitutes a motivational context, which also enables students to deal with difficulties and failures in school.[19] Consequently, low schoolwork behavioural engagement might lead to searching for comfort in health-compromising behaviours like smoking. This might in turn further increase disengagement to school, as the relationship between school engagement and health-compromising behaviour has been shown to be bi-directional.[33]

One limitation of our study is the use of self-reported data. Therefore, smoking might be underreported or over-reported, as students may have answered in socially acceptable ways in classrooms.[34] Adolescents' self-report of smoking has, however, been found to be in agreement with biochemical measures.[35–37] Another limitation is that only students living in the metropolitan area of Helsinki constituted the cohort, and they may not represent all Finnish adolescents. This might compromise the generalizability of the results to some extent, as people in the metropolitan area are better educated than elsewhere in Finland.[29,38] The non-response analysis showed some selection of the longitudinal sample so that students with smoking and schoolwork difficulties were underrepresented and those with better academic achievement and behavioural engagement were overrepresented. This may affect strengths of the associations but is unlikely to bias them. The strength of our study is that we were able to study the associations in a longitudinal setting allowing us to reveal potentially causal pathways. The cohort also consisted of numerous students, a quarter of the entire age cohort in Finland, which allowed to conduct the analyses with respect to gender. Additionally, several items constituted the variables with good reliabilities, thus capturing various aspects of the phenomena.

Key points

- Students' low behavioural engagement with schoolwork and schoolwork difficulties predict smoking initiation.
- The effect of low schoolwork engagement and schoolwork difficulties on smoking initiation is partly mediated through poor school achievement.
- Given that adolescent smoking often persists to adulthood and that poor academic achievement predicts short education, low schoolwork engagement and schoolwork difficulties can be considered a potential pathway to health inequalities.
- Support for students with schoolwork difficulties and poor cognitive skills could provide a buffer against the initiation of smoking.

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