# The smoking chain: friendship networks, education, social background and adolescent smoking behavior in the Netherlands

Huisman, C.

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# 5

# The social network, socioeconomic background, and school type of adolescent smokers[1]

## 5.1 Introduction and Research Problem

As described in the Chapter One, smoking is a well-documented health hazard, that is distributed unequally across different socioeconomic status groups (WHO, 2008). Although the causes of this inequality are partly unknown (Mackenbach, 1994), we do know that a negative relation between socioeconomic status and smoking is widely occurring (Pampel, 2002, 2005, 2006; Pampel & Rogers, 2004). Furthermore, it is well known that most smokers (80 – 90 percent) start their habit before the age of 18 (Cotterell, 2007; Gielkens-Sijstermans, et al., 2010). For this reason, adolescents are the prime target of smoking onset studies. These studies show that adolescent smoking is related to various factors (Cotterell, 2007; Voelkl & Frone, 2000), encompassing the family situation of parents and siblings (Avenevoli & Merikangas, 2003; Engels, 1998), socioeconomic background (De Vries, 1995; Lowry, et al., 1996; Van Lenthe, et al., 2001), peers and friends (Aloise-Young, et al., 1994; Ennett & Bauman, 1993, 1994), as well as the school environment (Ellickson, Bird, Orlando, Klein, & McCaffrey, 2003; Kumar, O'Malley, Johnston, Schulenberg, & Bachman, 2002). The findings of Chapter Four connect to this literature. Recently, researchers in the field of ado-

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lescent smoking behavior have argued that not just those individual factors but in particular their interrelationship needs to be accounted for when examining the development of smoking habits (Ennett, et al., 2010; Wen, et al., 2009). In this line of inquiry, the contribution of our chapter is its focus on the interrelatedness of parents, friends, and school in explaining health inequalities across different socioeconomic status groups. Furthermore, as many current smoking prevention programs only yield short-term results (at least in the Netherlands, see Crone et al., 2003), the practical relevance of this study lies providing a better understanding of smoking behavior as a stepping stone to develop more effective prevention programs. The research question of this chapter takes the key factors pointed out in the literature into account and reads: *What is the role of secondary school peer networks in mediating the socioeconomic background effect and the school type effect on adolescent smoking behavior?* We address this question in a study of second grade students (similar to grade 8 in the United States) in five secondary schools in the Netherlands. We do this by using longitudinal network data and SIENA modeling, which is especially developed for the examination of the type of question raised in this study. Recent studies on smoking behavior under the same age group, using SIENA modeling, have yielded valuable new insights on adolescent smoking (Mercken, Snijders, Steglich, & de Vries, 2009; Mercken, Snijders, et al., 2010a, 2010b; Mercken, Snijders, Steglich, & Vries, 2009). The novelty of this study is to add to these insights by looking at the interrelation with socioeconomic background and school type. We first discuss in more detail the relevance of socioeconomic background, school type, and friendship networks for adolescent smoking each in turn.

## 5.2 Theory and Hypothesis

The effect of the socioeconomic status of the parents on adolescent smoking varies between countries (Richter & Leppin, 2007), and in some countries there is no, or only a weak, association. Yet, a study done by De Vries (1995) shows that Dutch adolescents from low socioeconomic backgrounds smoke more than adolescents from high socioeconomic backgrounds, which is confirmed by the findings of the previous chapter. A possible mechanism that explains this relation is that children with a low socioeconomic background are more likely to grow up in a family environment where smoking is more prevalent and therefore more easily pick up smoking habits (De Vries, 1995).

According to data of the Dutch National School Survey on Substance Use 2007 (DNSSSU), there is considerable variation in smoking behavior among secondary school students across different school types. As Table 1 shows, the lifetime, last month, and daily prevalence of smoking behavior is the highest in the lowest school types. According to Elstad (2010), school type placement affects adolescents' self-perception and sense of self-esteem, which in turn affects their behavior towards health compromising behaviors such as smoking. The categorizing and labeling that comes with the assessment of school achievement and the placing in school types makes students aware of their future position in the socioeconomic hierarchy: "A higher inclination to engage in health-compromising behaviors among low-achieving adolescents may arise from more need for stress-alleviating behaviors, less interest in the future because of unpromising social prospects, adaptation to the lifestyles of future socioeconomic milieus, attempts to compensate lack of recognition in school by excelling in alternative social fields, and deliberate opposition to social authorities because of the experience of being rejected by them" (Elstad, 2010, p. 146).

In the past, much health research was done on the basis of attribute data only, such as socioeconomic status, age, and gender, while social interactions and relations were mostly left out. However, "individual actions typically are oriented towards others, and therefore relations to others are central when it comes to explaining why individuals do what they do" (Hedström & Bearman, 2009, p. 9). "(…) If we believe that actors, their properties, actions, and relations to one another are what explain social change, we should formulate our explanations in such terms and not in terms of various social abstractions and their relations to one another" (Hedström & Bearman, 2009, pp. 5-6). In this study, we take into account both individual attributes and social relations. A social tie between two people "summarizes" their dyadic interaction pattern over some period of time, in our case friendship at school, whereas a collection of people and their ties makes up a social network, in our case of second graders and their friendships at a school. When smokers are found to be socially linked (i.e. connected by friendship ties in the network), an important question is to what extent their smoking is due to social influence, and to what extent they are linked as a consequence of homophily (also called assortative selection). Homophily has been found for many different traits, such as ethnicity, gender, age, religion, education, occupation, social class, and delinquency (Cotterell, 2007; Snijders & Baerveldt, 2003; Valente, Gallaher, & Mouttapa, 2004), and is oftentimes shaped by, or enhanced through, shared social foci (Feld, 1981)

such as school class (Kossinets & Watts, 2009).

While "birds of same feather flock together," people can also be similar because they influence rather than select each other. For example, delinquents prefer to hang out with other delinquents, but they also imitate their friends' behavior, and are thereby influenced by those friends (Sutherland & Cressey, 1974). The discussion about selection versus influence has sparked various social network studies on friendship formation and smoking behavior. The findings of these studies indicate that both selection and influence are at play (Mercken, Snijders, Steglich, & de Vries, 2009; Mercken, Snijders, et al., 2010a, 2010b; Mercken, Snijders, Steglich, & Vries, 2009).

From the nineteen fifties, American studies repeatedly show that adolescents with lower educated parents smoke more, and that adolescents who smoke more have lower educational achievements (see Waldron and Lye 1990 for an overview). Some of these studies suggest that school tracking mediates social background effects (Waldron & Lye, 1990). The previous chapter shows that in the Netherlands, secondary schools also play a mediating role in the intergenerational transmission of this health inequality, as children with lower socioeconomic backgrounds are more likely to end up in the lower school types, and are more likely to smoke.

Table 5.1 *Percentages of smoking prevalence among Dutch secondary school students, age 12-16 Source: DNSSSU 2007*

| | Life time | Last month | Daily |
|---|---|---|---|
| **Preparatory vocational education (VMBO-b)** | 45.5 | 23.4 | 11.1 |
| **Preparatory vocational education (VMBO-t)** | 38.8 | 18.1 | 7.4 |
| **Intermediate general education (HAVO)** | 34.2 | 15.1 | 5.1 |
| **Academic preparatory secondary education (VWO)** | 28.2 | 11.3 | 1.7 |

Our question is, however, how friendship networks in turn mediate this relationship. As the educational level of parents affects school type placement (Brunello & Checchi, 2007; Lucas, 2001), and secondary schools are important social foci for friendship formation (Ennett & Bauman, 1994), school type affects the options for friendship formation. But perhaps the immediate cause of smoking behavior is social influence through friendship networks. Thus, in contrast with Elstad's argument

that school type placement has a direct effect on health related behavior such as smoking, we conjecture that: Even after controlling for friendship selection, the effect of parental education that runs via school type is strongly reduced by the influence of friends on smoking behavior.

## 5.3 Methods

### *5.3.1 Operationalisations*

The data collected consist of a network-and-behavior panel of 961 second grade Dutch secondary school students at five different schools, of which four in an urban area and one in a rural area, with nominal age of 13 at the beginning of the school year. According to research on the general Dutch student population, this is the school year in which most smoking onset is taking place (Monshouwer, et al., 2004; Monshouwer, et al., 2008). The data were collected at two time points, (Wave One) at the beginning of school year of 2008-09, and (Wave Two) six months later, halfway the school year.

The data were collected by means of a questionnaire. The students were assured that their responses were treated with confidentiality and could not be traced back to them. They were also told that they could refuse to participate. Only two students refused. As Table 2.2 shows, at Wave One (the first observation), 8.8 percent of the students was absent, which was slightly higher at Wave Two, 11 percent. Section 2.2.2 and Chapter Three give a detailed description of the LDNA data.

#### *Main variables*

Knowing that students in this age group mostly befriend students in the same grade (Shrum, Cheek, & Hunter, 1988), we asked them "Who are your friends in the second grade in this school?" to measure *friendship*. They could then list up to fifteen nominations. Table 5.2 shows the average *outdegree* (number of friends listed), SD for outdegree, and minimum and maximum for all five schools. These data were used to assess the network of second graders, within and across their classes at each school.

Table 5.2 *Descriptive statistics friendship nomination*

| | Wave One | | | | Wave Two | | | |
|---|---|---|---|---|---|---|---|---|
| | Average outdegree | SD average outdegree | Min | Max | Average outdegree | SD average outdegree | Min | Max |
| **School 1** | 7.910 | 4.620 | 0 | 15 | 8.186 | 4.577 | 0 | 15 |
| **School 2** | 8.225 | 4.660 | 0 | 15 | 7.662 | 4.678 | 0 | 15 |
| **School 3** | 4.279 | 3.457 | 0 | 14 | 4.856 | 4.241 | 0 | 15 |
| **School 4** | 7.469 | 4.466 | 0 | 15 | 7.193 | 4.261 | 0 | 15 |
| **School 5** | 8.159 | 4.818 | 0 | 15 | 7.444 | 4.386 | 0 | 15 |
| **Total*** | 7.521 | | | | 7.279 | | | |

*** Weighted**

The *smoking behavior* variable is a frequency-quantity interaction measure constructed from two items on smoking behavior. The first item, on frequency, contains five alternatives: never smoked; smoked once or twice; intermittent (non-daily) smoker; I used to smoke, but now I stopped; daily smoker. We recoded this item, by merging the categories "intermittent (non-daily) smoker" and "I used to smoke, but now I stopped" into one category, resulting in a four item ordinal variable for the frequency of smoking. The second item measures quantity by asking: on a day that you smoke, how many (self-rolled) cigarettes do you smoke? We recoded this variable into four categories: I never smoke; less than one cigarette; one to twenty cigarettes; twenty or more. We use this cut off point at twenty cigarettes because it is in accordance with the definition of heavy smoking used by the Dutch National Institute on Health and Environment (RIVM) and Statistics Netherlands (CBS). At both waves, these two items have a high correlation, 0.85 and 0.86, respectively. By multiplying these two items, the frequency-quantity interaction measure was constructed.

For *parental educational level*, the educational level of both the mother and the father were asked. We took the highest score among both parents, which could be one of four categories. As Table 5.3 on the frequencies of parental educational level shows, 26.6 percent of the students did not know their parents' educational level. For that reason, this variable was recoded into five dummies, one for unknown parental educational level, and tertiary education as the reference category.

Table 5.3 *Parental educational level, highest of the two parents*

| | N | % |
|---|---|---|
| **Lower secondary or lower education** | 157 | 16.3 |
| **Upper secondary general education** | 177 | 18.4 |
| **Upper secondary vocational education** | 65 | 6.8 |
| **Tertiary education** | 200 | 20.8 |
| **Unknown** | 256 | 26.6 |
| **Missing** | 106 | 11.0 |
| **Total** | 961 | 100.0 |

For school type, one dummy variable for preparatory vocational education (VMBO) and one dummy variable for intermediate general education (HAVO) are used. Academic preparatory education (VWO) is the reference category; see Table 5.4.

Table 5.4 *School Type*

| | N | % |
|---|---|---|
| **Preparatory vocational education (VMBO)** | 594 | 61.8 |
| **Intermediate general education (HAVO)** | 146 | 15.2 |
| **University preparatory secondary education (VWO)** | 221 | 23 |
| **Total** | 961 | 100 |

*The percentage of smokers among ego's friends* (where *ego* is a focal individual) is computed for the random intercept models indicating the percentage of daily smoking prevalence among friends with reciprocal ties. The *smoking similarity effect* in SIENA indicates the tendency to select friends with the same behavior or attribute characteristics. Lastly, in the selection part, *ego* and *alter parameters* are used, in our case for smoking. For *ego* (a focal individual) to establish a tie with *alter* (some other person), the ego parameter can be interpreted as the main effect of a particular behavioral trait, or as an individual attribute of ego. The alter parameter, then, is the main effect of a particular behavioral trait or individual attribute of a potential alter (for technical details, see Ripley & Snijders, 2010). The *average alter effect* expresses that students whose

alters have a higher value for smoking on average, also have themselves a stronger tendency towards higher values for smoking. Furthermore, there are parameters for *direct individual covariates effects* on behavioral change, which, for example, indicate if gender or school type influences changes in smoking behavior between the two waves.

Remainder variables, such as age and gender (male=1, female=2), do not need to be explained.

For *missing network data*, various treatments have been tested in simulations (M. Huisman & Steglich, 2008), among others naïve and "clever" (i.e. model based) imputations. Their study points out that when there are less than about 20 percent missing data, they can be left out without serious consequences for the estimated effects. When SIENA deals with them, standard errors are not underestimated. In our case we miss 8.8 percent of the students at Wave One and 11 percent at Wave Two, so we are well below the 20 percent threshold.

Table 5.5 gives an overview of the descriptive statistics.

Table 5.5 *Descriptive Statistics Attribute Variables*

| | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Smoking behavior at Wave 1** | 711 | 0.622 | 1.504 | 0 | 9 |
| **Smoking behavior at Wave 2** | 711 | 1.041 | 1.967 | 0 | 9 |
| **Preparatory vocational education** | 711 | 0.579 | 0.494 | 0 | 1 |
| **General intermediate education** | 711 | 0.162 | 0.368 | 0 | 1 |
| **Preparatory academic education** | 711 | 0.259 | 0.438 | 0 | 1 |
| **Percentage of friends who smoke at Wave 2** | 711 | 8.293 | 18.175 | 0 | 100 |
| **Age** | 711 | 13.457 | 0.610 | 11 | 16 |
| **Gender (1=male, 2=female)** | 711 | 1.511 | 0.500 | 1 | 2 |
| **Parental educational level unknown** | 711 | 0.280 | 0.449 | 0 | 1 |
| **Lower secondary education** | 711 | 0.190 | 0.392 | 0 | 1 |
| **Upper secondary vocational education** | 711 | 0.214 | 0.410 | 0 | 1 |
| **Upper secondary general education** | 711 | 0.068 | 0.251 | 0 | 1 |
| **Tertiary secondary education** | 711 | 0.249 | 0.433 | 0 | 1 |

### *5.3.2 Analytic Strategy*

First, we test the hypothesis without network effects by estimating the effects of gender, age, parental education, school type, and smoking behavior of friends on ego's smoking behavior, based on the data col-

lected at Wave two using random intercept modeling. Random intercept models take account of the nested structure of the data (students nested within classes).This approach is straightforward and well-known. However, random intercept modeling is centered on ego networks and can't take into account indirect network effects such as transitivity, assortative selection, "properties of non-chosen potential partners"(Steglich, et al., 2010, p. 339), and it can't deal with unobserved changes due to incomplete observations (Steglich, et al., 2010) . Therefore, we need a different approach, for which we use SIENA modeling, which uses complete network data instead of ego-centered data.

The data of five schools were merged into one dataset using the "structural zero" method (see Ripley, et al., 2011 for details). Ideally, when doing so, one should control for between school variation using fixed effects models. However, some of the schools in the sample have only one school type, whereas others have more than one but still not all types (at one location). Therefore, modeling both school type and school location leads to severe multicollinearity. For the same reason, a meta-analysis of the outcomes of five separate SIENA models, one for each school, would not make it possible to investigate the effect of variation in school type on smoking behavior. For this reason, we choose not to control for school location.

Our two-wave panel makes possible the employment of a longitudinal approach. In our case, (smoking) behavior and network ties change interdependently, and someone's decision, e.g. to establish a tie, may lead to a decision by somebody else, e.g. to reciprocate the tie or to start smoking. To take this complex interdependence into account, we turn to stochastic actor-based models for network dynamics, also called SIENA (Ripley, et al., 2011; Snijders, 2001; Snijders, et al., 2010).

The network part of these models rests on the assumption that people can decide about their "outgoing" ties only, i.e. whom they choose as social contacts, not by whom they are chosen. With respect to network dynamics, we control for reciprocity and transitivity (Davis, 1970; Wasserman & Faust, 1994). Reciprocity means in this case that if ego mentions alter as a friend, then alter also mentions ego as a friend. Transitivity means that if ego and alter have a common friend, their chance to meet and establish a friendship are much higher than if they do not have a friend in common. For a more detailed discussion of SIENA modeling, see Chapter Two.

## 5.4 Results

First, we discuss the outcomes of the random intercept models (see Table 5.6). Subsequently, we discuss the outcomes of the SIENA models (Table 5.7).

### *5.4.1 Results of the Random Intercept Models*

Model one to three show a positive and significant age effect. When controlling for smoking behavior at Wave one, the age effect declines and becomes non-significant; we will return to this finding at the SIENA modeling subsection. All four models show no significant difference in the mean smoking behavior between boys and girls. Except for the negative coefficient for the parameter of parental educational level unknown (model two), model one to four show no significant effects, suggesting that in contrast to former findings, parental educational level might not have a negative effect on their children's smoking behavior. In model two, the two dummy variables for school type are added, showing a negative and significant coefficient. However, when adding the percentage of friends who smoke effect in model three, which has a positive and significant value, the effect of preparatory vocational education decreases strongly and becomes non- significant at the $p< 0.05$ significance level. The effect of general intermediate education then stays significant but decreases strongly as well. We see a similar picture in model four when controlling for smoking behavior at the first Wave. The effects of general intermediate education and preparatory vocational education both decrease but stay significant at the $p<0.10$ significance level. When controlling for both smoking behavior at the first Wave and friends' smoking behavior (model five), the effect of general intermediate education decreases even more compared to the change we saw between model two and three, and becomes non-significant. In the same model (five), the effect of friends' smoking behavior decreases, but remains positive and significant. These findings suggest that one part of the school type effect is mediated by friends' smoking behavior and one part by smoking behavior at the first Wave. Taken together, these outcomes plea against Elstad's (2010) argument that school type placement affects behavioral motivations directly, but suggest instead that network effects are key. The latter are examined in more detail now with SIENA.

Table 5.6 *Random intercept models with smoking behavior at Wave Two on parental educational level, school type, percentage of friends who smoke, and smoking at Wave One.*

| **Model** | **0** | | **1** | | **2** | |
|---|---|---|---|---|---|---|
| | **Coef.** | **Sig.** | **Coef.** | **Sig.** | **Coef.** | **Sig.** |
| Constant | **1.096** | **0.000** | **-3.894** | **0.021** | **-4.013** | **0.016** |
| Age | | | **0.349** | **0.005** | **0.322** | **0.009** |
| Gender 1=male. 2=female | | | *0.255* | *0.079* | *0.239* | *0.099* |
| ***Parents' education (highest)*** | | | | | | |
| Parental educational level unknown | | | -0.205 | 1.687 | -0.306 | 0.136 |
| Lower secondary education | | | -0.018 | 0.934 | -0.110 | 0.622 |
| Upper secondary general education | | | -0.214 | 0.315 | -0.292 | 0.172 |
| Upper secondary vocational education | | | 0.012 | 0.968 | -0.058 | 0.854 |
| Tertiary education (reference category) | | | | | | |
| ***School type*** | | | | | | |
| Preparatory vocational education | | | | | **0.759** | **0.001** |
| General intermediate education | | | | | **0.634** | **0.046** |
| Preparatory academic education (reference category) | | | | | | |
| Percentage of friends who smoke at Wave 2 | | | | | | |
| Smoking behavior at Wave 1 | | | | | | |
| | | | | | | |
| Between class variance | **0.408** | **0.012** | **0.348** | **0.024** | 0.160 | 0.203 |
| Within class between student variance | **3.537** | **0.000** | **3.495** | **0.000** | **3.540** | **0.000** |
| Log likelihood | -1480 | | -1738 | | -1470 | |
| Total variance | 3.945 | | 3.842 | | 3.700 | |
| Variance partition component | 0.103 | | 0.091 | | 0.043 | |
| Observations | 711 | | 711 | | 711 | |
| Number of groups | 44 | | 44 | | 44 | |

**P < 0.05 in bold**. *p < 0.10 in italics*

Table 5.6 continued *Random intercept models with smoking behavior at Wave Two on parental educational level, school type, percentage of friends who smoke, and smoking at Wave One.*

| **Model** | **3** | | **4** | | **5** | |
|---|---|---|---|---|---|---|
| | **Coef.** | **Sig.** | **Coef.** | **Sig.** | **Coef.** | **Sig.** |
| Constant | **-3.054** | **0.032** | -1.590 | 0.164 | -1.335 | 0.218 |
| Age | **0.245** | **0.020** | 0.133 | 0.115 | 0.110 | 0.170 |
| Gender 1=male. 2=female | 0.177 | 0.157 | 0.105 | 0.294 | 0.109 | 0.251 |
| ***Parents' education (highest)*** | | | | | | |
| Parental educational level unknown | *-0.301* | *0.089* | -0.153 | 0.278 | -0.153 | 0.254 |
| Lower secondary education | -0.021 | 0.914 | -0.056 | 0.716 | 0.000 | 0.990 |
| Upper secondary general education | *-0.327* | *0.077* | -0.149 | 0.314 | -0.163 | 0.244 |
| Upper secondary vocational education | 0.017 | 0.951 | -0.080 | 0.713 | -0.022 | 0.916 |
| Tertiary education (reference category) | | | | | | |
| ***School type*** | | | | | | |
| Preparatory vocational education | *0.275* | *0.082* | **0.240** | *0.055* | 0.082 | 0.494 |
| General intermediate education | **0.442** | **0.026** | *0.276* | *0.081* | 0.229 | 0.127 |
| Preparatory academic education (reference category) | | | | | | |
| Percentage of friends who smoke at Wave 2 | **0.055** | **0.000** | | | **0.026** | **0.000** |
| Smoking behavior at Wave 1 | | | **0.944** | **0.000** | **0.810** | **0.000** |
| | | | | | | |
| Between class variance | 0.000 | 0.875 | 0.000 | 0.874 | 0.000 | 0.890 |
| Within class between student variance | **2.733** | **0.000** | **1.743** | **0.000** | **1.570** | **0.000** |
| Log likelihood | -1366 | | -1206 | | -1169 | |
| Total variance | 2.733 | | 1.743 | | 1.570 | |
| Variance partition component | 0.000 | | 0.000 | | 0.000 | |
| Observations | 711 | | 711 | | 711 | |
| Number of groups | 44 | | 44 | | 44 | |

**P < 0.05 in bold**. *p < 0.10 in italics*

### *5.4.2 Results of the SIENA Estimations*

In this study SIENA's default outputs, to assess the overall quality of the model, all meet the required criteria. The convergence of all coefficients is good in all models (<0,1). During the time in between consecutive waves, a sufficient number of network changes should have taken place, but not too many, else the network at Wave two can no longer be related to the network at Wave one. The Jaccard score indicates how similar (maximally 1) the two networks are (0 for complete dissimilarity). The value is computed by dividing the overlap of the two waves (i.e. the number of ties that are present at both waves) by the sum of the ties present at Wave one but absent at Wave two; the ties absent at Wave two but present at Wave one; and, the ties present at both. In this study, the Jaccard score is 0.42, which is well above 0.3, as it should (Snijders, et al., 2010).

Table 5.7 displays the parameter values for the friendship selection part of the SIENA model. The dependent variable of this part is network change, i.e. friendship selection. As usual in network studies, outdegree is negative and significant, and reciprocity and transitivity are positive and significant. The effect of gender similarity is positive and significant, which shows, in line with former studies, that also gender assortment influences friendship selection. The positive and significant smoking ego effect shows that smoking increases the likelihood to nominate other students as friends. The positive and significant smoking alter effect indicates that students who smoke are more likely to be nominated as a friend by other students. The smoking similarity effect is positive and significant, which strongly suggest that assortative selection on smoking behavior governs friendship formation.

The second part of Table 5.7, displaying the parameter values for the behavioral influence part of the SIENA model, shows that the gender effect on smoking is non-significant. This is in line with the findings in the OLS models that there is no difference in smoking behavior between boys and girls. The age effect is also non-significant.. The dummy variables for parental educational level are non-significant. Furthermore, the parameters for preparatory vocational education and intermediate general education are also non-significant, implying that on top of social influence by friends, and controlling for friendship selection, there is no effect of school type. Indeed, the average smoking behavior of friends effect is positive and significant. Taken together, these results suggest that there is support for our hypothesis that the school type effect is mediated by peer networks.

Table 5.7 *Results of SIENA analyses (five schools) of friendship selection, smoking behavior, Parental educational level, and school type.*

| **Model** | **1** | |
|---|---|---|
| *Selection part of the model* | **Coef.** | **Sig.** |
| Basic rate parameter friendship | **17.986** | **0.000** |
| Outdegree (density) | **-2.514** | **0.000** |
| Reciprocity | **1.763** | **0.000** |
| Transitive triplets | **0.203** | **0.000** |
| Gender similarity | **0.675** | **0.000** |
| Smoking alter | **0.422** | **0.000** |
| Smoking ego | **0.045** | **0.000** |
| Smoking similarity | **0.068** | **0.000** |
| *Influence part of the model* | | |
| Rate smoking period 1 | **3.160** | **0.000** |
| Tendency to smoke | **-0.824** | **0.000** |
| Tendency to smoke squared | **0.158** | **0.000** |
| Average smoking behavior friends | **0.206** | **0.041** |
| Gender | 0.148 | 0.131 |
| Age | 0.141 | 0.132 |
| ***Parents' education (highest)*** | | |
| Unknown | *-0.242* | *0.085* |
| Lower secondary or lower | -0.087 | 0.586 |
| Upper secondary vocational | -0.073 | 0.645 |
| Upper secondary general | -0.239 | 0.238 |
| Tertiary (reference category) | | |
| ***School type*** | | |
| Preparatory vocational education | 0.160 | 0.245 |
| Intermediate general education | *0.265* | *0.088* |
| Academic preparatory education (reference category) | | |

**P < 0.05 in bold**. *p < 0.10 in italics*

## 5.5 Conclusion and Discussion

The relevance of peer networks for adolescent smoking behavior is well established, and the same goes for socioeconomic background and school type. However, little is known about how these three factors are interrelated. This is especially regrettable for a country as the Netherlands, where there are stark differences in smoking prevalence between students across different school types, and school type plays such an important role in the intergenerational transmission of inequities. Therefore, the aim of this chapter was to investigate the role of secondary school peer networks in mediating the effects of socioeconomic

background and school type on adolescent smoking behavior. We preselected the school year in which the onset of smoking is largest, which is grade two of secondary education in the Netherlands, the country where we collected the data. First, we examined the effects of age, gender, parental education, school type, and smoking behavior of friends, on ego's smoking behavior, using the data collected at Wave Two, modeled by random intercept models. Second, we investigated the same list of effects combined with friendships dynamics of selection and influence by using SIENA. Looking at the attributes without controlling for the network dynamics in in the random intercept models, we found no significant relation between parental educational level and smoking behavior. Furthermore, we found a significant relation between school type and smoking behavior, until we controlled for the smoking behavior of friends and for smoking behavior at the first Wave, which both have a significant effect on smoking behavior at the second Wave. This preliminary result indicated that smoking behavior of friends and previous smoking behavior are relevant factors to further look into. Consistent with the random intercept models, after controlling for friendship network effects in SIENA, we found no direct effects of parental educational level and school type on smoking behavior. Finally, after controlling for assortative friendship selection, we found that friends' smoking behavior has a positive effect on the smoking behavior of focal actors.

Although the novel possibilities provided by SIENA are a welcome addition to the statistical toolkit, Burk et al, (2007) point out several limitations, of which two might have affected our study. First, SIENA does not provide a model-fit, such as R-square, making it difficult to compare outcomes with those of other statistical approaches, such as regression, in a clear-cut manner. Second, "(…) the assumption of Markov chains implies that there are no systematic influences on the network and behavioral dynamics other than the influences implied by the effects in the model specification" (Burk et al 2007, p. 403). This limitation is related to the data, wherein confounding unobserved variables may not have been taken on board as pointed out by Ali and Dwyer (2009) and Cohen-Cole and Fletcher (2008). Our data were collected on second grade networks within the school, while it is possible that adolescents also pick up smoking habits from higher graders or outside the school. In that case, we might have underestimated the social network effects. Moreover, the measurements for smoking are based on self-reported data and not on biochemical indicators such as nicotine concentration measurements in saliva. Self-reported smoking prevalence is significantly underreported by respondents (Wagenknecht, Burke,

Perkins, Haley, & Friedman, 1992). If smoking behavior is systematically higher than we have measured, our qualitative outcome would not be affected, though. Another limitation to the data is that the categories unknown and missing of the parental educational level variable added up to 37.8 percent. Of these unknown and missing values, a large part (45.9 percent) is found among the students in preparatory vocational education. This might have resulted in underestimating the effect of socioeconomic background; while we found that it was not significant, it might turn out to be significant if we would have had all data. Furthermore, our data were gathered in a rural area and in a small town. Research at schools in urban areas might yield different results, because in the Netherlands smoking is more prevalent in urban areas (POLS survey, CBS). Finally, due to the nature of the data used to address this study's research question, we cannot appropriately distinguish between school location and school type effects.

These possible shortcomings should be seen in the right perspective. A great many studies on adolescent smoking have already been conducted, which provide useful guidelines when it comes to assessing relevant variables and their measurement. Even with the listed modeling and data limitations in the back of our minds, it seems that we found reasonable support for our claim that social networks have a strong impact on smoking behavior, and that they mediate the effects of socioeconomic background and school type. Socioeconomic background does affect school type placement, as children with higher educated parents are more likely to end up in higher school types. School type placement in turn affects students' opportunities to establish social ties, but the negative effect of school type on smoking is overruled by network effects. In sum, the chance to start smoking does not depend on socioeconomic background or school type directly, but mostly on the social network.

Recently, a number of studies have been done on adolescent smoking behavior in the Netherlands and other European countries (Mercken, Snijders, Steglich, & de Vries, 2009; Mercken, et al., 2010a, 2010b; Mercken, Snijders, Steglich, & Vries, 2009), but also on alcohol use, delinquency and school attitudes (Knecht, 2007) using longitudinal network data and SIENA models. Although these studies provide valuable new insights in adolescents' behavior, they do not account for institutional factors such as school organization, which are well known to play in significant role for the variations in adolescent behaviors, such as smoking. This study aimed at filling up that gap in the literature.

Although no direct effect was found of parental education, it might still be the case that parents and parents of friends are an important fac-

tor for explaining the variation in smoking behavior between students across different school types. Possibly, students' smoking is affected by other contacts (e.g. parents) in the social network outside the school, which in turn channels social influence to other students via the school friendship network, in line with Coleman's (1988) notion of social capital. Keeping in mind the relevance of school based smoking prevention programs (Isensee & Hanewinkel, 2012), future research should be aimed at exploring this possibility. Finally, in line with Crone et al. (2003), the findings of this study underscribe that smoking prevention programs should be school based, school type based, and long-term.