Smoking-based selection and influence in gender-segregated friendship networks: a social network analysis of adolescent smoking

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ABSTRACT

Aims The main goal of this study was to examine differences between adolescent male and female friendship networks regarding smoking-based selection and influence processes using newly developed social network analysis methods that allow the current state of continuously changing friendship networks to act as a dynamic constraint for changes in smoking behaviour, while allowing current smoking behaviour to be simultaneously a dynamic constraint for changes in friendship networks. Design Longitudinal design with four measurements. Setting Nine junior high schools in Finland. Participants A total of 1163 adolescents (mean age = 13.6 years) who participated in the control group of the ESFA (European Smoking prevention Framework Approach) study, including 605 males and 558 females. Measurements Smoking behaviour of adolescents, parents, siblings and friendship ties. Findings Smoking-based selection of friends was found in male as well as female networks. However, support for influence among friends was found only in female networks. Furthermore, females and males were both influenced by parental smoking behaviour. Conclusions In Finnish adolescents, both male and female smokers tend to select other smokers as friends but it appears that only females are influenced to smoke by their peer group. This suggests that prevention campaigns targeting resisting peer pressure may be more effective in adolescent girls than boys.

Keywords Adolescent smoking, gender differences, peer influence, peer selection, SIENA, social networks.

INTRODUCTION

Cigarette smoking continues to be one of the main preventable causes of cancer, heart disease and premature death [1–4]. During adolescence many youngsters experiment with smoking, which may lead to regular smoking [5].

Numerous studies report smoking behaviour to be similar among friends [6–9]. Although early research argued predominantly that similarity was caused by peer influence, recent studies have provided evidence that similarity is also caused by selection of similar friends [10–17]. Friendships are an important aspect of an adolescent’s life. Children tend to associate mainly with same-sex others and most close friends are of the same gender [18]. Although cross-gender friendships begin to develop during adolescence, gender similarity among friends is still marked [19,20]. Same-gender peer relationships are an important socializing context that influences the development of gender differences in social interaction styles. Differences between female–female and male–male friendships may lead to differences in smoking-based selection and influence processes. This study aims to examine selection and influence processes, differentiated by gender, in the context of smoking behaviour among adolescent friendship networks.

Researchers have demonstrated that friendship patterns differ for adolescent males and females. Females have more intimate friendships [18,21,22], report higher intimacy levels [22] and are more likely to turn to peers...
for support [23], which could result in more opportuni-
ties for influence. Furthermore, previous research has
found that females perceived more social pressure to
smoke [24,25] and were more susceptible to social in-
fluences [26]. However, to our knowledge, no study has
examined specifically differences between adolescent
male and female friendship networks regarding smoking-
based selection and influence processes.

The present study will examine selection and influ-
ence processes in male and female networks by using new
methods of social network analysis [27,28] which, con-
trary to conventional methods [10,12], allow the current
state of continuously changing friendship networks to
act as a dynamic constraint for changes in smoking
behaviour, while allowing smoking behaviour to be
simultaneously a dynamic constraint for friendship
changes. The possibility of unobserved changes in friend-
ships and smoking between two observations is consid-
ered and as well as including other possible determinants
of smoking behaviour, such as age, parental and sibling
smoking [29], these methods allow controlling for other
determinants of friendship selection besides smoking-
based selection of friends. Some of these determinants
are reciprocation of friendship; becoming a friend of
someone who is a friend of a friend [30,31]; and selec-
tion based on alcohol consumption [27], age, ethnicity
and education [20].

We hypothesize that smoking-based selection will be
present in males and females and that females will be
more susceptible to influence. Furthermore, we will
explore the impact of reciprocity of friendship on the
strength of smoking-based selection and influence.

METHODS

Participants

The sample comprised 1163 Finnish adolescents who
participated as a control group in the ESFA (European
Smoking prevention Framework Approach) study
[32,33]. Participating schools were based on a random
selection of communities in the Helsinki region and had a
50% chance of becoming an experimental school. Only
control schools that participated at all four measure-
ments and encompassed a minimum number of 20 males
and females were included, resulting in nine schools
including 605 males (mean age = 13.62 years) and 558
females (mean age = 13.57 years).

Procedure

Self-administered questionnaires were distributed
among all 7th graders of participating schools. Similar
questionnaires were distributed during follow-up among
8th (12-month follow-up) and 9th (24 and 30 months’
follow-up) graders [32,33]. Students present on the
days of data collection completed the questionnaire.
It was explained that responses would be treated confi-
dentially. Students could refuse to participate, and
returned questionnaires in sealed envelopes to guaran-
tee anonymity. At baseline, the proportion of refusals
was 0.03% [32].

Questionnaire

The ESFA questionnaire was based upon earlier studies
about adolescent smoking [33–38].

• Friendship ties were assessed by asking adolescents to
name up to five best friends inside and/or outside
school [39]. Only best friends inside the same school
grade are included, as only they also completed the
questionnaire.

• Smoking behaviour of adolescents was assessed by one
question: ‘On average, how many cigarettes do you
smoke during a week (also count the weekend)?’
(0 = none, 1 = between none and one, 2 = two to 10,
3 = 11–30, 4 = >30).

• Parental smoking behaviour was measured by two
questions: ‘Does your father (male caregiver) smoke?’
and ‘Does your mother (female caregiver) smoke?’, and
was recoded into one variable (0 = neither smokes,
1 = at least one smokes).

• Sibling smoking behaviour was measured by two ques-
tions: ‘Do one or more of your brother(s) smoke?’
and ‘Do one or more of your sister(s) smoke?’, and
was recoded into one variable (0 = no siblings smoke, 1 = at
least one smokes).

• School achievement was assessed by one question: ‘Last
year, how well did you do in school, compared to the
others in your class?’ (1 = among the lower third of my
class, 2 = the middle third, 3 = the best third).

• Alcohol consumption (0 = 0 glasses of alcoholic drinks
per week, 1 = one or two glasses, 2 = three to five,
3 ≥ five); age (in years) was also recorded.

Analysis plan

A stochastic actor-based model [28,40–42] was con-
structed to represent realistically mutual dependencies
between friendship changes and changes in smoking
behaviour by a simulation model. This model takes into
account the mutual feedback processes between friend-
ship and smoking occurring between observations. This
new approach was applied successfully to delinquency
[31] and alcohol consumption [43]. All respondents were
included and allowed to enter the study later or leave
earlier [44]. Missing values on adolescents’ attributes
and smoking behaviour were allowed and treated as non-
informative in the estimation procedure and imputed by
the mean for the start of the simulations [45]. The model
encompasses two parts: one part models friendship network changes (selection processes), the other part models smoking behaviour changes (influence processes). Both parts are integrated as one internally dependent process. In this manner, selection and influence processes can be examined simultaneously while controlling either process for the other one. Mathematical specifications are given by [28,40] and a sketch of the model is described in the next section.

Friendship network changes: selection processes

The friendship network evolution part of the model specifies the preferred direction of friendship change by including effects that determine probabilities of changes in friendship status, such as current network structure and adolescent’s attributes. Four main smoking-based friendship selection components were included: the effect of adolescent’s smoking behaviour on number of friends chosen (smoking behaviour ego); the effect of potential friends’ smoking behaviour (raw as well as squared value) on choosing them (smoking behaviour alter, smoking behaviour squared alter); and the interaction between smoking behaviour of adolescents and potential friends, to test that adolescents who smoke more also prefer friends who smoke more (smoking behaviour ego × alter). We included the raw and squared value of alters’ smoking to control for possible curvilinear dependence of the attractiveness of potential friends on their smoking behaviour. Because friendship choices depend strongly upon characteristics of the current network [20,40,46], the effects of number of friends chosen (outdegree), number of reciprocal friends chosen (reciprocity) and number of friends chosen who are also a friend-of-a-friend (transitivity) were included. The selection model controlled for alcohol consumption, age, and school achievement of adolescents and potential friends. All included effects are presented in the upper part of Table 1.

Smoking behaviour changes: influence processes

The smoking behaviour evolution part of the model specifies the preferred direction of change in smoking behaviour by including a list of functions of network, smoking behaviour and other attributes upon which changes in smoking behaviour may depend. Included effects are described in the lower part of Table 1. Three main friendship network-related influence components were modelled: the effect of friends’ average smoking behaviour, effect of the number of received friendship nominations (incoming friendships) and the number of outgoing friendship nominations on adolescent smoking behaviour (outgoing friendships). Included control effects were the tendency to smoke, a feedback effect of own previous smoking behaviour to control for non-linearities in smoking (tendency to smoke squared), parental and sibling smoking and adolescents’ alcohol consumption, age and school achievement.

Analysis

For each wave, a female and male network were constructed within each school. All female adolescents would be members of the female network, all males formed the male network. As the focus of the present paper was upon same-gender friendships, cross-gender friendships were excluded. For each network, the dynamic actor-based model was analysed using SIENA (Simulation Investigation for Empirical Network Analysis) software [44]. Effects were tested on the basis of t-ratios defined as estimate divided by standard error, which follow an approximate standard normal distribution [40]. Subsequently, results of all network analyses were combined for males and females in two meta-analyses. The null hypothesis that the effect is 0 in all networks was tested twice by Fisher’s combination procedure [47], once for the right-sided and once for the left-sided test. The right-sided test, for example, examines the null hypothesis that in all networks the coefficient of this effect is non-positive, while the alternative hypothesis is that in at least one school the coefficient is positive. To control for multiple (right and left) testing, there was deemed to be significant support for an effect if either of these combination tests were significant at the 0.025 level. This Fisher’s combination procedure [47] is preferred over the Snijders–Baerveldt method [30], as it does not make the assumption that estimated standard errors and parameter values are uncorrelated, nor the assumption that the networks are a sample of a population.

The null hypothesis, that effect parameters are constant across schools, was tested by Cochran’s method [48], adapted for network dynamics by Snijders & Baerveldt [30,48].

To examine differences between male and female networks, within each school parameter results of the male and female networks were compared with an independent-sample t-test. The results of these nine t-tests were then combined using Fisher’s combination procedure [47], assuming a significance level of 0.025.

Differences between reciprocal and non-reciprocal friendships

To explore whether the strength of smoking-based selection of friends differs when selecting non-reciprocal or reciprocal friends, and whether influence of friends differs within non-reciprocated and reciprocated friendships, interaction effects of smoking-based selection and
Table 1 Included effects for modelling selection and influence processes simultaneously.

<table>
<thead>
<tr>
<th>Description</th>
<th>Network decision: selection processes</th>
<th>Behaviour decision: influence processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effect of the adolescent’s own smoking behaviour on selection of friends</td>
<td>Smoking behaviour ego</td>
<td>Smoking behaviour friends**</td>
</tr>
<tr>
<td>Main effect of potential friends’ smoking behaviour on selection of friends</td>
<td>Smoking behaviour alter</td>
<td>Main effect of friend’s smoking behaviour on his own smoking behaviour</td>
</tr>
<tr>
<td>Main effect of potential friends’ squared smoking behaviour on selection of friends</td>
<td>Smoking behaviour alter squared</td>
<td>Main effect of adolescents’ number of nominations by others on his own smoking behaviour</td>
</tr>
<tr>
<td>Tendency to choose a friend based on similar smoking behaviour</td>
<td>Smoking behaviour ego × alter</td>
<td>Tendency to choose a friend based on similar smoking behaviour</td>
</tr>
<tr>
<td>General tendency to choose a friend</td>
<td>Outdegree</td>
<td>General tendency to smoke</td>
</tr>
<tr>
<td>Tendency to have reciprocal friendships</td>
<td>Reciprocity</td>
<td>Feedback effect of adolescent’s own smoking behaviour on itself</td>
</tr>
<tr>
<td>Tendency to become a friend of a friends’ friend</td>
<td>Transitivity*</td>
<td>Main effect of parental smoking behaviour on own smoking behaviour</td>
</tr>
<tr>
<td>Tendency to have reciprocal friendships</td>
<td>Alcohol consumption ego</td>
<td>Main effect of adolescent’s alcohol consumption on own smoking behaviour</td>
</tr>
<tr>
<td>Tendency to choose a friend based on similar alcohol consumption</td>
<td>Alcohol consumption alter</td>
<td>Main effect of adolescent’s age on own smoking behaviour</td>
</tr>
<tr>
<td>Tendency to choose a friend based on similar age</td>
<td>School achievement ego</td>
<td>Main effect of adolescent’s school achievement on own smoking behaviour</td>
</tr>
<tr>
<td>Tendency to choose a friend based on similar school achievement</td>
<td>School achievement alter</td>
<td></td>
</tr>
</tbody>
</table>

Extra effect tested with score test

- Smoking behaviour ego × alter × reciprocity: Effect to test whether selection based on similar smoking behaviour differs when selecting reciprocal or non-reciprocal friends
- Smoking behaviour of friends × reciprocity: Effect to test whether the effect of friend’s smoking behaviour differs among reciprocal and non-reciprocal friends

*Transitive ties; **average alter effect. Adequately controlling for attributes, such as age, results in a larger number of effects included in the friendship evolution part compared to the smoking behaviour evolution part. This difference is due to the multi-dimensional nature of selection processes. The probability to select a friend may depend upon the age of the adolescent, the age of the potential friend and similarities in age of both. The effect of age on adolescent smoking behaviour can be modelled by including only the effect of adolescents’ age on their own smoking behaviour.

Influence of friends with reciprocity were tested with score tests [31, M. Schweinberger, unpublished data].

The relative contribution of smoking-based selection and influence

As a similarity measure of individuals linked in a network we used Moran’s I, a spatial autocorrelation coefficient [49]. By calculating the average similarity of linked individuals in simulated models with coefficients estimated under different model specifications, the relative contributions of selection, influence and control effects to observed smoking similarity can be expressed. This method is explained in detail elsewhere [42,50]. Two male networks were excluded (n = 92) due to very low smoking rates (mean smoking behaviour <0.5), which might bias the results of these simulations. For comparative purposes the two female networks within these schools were also excluded (n = 123). We will represent graphically average proportions of similarity allocated to smoking-based selection, peer influence, selection and influence mechanisms not based upon links between friendship and smoking (i.e. controls), and general trend effects (previous friendships and smoking behaviour).
Table 2 presents the average network structure within male and female networks, the average smoking behaviour in each wave and baseline characteristics. Males and females smoked at similar rates. Females nominated more friends at wave 2 and reported more often to have smoking parents and siblings.

### Differences between male and female networks: selection processes

The results for the friendship evolution submodel are reported in the upper part of Table 3. Males and females tended to nominate more smoking friends when their own smoking behaviour was higher, as indicated by the significant ‘smoking behaviour ego × alter’ effects. There were no significant effects of adolescent
Table 3 Meta-analysis results: estimates, P-values and differences between schools of the combined model.

<table>
<thead>
<tr>
<th>Friendship network change</th>
<th>Males (n = 605)</th>
<th>Females (n = 558)</th>
<th>Difference test*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>OR</td>
<td>P-values</td>
</tr>
<tr>
<td>Smoking behaviour ego</td>
<td>-0.048</td>
<td>0.953</td>
<td>0.286</td>
</tr>
<tr>
<td>Smoking behaviour alter</td>
<td>0.070</td>
<td>1.073</td>
<td>0.636</td>
</tr>
<tr>
<td>Smoking behaviour alter squared</td>
<td>-0.055</td>
<td>0.946</td>
<td>0.261</td>
</tr>
<tr>
<td>Smoking behaviour ego x alter</td>
<td>0.116</td>
<td>1.123</td>
<td>1.000</td>
</tr>
<tr>
<td>Outdegree</td>
<td>-2.239</td>
<td>0.107</td>
<td>0.000</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.433</td>
<td>4.191</td>
<td>1.000</td>
</tr>
<tr>
<td>Transitivity</td>
<td>1.083†</td>
<td>2.954</td>
<td>1.000</td>
</tr>
<tr>
<td>Alcohol consumption ego</td>
<td>0.048</td>
<td>1.049</td>
<td>0.311</td>
</tr>
<tr>
<td>Alcohol consumption alter</td>
<td>-0.036</td>
<td>0.736</td>
<td>0.054</td>
</tr>
<tr>
<td>Alcohol consumption alter squared</td>
<td>0.081</td>
<td>1.084</td>
<td>0.955</td>
</tr>
<tr>
<td>Alcohol consumption ego x alter</td>
<td>0.155</td>
<td>1.168</td>
<td>0.925</td>
</tr>
<tr>
<td>Age ego</td>
<td>-0.191</td>
<td>0.826</td>
<td>0.142</td>
</tr>
<tr>
<td>Age alter</td>
<td>-0.022</td>
<td>0.978</td>
<td>0.515</td>
</tr>
<tr>
<td>Age ego x alter</td>
<td>0.191</td>
<td>1.210</td>
<td>0.783</td>
</tr>
<tr>
<td>School achievement ego</td>
<td>0.045</td>
<td>1.046</td>
<td>0.641</td>
</tr>
<tr>
<td>School achievement alter</td>
<td>-0.122†</td>
<td>0.885</td>
<td>0.002</td>
</tr>
<tr>
<td>School achievement ego x alter</td>
<td>0.050</td>
<td>1.051</td>
<td>0.689</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smoking behaviour change</th>
<th>P-values</th>
<th>Left</th>
<th>Right</th>
<th>P-values</th>
<th>Left</th>
<th>Right</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking behaviour friends</td>
<td>0.030†</td>
<td>1.030</td>
<td>0.492</td>
<td>0.074</td>
<td>0.062†</td>
<td>1.064</td>
<td>0.580</td>
</tr>
<tr>
<td>Incoming friendships</td>
<td>-0.028</td>
<td>0.972</td>
<td>0.404</td>
<td>0.578</td>
<td>0.030</td>
<td>1.030</td>
<td>0.850</td>
</tr>
<tr>
<td>Outgoing friendships</td>
<td>-0.208</td>
<td>0.812</td>
<td>0.000</td>
<td>0.994</td>
<td>-0.237</td>
<td>0.789</td>
<td>0.000</td>
</tr>
<tr>
<td>Tendency to smoke</td>
<td>-0.464†</td>
<td>0.629</td>
<td>0.000</td>
<td>1.000</td>
<td>-0.241†</td>
<td>0.786</td>
<td>0.019</td>
</tr>
<tr>
<td>Tendency to smoke squared</td>
<td>0.396</td>
<td>1.486</td>
<td>1.000</td>
<td>0.000</td>
<td>0.377</td>
<td>1.458</td>
<td>1.000</td>
</tr>
<tr>
<td>Smoking behaviour parents*</td>
<td>0.414†</td>
<td>1.513</td>
<td>0.982</td>
<td>0.000</td>
<td>0.339</td>
<td>1.404</td>
<td>0.920</td>
</tr>
<tr>
<td>Smoking behaviour siblings*</td>
<td>0.229</td>
<td>1.257</td>
<td>0.981</td>
<td>0.082</td>
<td>0.190</td>
<td>1.209</td>
<td>0.701</td>
</tr>
<tr>
<td>Alcohol consumption adolescent*</td>
<td>-0.159†</td>
<td>0.853</td>
<td>0.000</td>
<td>0.973</td>
<td>-0.253†</td>
<td>0.776</td>
<td>0.017</td>
</tr>
<tr>
<td>Age adolescent</td>
<td>0.025</td>
<td>1.025</td>
<td>0.341</td>
<td>0.329</td>
<td>-0.087</td>
<td>0.917</td>
<td>0.247</td>
</tr>
<tr>
<td>School achievement adolescent*</td>
<td>0.009</td>
<td>1.009</td>
<td>0.520</td>
<td>0.313</td>
<td>-0.123†</td>
<td>0.884</td>
<td>0.018</td>
</tr>
</tbody>
</table>

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Results for the control effects indicate that males and females tended to choose relatively few friends (outdegree) to reciprocal friendships (reciprocity), and to become friends with friends of their friends (transitivity). Adolescents did not select friends based upon similar alcohol consumption, age or school achievement. Among males, a propensity to select low-achieving friends was found, while females tended to select friends drinking alcohol at medium level (preferred scale value 1). Only transitivity differed significantly between males and females (combination left-sided tests \( \chi^2 = 34.46, \text{df} = 18, P = 0.01 \)), implying that females showed a stronger tendency to select friends of their friends.

Differences between male and female networks: influence processes

Results of the smoking behaviour evolution submodel are reported in the lower part of Table 3. Females were influenced by their friends’ smoking behaviour. Although there was evidence that the magnitude of effect of friend’s smoking behaviour differed across the nine included female networks \( \chi^2 = 25.43, \text{df} = 8, P = 0.001 \), estimated true standard deviation \( (\text{SD}) = 0.000 \). the effect was found to be consistently positive (right-sided \( P = 0.002 \), left-sided \( P = 0.58 \)). Although males and females did not differ significantly, males did not adjust their smoking behaviour significantly to their friends’ smoking behaviour. However, there was evidence for

\[ n: \text{Number of adolescents; estimate: unstandardized coefficients according to the Snijders–Baerveldt method (2003); OR: odds ratio; P-values: Fisher's combination of one-sided tests; bold-type values represent significant results; *attributes modelled as changing covariates; †significant differences found between schools according to the Snijders–Baerveldt method (2003).} \]
some variation in the effects across the male networks ($\chi^2 = 16.33$, df = 8, $P = 0.038$, estimated true SD = 0.000). Both males and females who nominated fewer friends tended to smoke more.

The control effects indicated that adolescents had a significant overall tendency not to smoke, but smoking behaviour tended to be self-reinforcing, as indicated by the significantly positive ‘tendency to smoke squared’ effect. Male and female adolescents smoked more when their parents smoked and when they drank less alcohol. Females smoked significantly more when they were low achievers. High-achieving males had a higher tendency to smoke, but this effect was not significant. None of these effects differed significantly between males and females.

Differences between reciprocal and non-reciprocal friendships

The score test of the interaction between smoking of adolescents, friends and reciprocity indicated that in male and female networks, the tendency to select reciprocal or non-reciprocal friends who are similar in smoking behaviour did not differ (combination left-sided tests $\chi^2$ males = 20.53, df = 18, $P = 0.30$, females = 29.07, df = 18, $P = 0.05$; combination right-sided tests $\chi^2$ males = 11.54, df = 18, $P = 0.87$, females = 12.77, df = 18, $P = 0.81$).

The score test of the interaction between friends’ smoking and reciprocity in its effect on smoking dynamics showed that among males and females influence of friends did not differ between reciprocal and non-reciprocal friendships (combination left-sided tests $\chi^2$ males = 13.34, df = 18, $P = 0.77$, females = 7.72, df = 18, $P = 0.98$; combination right-sided tests $\chi^2$ males = 23.86, df = 18, $P = 0.16$, females = 22.39, df = 18, $P = 0.22$).

The relative contribution of smoking-based selection and influence

Figure 1 shows that the mean proportion of similarity in smoking behaviour between friends attributed to smoking-based friendship selection was 22% for males and 18% for females. The mean proportion attributed to influence of friendship networks was 15% for males and 21% for females. Trend effects (previous state of friendships and smoking behaviour) accounted for 42% in male and female adolescents, and other determinants of friendship and smoking played only a small role in the explanation of smoking behaviour similarity.

DISCUSSION

The main goal of this study was to examine differences between adolescent male and female friendship networks regarding smoking-based selection and influence processes using newly developed tools of social network analysis.
We found evidence that males and females formed friendships based on similarities in smoking behaviour. This process was similar for adolescent males and females. These results are in line with our hypothesis and earlier research reporting peer selection to be important in explaining similarities between adolescent friends with respect to smoking [11,13–17]. However, no study examined smoking-based selection processes specifically in gender-segregated friendship networks.

We found empirical support for influence of friends with respect to smoking behaviour within female networks. This effect was not significant among males. Although our findings seem in line with previous studies, suggesting that girls perceive more social pressure [25] and are more susceptible to social influences [26], the difference between males and females was not significant and parameter estimates were such that a relatively large amount of the smoking behaviour similarity among male friends was explained by influence (Fig. 1). The lack of strong support for influence processes within male networks might be explained by males fostering friendship intimacy through sharing activities with friends [51], which takes place mainly outside school. Out-of-school friends may exert a stronger influence compared to within-school friends. Further research with a larger database is needed to give more unequivocal results about male–female differences in this respect, and to study dependencies of these differences on school context.

There was no evidence that reciprocation of friendship modified the effect of smoking similarity on friendship choice. In contrast with previous studies reporting stronger support for influence processes among reciprocal friends [52,53], the strength of influence processes did not differ significantly between reciprocal and non-reciprocal friendships in the present study. However, researchers found support for influence among reciprocal [12,52,53] and non-reciprocal friends [10,54] among different populations. More research is needed to clarify the specific role of friendship reciprocity.

Besides smoking-based selection, we controlled for several alternative processes explaining peer selection. Only transitivity differed significantly between males and females, indicating that females showed a higher tendency to select friends who were friends of their friends. Males and females were similar in their tendency to select arbitrary friends and reciprocate friendships. Furthermore, females preferred to select females who reported medium scores on alcohol consumption. In contrast with findings of previous studies [27], no support was found for selection based upon similar alcohol consumption. However, as findings on the complete Finnish sample showed support for adolescents selecting their friends based on similar alcohol consumption [50], lack of support may be caused by the reduced sample size due to restricting the networks to solely males or females. In line with earlier studies arguing that boys’ culture is less study-orientated [55], and school achievement is not considered to be ‘cool’ among boys [56,57], males preferred to select males scoring low on school achievement.

Regarding alternative influence mechanisms, no significant gender differences were found. Females smoked more when they scored low on school achievement. In line with previous studies, males and females were influenced by parental smoking [17,25,29]. Although previous research has demonstrated that tobacco use predicts subsequent alcohol use more effectively than the converse [58], the negative effects of alcohol consumption on smoking were counterintuitive. Complete-sample in-depth analyses confirmed the significant negative effect during the first wave, but this effect lost significance during the second wave and became positive, although not significant, during the last wave. Alcohol is very expensive in Finland. Lack of sufficient resources at a very young age may have forced youngsters’ to choose between smoking or alcohol.

The following limitations of this study can be reported. First, self-reported smoking behaviour was not validated biochemically. However, self-reported smoking can correspond well with biological indicators under measurement conditions assuring anonymity [59]. The ESF A project optimized measurement conditions by guaranteeing confidentiality [32]. Secondly, data were gathered from the Helsinki area only. Further research should illuminate differences between urban and rural areas. Thirdly, we included only friendships within the same school grade. Although these friends represent an important part of adolescents’ social environment, future studies should include out-of-school friendships. Fourthly, previous research has demonstrated that parents can also have an effect on the types of friends that adolescents select [60]. The role of parenting styles and practices in smoking-based selection processes should also be studied using actor-based modelling techniques. Fifthly, several included constructs were measured with one item. Future studies should include variables based on multiple questions to increase reliability and validity. Sixthly, although adolescents can report parental smoking reliably [61] our results might be biased, as no direct measures of parental and sibling smoking were available. Finally, we did not consider possible differences between the successive data waves. However, a previous study on the same data set indicated no differences in smoking-based selection and influence effects between the three waves [50].

This study has several practical implications. First, both male and female adolescents selected friends based upon similar smoking behaviour, implying that prevention programmes for adolescent males as well as females
should focus upon selection processes. Previous studies have already demonstrated the importance of peer networks besides the focus on social influences [62,63]. Although more research is needed on the relation between attitudes and selection processes, reinforcing non-smoking attitudes among males and females might be a way to increase the likelihood that they select non-smoking peers. Secondly, only females were influenced significantly by their friends to take up smoking and should therefore benefit from learning skills to resist influence of friends. Although support for influence of friends among males was weak, the effects between males and females did not differ significantly and we therefore cannot conclude that prevention programmes will benefit from targeting adolescent males and females in a different way. Thirdly, as both males and females were influenced by parental smoking, the nature of this link should be investigated in more detail to learn how parents should be involved in youth smoking prevention programmes.

Declarations of interest

None.

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