Social Determinants of Adolescent Smoking Over three Generations

David Teye Doku, PhD*[a,b](daviddoku@gmail.com) Paulyn Jean Acacio-Claro, MSc[a] (claro.paulyn.j@student.uta.fi), Leena Koivusilta, PhD[c] (leena.koivusilta@utu.fi), Arja Rimpelä, PhD[a,d] (arja.rimpela@uta.fi)

[a] Tampere University, Faculty of Social Sciences, Health Sciences and PERLA (Tampere Centre for Childhood, Youth and Family Research), Tampere University, Tampere, Finland
[b]Department of Population and Health, University of Cape Coast, Cape Coast, Ghana
[c]University of Turku, Faculty of Social Sciences, Department of Social Research, Turku, Finland
[d]Tampere University Hospital, Department of Adolescent Psychiatry, Nokia, Finland

***Address correspondence to**:
David Teye Doku, PhD
Faculty of Social Sciences, School of Health Sciences
P.O. Box 100, 33014 Tampere University, Finland
Telephone: +358505099009
Email: dokudavid@gmail.com

Abstract

Aim: We study how multigenerational socioeconomic circumstances influence adolescents' smoking. Previous studies have shown that low academic achievement as well as parents' low socioeconomic circumstances are associated with adolescents' smoking, but there are few studies on grandparents' influence on their grandchildren's smoking. For the chain of three generations, we hypothesise that high socioeconomic circumstances of both parents and grandparents decrease the probability of smoking and adolescents' own education and circumstances contribute to this association. We further investigate the role of intergenerational social mobility.

Method: Survey data from 1979 to 1997 on 12-18-year-old Finns (N=54487) were linked with 1970-2009 registry-based data of their grandparents, parents and themselves. Socioeconomic circumstances among parents and grandparents were measured by socioeconomic status (SES), education and material resources and among adolescents by academic achievement, educational orientation, family structure and parental smoking. Logistic regression analysis was used to study the associations.

Results: Associations of adolescent smoking with grandparental socioeconomic circumstances were weak and mediated through parental circumstances. Parental smoking and divorce, and living in a non-intact family increased smoking. Adolescents' low academic achievement and orientation to low education level were the most important predictors of smoking. Upward intergenerational social mobility between fathers and children decreased the risk of smoking, whereas downward mobility increased it.

Conclusion: The influence of grandparents' low socioeconomic circumstances on grandchildren's smoking is mediated through parents' socioeconomic circumstances. Low academic achievement in adolescence is a strong predictor of smoking, and adolescents orient towards the group of their future education level, not that of their parents.

Keywords: Socioeconomic status; Adolescents; Smoking; Academic achievement; Intergenerational social mobility; Inequalities; Parents and grandparents

Background

Among adult populations, socioeconomic inequalities in health caused by tobacco smoking are well known; those with low education and low socioeconomic status (SES) smoke more than those with high education and high SES.[1,2] Adolescent smoking has shown a similar pattern when parents' SES or education has been used as a measure of SES.[2-5] However, the associations have usually been weak and in some studies they have not been found.[3-7] West and Sweeting[8] have presented an equalisation hypothesis to explain the lack of or a weak association of SES and health in adolescence. Peer and school influences during adolescence may create homogeneity in health behaviours. It is therefore argued that the developmental processes of adolescence and the potentially equalizing influences diminish the effects of family SES on health behaviours.

Low academic achievement during the school years, low educational orientation and low aspirations for future education are strong determinants of adolescent smoking.[3-6,9] Low academic achievement is also a strong predictor of early school dropout and unsuccessful transition to secondary education[10,11] and thus a critical factor in determining the educational level an adolescent will have in adulthood as well as his/her later life course in general.[12] Academic achievement and the selected educational path in adolescence have been used as measures of adolescents' future SES.[12-13]

Family socioeconomic circumstances, usually measured by parental indicators like education, socio-economic position or material resources, as well as parent-child interactions, affect adolescents' academic achievement and behaviours.[14,15] Very few studies have included grandparents when investigating the association between SES and child health behaviour.[16-20] Life expectancy has increased across Western countries and the proportion of children with living grandparents has increased.[21] Consequently, grandparents may now have more interaction with their grandchildren and invest more

resources in them than in the past.[22,23] Interaction between generations, e.g. how much contact the generations have and how intensively the generations are together may include transmission or reinforcement of behaviour-related traditions. For example, a recent study found a direct relationship between adolescent smoking and grandparents' smoking.[24]

An element in the interaction between generations is the transmission of material resources and socio-cultural factors.[25] It is possible that resource-based constraints will limit poorer families' investment in their children's education, which may generate a cycle of educational inequalities in each successive generation.[26] Thus, the so-called process of embodiment of social inequalities, which is said to happen within individuals,[27] might either strengthen or weaken during a chain of generations possibly sharing similar economic resources, socio-cultural circumstances and traditions. Inequalities in education have also been explained by the rational action theory.[28,29] It is argued that because of their own high status, parents with high education invest more in the education of their children as they envisage high SES for them resulting from their high adult education level. On the contrary, because of the high investment required to yield an additional status gain, parents with low education tend to invest less in the education of their children, consequently, these children end up with low adult education level.[28,29] Evidence shows that a low share of resources or experiencing a low rank compared to one's reference groups may be reflected in health behaviours.[30,31] A recent study that explored the association between an adolescent's smoking and grandparental SES found that lower levels of grandparental schooling were associated with smoking among grandchildren.[19] For a chain of three generations, we hypothesise that a high socioeconomic position, high education and better material resources of both parents and grandparents add to the probability of non-smoking among the offspring.

Aims

We studied how socioeconomic circumstances of parents and grandparents (SES, education and material resources), the adolescent's academic achievement at school, his/her educational orientation (measured as education level in adulthood) and parental smoking were associated with adolescent smoking. We further investigated, whether smoking in adolescence was associated with intergenerational social mobility, the child going upward or downward in the social hierarchy compared to his/her parents. These results will increase the understanding of the origin of socio-economic health inequalities and the role of different generations in this process.

Methods

Study design and data

The study design is presented in the supplementary figure (Figure S1). Data from the Adolescent Health and Lifestyle surveys (AHLS) were linked with census and registry data from Statistics Finland concerning the survey participants and their parents and grandparents using unique identification numbers (Table S1). The data from Statistics Finland covered censuses every fifth year from 1970 to 1995 and yearly registry data from 2000 until the end of 2009. Statistics Finland had constructed family formation data to link generations.

The AHLS were conducted in 1979, 1985, 1987, 1991, 1993, 1995 and 1997 (N=54487) using nationally representative samples of 12-, 14-, 16-, and 18-year-olds based on birthdays of those born in June, July and August in order to minimise the age range, because smoking increases rapidly in teenage. The participants were drawn from the Population Register Centre. Self-administered questionnaires were sent in February, followed by two re-inquiries to non-respondents. The data collection methods, timing of the survey, age and questions were maintained as similar as possible to ensure the comparability of the results in various study years. The average response rate across the surveys was 79.1% (N=54487): 72.2%

(N=25420) for boys and 86.3% (N=29067) for girls. The participation was voluntary and the Ethics Committees of the Department of Public Health at the University of Helsinki and the Pirkanmaa Hospital District, Finland, approved the AHLS study protocol.

Statistics Finland linked the two data sets in accordance with a contract specifying the rights and duties of the respondents and the Statistics Finland. The Institutional Review Board of Statistics Finland and the Data Protection Ombudsman approved the data linkages. The Data Protection Ombudsman is an independent public office with the responsibility of representing the public interest in matters of data protection in Finland. Identification of the study participants was withheld from the investigators at all stages of the study. The Joint Commission on Ethics of the University of Turku and the Turku University Hospital stated that no human rights were violated in the research protocol and approved it.

In the earlier censuses, children (in this study parents) who were no longer living with their parents (in this study grandparents) during the time of the census could not be linked to their families, which explains the large number of missing grandparents (Table 1). Part of the missing information is due to the late digitalisation of censuses (from 1970 onwards only).

In order to find out, if there was a selection bias between those who had a grandparent and who did not, we compared these groups. The response rate in the AHLS was slightly higher among adolescents who had no grandparents (80.2%) compared to those who had at least one (78.6%). In further analysis of adolescent smoking rates, we found that the proportion of smokers was nearly similar among those with no grandparents (25.6%) and those who had at least one (24.2%), p=0.001.

Among adolescents who did not have at least one grandparent, 17.3% had poor, 34.5% had average, 26.4% had good and 21.8% had excellent school achievement. The corresponding proportions among

those with at least one grandparent were: poor (13.4%), average (36.0%), good (29.4%) and excellent (21.3%), p<0.001. Furthermore, among adolescents who did not have any grandparent, 13.5% had low, 64.5% had middle and 22.0% had high adult education level, while among those who had at least one grandparent, the corresponding proportions were low (9.5%), middle (57.1%) and high (33.3%), p<0.001.

Outcome: adolescent smoking

Smoking was defined differently for each age group to reflect the process of smoking initiation and to have enough smokers in each age group; for12-year-olds, smokers were those who had smoked more than two cigarettes; for 14-year-olds, smokers were those had smoked more than 50 cigarettes in their lifetime; and for 16-18-year-olds smokers refers to those who smoked daily. The 659 (1.2%) missing cases of smoking were excluded from the analysis. Of the smokers, 50.1% were girls.

Parental and grandparental variables

Socioeconomic circumstances

Socioeconomic circumstances followed the classifications of Statistics Finland.[32] Because adolescent smoking was measured at the ages of 12 to 18 years, we formed variables that described their parents' and grandparents' socioeconomic circumstances nearest to the age when the adolescent was 15 years old, because yearly estimates were not available. Socioeconomic measures within five years of the child's 15th birthday were used because age 15 corresponds best to the mean age of adolescence (12-18 years). Furthermore, during five years, parents' and grandparents' socioeconomic factors change quite little. Grandparents' information was combined from paternal and maternal sides. If both grandparents

belonged to the same category of socioeconomic circumstances, this category was used. If they belonged to different categories, the higher category was selected.

Socioeconomic status (SES) was classified to upper white-collar, lower white-collar, blue-collar, agricultural entrepreneur, other (pensioners, students, those in military service) and unknown. For parents, the unknown category also included those who had died before the AHLS survey. *Education* was classified according to years of schooling: low (9 years or less), middle (10–12 years) and high education (over 12 years). *Material resources* were measured by the ownership of the dwelling classified as owner-occupied (owns a house or shares in the housing unit), rented (living in a rented apartment) or unknown (no information or the parents had died).

Unemployed persons had at least one month of unemployment or unemployment pension during the preceding 12 months. The classification was: not unemployed, unemployed, unknown, which included those who were retired or outside of workforce for any reason. Most grandparents had retired, and this variable was not used for them.

Father's and mother's smoking were reported by their children: does not smoke, stopped smoking, or smokes.

Adolescent variables

In the surveys, adolescents reported *family structure*: lives with both parents (intact family) or not (non-intact- all other family types, e.g. one parent family or living with stepparents). *Parental divorce* within

5 years before or after the survey (yes/no) and *parental death* by the time of the survey (yes/no) were extracted from the registry data.

Academic achievement from the surveys categorised as excellent, good, average, and poor, was measured differently for 12-14 and 16-18-year-olds. For 12-14-year-olds, the respondent's self-assessment of his/her school performance in the latest end-of-term school report compared with the class average was used. In Finland, compulsory education ends at age 16, after which the adolescents can continue to academic or vocational upper secondary school or end their education. Previous studies have shown that both performance and the educational track chosen in adolescence are associated with health behaviours and socioeconomic status in adulthood.[13] As 16-18-year-old adolescents had already chosen an educational track, their academic achievement was measured by the combination of academic achievement and the type of the educational track as follows: excellent (academic upper secondary school, better school performance), good (academic upper secondary school, poor or average school performance), average (vocational school), and poor (not in school).

Educational orientation was the education level that the respondents had obtained by the age of 29 years, information obtained from the Registry of Completed Education and Degrees of Statistics Finland. All survey participants had reached that age by the end of the year 2009. The education level was categorised as low, middle and high in the same way as for parents and grandparents.

Social mobility was defined using the adolescents' adult education level (high, middle, low) in relation to his/her parents' education level (high, middle, low), separately for father and mother. Stable were those who stayed on the same level as their parents, while those ending up higher were upwardly mobile and those ending up lower were downwardly mobile (see the categories in Table 5).

Statistical analysis

We used logistic regression analysis to study the associations of grandparental, parental and adolescent variables with smoking. First, we studied age- and sex-adjusted bivariate associations, separately for the adolescents, parents and grandparents. Second, we conducted multivariate analysis involving parental and grandparental socioeconomic circumstances in order to investigate whether the associations between grandparents' circumstances and adolescent smoking were mediated through parental socioeconomic circumstances. Next, multivariate models involving all adolescents', parental and grandparental variables, which were statistically significant at the bivariate analysis, were fitted to study the independent associations between smoking and adolescents', parental and grandparental variables. Further, we included two-way interactions between adolescents' education level in adulthood, and fathers' and mother's education. We found statistically significant interactions and constructed two social mobility measures to indicate the transition from fathers' and mothers' educational attainment to adolescents' education in adulthood and explored the associations with adolescent smoking. All model estimates are presented as odds ratios (OR) with 95% confidence intervals (CI). The analyses were performed using the SPSS package, version 23.

Results

Descriptive statistics

Of all adolescents, 24.8% were smokers. The distributions of the socioeconomic variables of the parents and grandparents are presented in Table 1 and those of the adolescents in Table 2.

Associations of parental and grandparental socioeconomic circumstances with adolescent smoking

All grandparental variables were statistically significantly associated with adolescent smoking in the bivariate models (Table 3). Most associations were weak. Adolescents whose grandparents were blue collar employees were more likely to smoke compared to the offspring of upper white-collar employees (OR=1.30, 95% CI=1.08-1.56, for paternal grandparents and OR=1.27, 95% CI=1.08-1.50, for maternal grandparents). Adolescents whose maternal grandparents were agricultural entrepreneurs smoked less compared to those whose maternal grandparents were white collar workers. The odds for smoking were higher when paternal grandparents had low or unknown education and maternal grandparents had middle, low or unknown education compared to those with a high education. Smoking was more prevalent among those whose grandparents did not own their dwellings. All parental socioeconomic variables were associated with adolescent smoking in the bivariate models (Table 3). The results mainly followed the same pattern as those for the grandparents. Furthermore, parents' smoking and unemployment during the previous year increased adolescents smoking. When all parental and grandparental variables were simultaneously in a multivariate model, the associations of grandparental socioeconomic variables with smoking lost their statistical significance (Table S2), suggesting that the grandparents' effects were mediated through parents' circumstances. In the final multivariate models of parents' variables, only mother's rented dwelling and parents' smoking increased smoking (OR=1.14, CI=1.06-1.23, Table 4). None of the grandparental socioeconomic variables showed a statistically significant association with adolescent smoking.

Associations of adolescents' social circumstances with smoking

In bivariate analysis, living in non-intact families and the experience of parental divorce or death were related to a higher risk of smoking (Table 2). The odds for smoking were over eight times higher for those with poor academic achievement compared to those with excellent achievement, and six times

higher for those with a low educational orientation, compared to those with a high educational orientation (Table 2).

Final models with grandparents', parents' and adolescents' social circumstances

Final multivariate models showed that adolescents' own socioeconomic variables had the strongest effect on their smoking (Table 4). Academic achievement had the strongest effect (Table 4). Adolescents who had poor academic achievement were more likely to smoke compared with those who had excellent achievement (OR=5.43, CI=4.96-5.94).

Intergenerational social mobility and adolescent smoking

We found statistically significant interactions between adolescents' educational orientation and parents' education. Intergenerational social mobility variables were used to further study these interactions. The gradients in the associations between social mobility and smoking were consistent so that the higher the upward social mobility, the lower the likelihood of smoking and the lower the downward mobility, the higher the likelihood of smoking (Table 5). The future adult education level determined the adolescent smoking rate, not their parents' education level.

We also estimated the expected proportion of adolescents within each parental educational category based on the distribution of the adolescents' adult education level in the population. Similarly, an observed proportion was estimated from adolescents' adult education level in relation to their parents' education level. It was observed that a higher than expected proportion of children whose parents had high education ended up with high education, similarly, a higher proportion of those whose parents had low education ended up with low education (Table 5).

Discussion

This study investigated the association of socioeconomic circumstances of the family, the adolescent's academic achievement at school and educational orientation, and parental smoking with adolescent smoking. We further examined, whether smoking in adolescence was associated with intergenerational social mobility between adolescents and their parents. Associations of adolescent smoking with grandparental socioeconomic circumstances were weak and disappeared when adjusting for parental socioeconomic circumstances. Parental socioeconomic circumstances also weakly predicted smoking but parental smoking, parental divorce and the adolescent living in a family where mother and father did not live together, clearly increased the smoking risk. An adolescent's academic achievement at school was the strongest predictor of smoking. The higher the achievement, the lower the likelihood of smoking. Adolescents' educational orientation measured by their future education in adulthood was also related to smoking. A higher than expected proportion of children whose parents had high education ended up with high education. Similarly, a higher proportion of those whose parents had a low education ended up with a low education. Upward social mobility decreased the risk of smoking, whereas downward mobility increased it.

Our findings suggest that parental socioeconomic circumstances mediate the associations of grandparents' socioeconomic circumstances with adolescent smoking. This may imply intergenerational socialisation, which leads to the repetition of transmission of social, emotional, behavioural and psychological processes between generations.[23,26] Regarding the associations between parental socioeconomic circumstances and adolescent smoking, our finding of weak associations is consistent with previous studies[3,4,10] and partly support the equalisation hypothesis.[8] However, we could see an indirect effect as children of highly educated parents ended up with high education more often than was

expected and thus had low smoking rates. This finding is consistent with the rational action theory, which suggests that notion of costs and benefits of higher education by social position of origin contributes to inequalities in educational attainment.[28,29] Our findings support this type of educational inheritance cycle within the family and its association with smoking during adolescence.

Additionally, we found intergenerational social mobility between adolescents' education in adulthood and within parental education. Our findings suggest that downwardly and upwardly mobile adolescents tend to adopt the risky behaviours of their destination group. These results are consistent with previous studies among adolescents in Germany[6] and Ghana,[5] as well as among young people in France.[33] We further highlight the role of upward social mobility as a potential protective factor against smoking uptake among adolescents. This finding could also be explained by West and Sweeting's equalisation hypothesis.[8] Behaviours of peers and orientation towards future education may also determine the adoption of smoking in adolescence. One novel finding in this study is that, in each destination group of education, adolescents' smoking rates were nearly the same, independently of their group of origin. This finding has important implications for the role of education in smoking prevention among adolescents.

Living in a non-intact family and parental divorce were associated with a higher likelihood of smoking among the children. Family circumstances and critical life events such as divorce have been reported to influence risky health behaviour among adolescents in previous studies.[4,34] The effects of these family circumstances on smoking have been documented to persist from childhood through adulthood.[34,35] Various mechanisms underlying these relationships have been suggested. Some studies link mental health problems with the relationship between parental divorce and risk taking behaviours, such as alcohol abuse and cigarette smoking.[35,36] Another effect of parental divorce and family structure on cognitive ability and health may operate through familial SES and smoking, so that higher familial SES

can facilitate parents to invest in their children's education, and in their social and cultural capital. These investments have returns on cognitive ability and health behaviour including smoking.[36,37] An alternative school of thought suggests that the relationship between smoking and divorce is not attributable to the divorce per se, but rather family conflict between parents and children, which may be the consequence of the family structure or the divorce, as well as its processes.[38]

We used a nationally representative data with large samples, which have high response rates, and multiple socioeconomic variables that captured a wide range of adolescents' immediate and wider socioeconomic circumstances, as well as their future orientation. Our findings therefore provide robust evidence of the effect of socioeconomic circumstances across three generations on adolescent smoking. Previous studies have used adolescents' school performance as a proxy for their future SES when measuring social mobility.[5,6,28] In this study, we used the adolescents' adult education level. Our strategy thus strengthens the measurement of intergenerational social mobility and makes an important contribution to literature. Our findings are supported by recent studies from Finland and elsewhere, which show the importance of the association of academic achievement with smoking. Our findings are an extension of previous one or two-generational studies, which found associations of adolescents' school achievement with smoking. There are some limitations. Firstly, only about half of grandparents' data on the socioeconomic circumstances were available in the database of Statistics Finland. We were unable to analyse a possible small bias, which might have resulted from intra-generational clustering of siblings because the data did not contain that information. We also found that the proportion of those who had poor educational achievement or low adult education was higher among those who did not have a grandparent compared to those who had at least one while higher proportion of adolescents who had at least one grandparent had adult education than those who did not a grandparent. However, the proportion of smokers was nearly similar among those with no grandparents and those who had at least one. Secondly, respondents who

did not have or were yet to receive their educational degrees were both categorised as having low education and hence persons who will obtain their degrees after the end of the follow-up at the age of 29 years have been misclassified as having low education. However, further analysis showed that the proportion of those who received a degree after the age of 29 was small (1.38%). Analysis of the response rates in the previous studies using these data suggests that non-respondents smoke slightly more than respondents.[39] Thirdly, the measures from the AHLS were self-reported and therefore may be subject to bias. Nonetheless, adolescents' self-reports of their smoking behaviour are known to be valid.[40] Lastly, the surveys were collected in the 1980's and 1990's. It can be questioned whether the results are generalizable to contemporary society. Our findings are supported by recent studies from Finland and elsewhere that show a strong relationship between academic achievement in school and smoking.[5,6,33,41]

Conclusions

Adolescents' own academic achievement at school and educational orientation are the most powerful predictors of smoking. The influence of grandparents' low socioeconomic circumstances on adolescents' smoking seems to mediate through parents' low socioeconomic circumstances and their smoking. Furthermore, downwardly and upwardly mobile adolescents tend to adopt the risky behaviour of their destination group. Education has the potential to equalise the effects of low family socioeconomic circumstances on adolescent smoking. Tackling differences in adolescents' academic achievement and educational orientation through investment in their education can be a key strategy for adolescent smoking prevention and can contribute to diminish socioeconomic health differences. The need to provide social and emotional support for disadvantaged families, including counselling on smoking cessation in order to promote health equality is emphasised. Research on intrafamilial transmission of socioeconomic and educational resources between the generations and their influences on the adoption of health behaviours is an important dimension in future research.

List of abbreviations
AHLS-Adolescent Health and Lifestyle Survey
CI-Confidence interval
OR-Odds ratio
SES-Socioeconomic status

Competing interests

The authors declared that they have no competing interests.

Authors' contributions

Dr. David Teye Doku contributed to the design and conceptualisation of the study, drafted the initial manuscript, and critically reviewed and revised the manuscript.

Ms. Paulyn Jean Acacio-Claro contributed to the design and conceptualisation of the study and critically reviewed and revised the manuscript.

Professors Arja Rimpelä and Leena Koivusilta, contributed to the design and conceptualisation of the study, initiated the linkage of the survey and registry data, and critically reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

Acknowledgement
The authors would like to thank Mr. Lasse Pere for providing data management support.
Funding

The study was supported by funding from the following sources:

Ministry of Social Affairs and Health, Finland; Competitive State Research Financing of the Expert

Responsibility Area of Tampere University Hospital (9S055, 9L084); and Juho Vainio Foundation.

References

1. David A, Esson K, Perucic AM, Fitzpatrick C. Tobacco use: equity and social determinants. Equity, social determinants and public health programmes. 2010;199.
2. Sandoval JL, Leão T, Cullati S, Theler JM, Joost S, Humair JP, Gaspoz JM, Guessous I. Public smoking ban and socioeconomic inequalities in smoking prevalence and cessation: a cross-sectional population-based study in Geneva, Switzerland (1995–2014). Tob Control 2018;27:663-669
3. Robert PO, Kuipers MA, Rathmann K, Moor I, Kinnunen JM, Rimpelä A, Perelman J, Federico B, Richter M, Kunst AE, Lorant V. Academic performance and adolescent smoking in 6 European cities: the role of friendship ties. Intl J Adolesc Youth 2018
2.4. Doku D, Koivusilta L, Rainio S, Rimpelä A. Socioeconomic differences in smoking among Finnish adolescents from 1977 to 2007. J Adolesc Health 2010;47, 479-487.
3.5. Doku D, Koivusilta L, Raisamo S, Rimpelä A. Do socioeconomic differences in tobacco use exist also in developing countries? A study of Ghanaian adolescents. BMC Public Health 2010;10(1):758.
4.6. Kuntz B, Lampert T. Educational differences in smoking among adolescents in Germany: what is the role of parental and adolescent education levels and intergenerational educational mobility?. Int J Environ Res Public Health 2013;10(7):3015-32.
7. Moor I, Rathmann K, Lenzi M, Pförtner TK, Nagelhout GE, de Looze M, Bendtsen P, Willemsen M, Kannas L, Kunst AE, Richter M. Socioeconomic inequalities in adolescent smoking across 35 countries: a multilevel analysis of the role of family, school and peers. The Eur J Public Health. 2015;25(3):457-63.

5.8. West P, Sweeting H. Evidence on equalisation in health in youth from the West of Scotland. Soc Sci Med 2004;59(1):13-27.

6.9. Brook JS, Balka E, Zhang C, Pahl K, Brook DW. Adolescent academic adjustment factors and the trajectories of cigarette smoking from adolescence to the mid-30s. Int J Ment Health 2011;40(1):7-21.

7.10. Battin-Pearson S, Newcomb MD, Abbott RD, Hill KG, Catalano RF, Hawkins JD. Predictors of early high school dropout: A test of five theories. J Educ Psychol. 2000;92(3):568.

8.11. Hotulainen R, Lappalainen K, Ruoho K, Savolainen H. Pre-school Verbo-sensory Motor Status as a Predictor of Educational Life-courses and Self-perceptions of Young Adults. Intl J Disabil Dev and Educ 2010;57(3):299-314.

9.12. Koivusilta LK, West P, Antero SV, Nummi T, Rimpelä AH. From childhood socio-position to adult educational level-do health behaviours in adolescence matter? A longitudinal study. BMC Public Health 2013;13(1):711.

10.13. Lorant V, Soto VE, Alves J, Federico B, Kinnunen J, Kuipers M, Moor I, Perelman J, Richter M, Rimpelä A, Robert PO. Smoking in school-aged adolescents: design of a social network survey in six European countries. BMC Research Notes 2015;8(1):91.

11.14. Castro BO, Thomaes S, Reijntjes A. Using experimental designs to understand the development of peer relations. J Res Adolesc 2015;25(1):1-3.

12.15. Wilder S. Effects of parental involvement on academic achievement: a meta-synthesis. Educ Rev 2014;66(3):377-97.

13.16. Osler M, Andersen AM, Lund R, Holstein B. Effect of grandparent's and parent's socioeconomic position on mortality among Danish men born in 1953. Eur J Public Health 2005;15(6):647-51.

14.17. Osler M, Andersen AM, Batty GD, Holstein B. Relation between early life socioeconomic position and all-cause mortality in two generations. A longitudinal study of Danish men born in 1953 and their parents. J Epidemiol Community Health 2005;59(1):38-41.

15.18. Chaparro MP, Koupil I. The impact of parental educational trajectories on their adult offspring's overweight/obesity status: A study of three generations of Swedish men and women. Soc Sci Med 2014;120:199-207.

16.19. Lê-Scherban F, Roux AV, Li Y, Morgenstern H. Associations of grandparental schooling with adult grandchildren's health status, smoking, and obesity. Am J Epidemiol 2014;180(5):469-81.

17.20. Huang JY, Gavin AR, Richardson TS, Rowhani-Rahbar A, Siscovick DS, Enquobahrie DA. Are early-life socioeconomic conditions directly related to birth outcomes? Grandmaternal education, grandchild birth weight, and associated bias analyses. Am J Epidemiol 2015;182(7):568-78.

18.21. Organisation for Economic Co-operation and Development (OECD). Society at a Glance 2014: OECD Soc Indic DOI: 10.1787/19991290. Available online: http://dx.doi.org/10.1787/soc_glance-2014-en

19.22. Coall DA, Hertwig R. Grandparental investment: Past, present, and future. Behav Brain Sci 2010 ;33(01):1-9.

20.23. Mare RD. A multigenerational view of inequality. Demography 2011;48(1):1-23.

21.24. El-Amin SE, Kinnunen JM, Ollila H, Helminen M, Alves J, Lindfors P, Rimpelä AH. Transmission of Smoking across Three Generations in Finland. Intl J Environ Res Public Health 2015;13(1):74.

22.25. Airio I, Moisio P, Niemelä M. Intergenerational Transmission of Poverty in Finland in the 1990s. University of Turku; 2004.

https://www.researchgate.net/profile/Mikko_Niemelae/publication/28365089_Intergenerational_transmission_of_poverty_in_Finland_in_the_1990s/links/02e7e53564416ba4d2000000.pdf

~~23.~~26. Mackenbach JP. Persistence of social inequalities in modern welfare states: Explanation of a paradox. Scand J Public Health.2017;45(2):113-20.

~~24.~~27. Krieger N. Embodiment: a conceptual glossary for epidemiology. J Epidemiol Community Health 2005;59:350-5.

28. Breen R, Jonsson JO. Inequality of opportunity in comparative perspective: Recent research on educational attainment and social mobility. Annu Rev Sociol 2005;31:223-43.

29. Thompson R. Explaining inequality? Rational action theories of educational decision making. In Mountford-Zimdars A, Harrison N, (eds). *Access to higher education: Theoretical perspectives and contemporary challenges*. London: Routledge 2017; 67–84.

~~25.~~30. Rostila M. Social capital and health inequality in European welfare states. Springer; 2013 Feb 4. https://books.google.fi/books?hl=en&lr=&id=x-EwGcEsbwsC&oi=fnd&pg=PP1&dq=Social+capital+and+health+inequality+in+European+welfare+states&ots=4N_hcNX85M&sig=On9p4UEeC0hotGanI7sdTCWV8t0&redir_esc=y#v=onepage&q=Social%20capital%20and%20health%20inequality%20in%20European%20welfare%20states&f=false

~~26.~~31. Mmari K, Marshall B, Lantos H, Blum RW. Who adolescents trust may influence their health: findings from Baltimore. J Urban Health 2016;93(3), 468-78.

~~27.~~32. Statistics Finland 2016 http://www.stat.fi/til/vkour/kas_en.html (Accessed 19.11.2018)

~~28.~~33. Bowes L, Chollet A, Fombonne E, Galéra C, Melchior M. Lifecourse SEP and tobacco and cannabis use. Eur J Public Health. 2013;23(2):322-7.

29.34. Zeratsion H, Bjertness CB, Lien L, Haavet OR, Dalsklev M, Halvorsen JA, Bjertness E, Claussen B. Does parental divorce increase risk behaviors among 15/16 and 18/19 year-old Adolescents? A study from Oslo, Norway. Clin Pract Epidemiol Ment Health 2014;10:29.

30.35. Huurre T, Lintonen T, Kaprio J, Pelkonen M, Marttunen M, Aro H. Adolescent risk factors for excessive alcohol use at age 32 years: a 16-year prospective follow-up study. Soc Psychiatry Psychiatr Epidemiol 2010;1:125-34.

31.36. Thomas JR, Högnäs RS. The effect of parental divorce on the health of adult children. Longit Life Course stud 2015;6(3):279.

32.37. Conti G, Heckman JJ. Understanding the early origins of the education-health gradient: a framework that can also be applied to analyze gene-environment interactions. Perspect Psychol Sci 2010;5:585-605.

33.38. Kristjansson AL, Sigfusdottir ID, Allegrante JP, Helgason AR. Parental divorce and adolescent cigarette smoking and alcohol use: assessing the importance of family conflict. Acta Paediatr 2009;98(3):537-42.

34.39. Rimpelä A, Rainio S, Pere L, Lintonen T, Rimpelä M. Use of tobacco products, alcohol use. Reports of the Ministry of Social Affairs and Health. 2006:29.

35.40. Post A, Gilljam H, Rosendahl I, Meurling L, Bremberg S, Galanti MR. Validity of self-reports in a cohort of Swedish adolescent smokers and smokeless tobacco (snus) users. Tob Control. 2005;14(2):114-7.

36.41. Kinnunen JM, Lindfors P, Rimpelä A, Salmela-Aro K, Rathmann K, Perelman J, et al. Academic well-being and smoking among 14- to 17-year-old schoolchildren in six European cities. J Adolesc 2016;50:56-64. dx.doi.org/10.1016/j.adolescence.2016.04.007

Figure Legends

Figure S1. Study design showing the determinants of adolescent smoking across three generations