

0 stood for having no socioeconomic adversities (living with both parents, no parental unemployment and at least one parent with higher than basic education) and a score of 4 stood for having all socioeconomic adversities (not living with both parents, both parents unemployed, both parents with basic education only). The prevalences of socioeconomic adversities are presented elsewhere [29].

Statistical analysis

All statistical analyses were conducted using SPSS software (version 24). Bivariate associations were studied using binomial logistic regression results shown as odds ratios with 95% confidence intervals. Frequent smoking and lifelong nonsmoking were entered as dependent variables. In the first model, categorical time periods (2000–2001, 2002–2003, 2004–2005, 2006–2007, 2008–2009, 2010–2011, 2012–2013, 2014–2015) were entered as independent factors using the time period 2000–2001 as a reference category. In the second model, family structure (living with both parents/other), parental unemployment during the past year (neither/one parent/both parents) and parental education (both parents basic education only/other) were entered as independent factors one at a time. In the third model, the file was split according to categorical time periods and cumulative socioeconomic adversity was entered as an independent factor.

Results

The overall prevalence of frequent smoking was 22% among boys and 20% among girls. 54% of boys and 56% of girls had never tried smoking. (Table 1) At the overall level, the ORs for frequent smoking decreased among both sexes over the study period, whereas the ORs for lifelong nonsmoking increased among both sexes over time (Table 2).

Socioeconomic differences were observed both in frequent smoking and lifelong nonsmoking (Table 3). Frequent smoking was more common among boys and girls not living with both parents than among those living with both parents. Frequent smoking was more common among boys and girls both of whose parents had only basic education than among those who had at least one parent with higher than basic education. Frequent smoking was also more common among both sexes the more parental unemployment there had been in the family during the past year. Opposite associations were observed in lifelong nonsmoking.

The prevalences of smoking according to cumulative socioeconomic adversity are presented in Table 4. The prevalence of frequent smoking decreased among boys and girls with the least socioeconomic adversities over the study period, whereas no decrease was observed among adolescents with most socioeconomic adversities. Similarly, the prevalence of lifelong nonsmoking increased among adolescents with least socioeconomic adversities, whereas they varied only slightly among those with most socioeconomic adversities (Tables 4 and 5). The relative differences according to cumulative socioeconomic adversity are presented in Table 5. The ORs in frequent smoking between adolescents not living with both parents, with both parents unemployed, and with parents having basic education only, and adolescents living with both parents, with no parental unemployment, and at least one parent with higher than basic education increased among both sexes over the study period. The ORs in lifelong nonsmoking according to cumulative socioeconomic adversity varied only slightly over time.

Discussion

In this study both frequent smoking and lifelong nonsmoking were associated with socioeconomic adversities among 14–16-year-old adolescents in Finland. The prevalence of frequent smoking was greater among adolescents with any of the socioeconomic adversities studied than among those with no socioeconomic adversities. Conversely, the prevalence of lifelong nonsmoking was lower among adolescents with any of the socioeconomic adversities studied than among those with no socioeconomic adversities. Frequent smoking was positively associated and lifelong nonsmoking negatively associated with the number of socioeconomic adversities. Most importantly, although the overall prevalences of frequent smoking decreased and lifelong nonsmoking increased, no similar changes were observed among adolescents with most socioeconomic adversities. The relative differences in frequent smoking also increased over the study period.

The association between adolescent smoking and parental education has been observed in earlier studies [7,8]. Parents with low education level are more likely to smoke [30,31], and parental smoking is a major risk factor of adolescent smoking [32]. Parents with higher education may also know more about the adverse health effects of smoking and thus disapprove more of smoking. The association between adolescent smoking and not living with both parents also corroborates earlier studies [18–20]. Children of divorced parents experience on average more stressful life events and have more mental health problems than children of non-divorced parents, which predispose adolescents to smoking [33,34]. To the best of our

knowledge, the association between adolescent smoking and parental unemployment has not been studied previously. Parental unemployment is associated with financial problems in the family and adolescent psychosocial problems, which are known risk factors of adolescent smoking [35], [36].

Most importantly, although the overall proportion of frequent smoking decreased from 2000 to 2015, no similar decrease was observed among adolescents with most socioeconomic adversities. This resulted in an increase in relative socioeconomic differences across the study years. Similarly, although the overall prevalence of lifelong nonsmoking increased, no similar increase was observed among adolescents with most socioeconomic adversities. However, relative differences in lifelong nonsmoking varied only slightly over time. Increased socioeconomic disparities in adolescent smoking have also been observed in other studies over Europe in the 21st century [9,25,27]. Smoking prevention programs have been shown to be less effective in lower socioeconomic groups [37], which may partly explain why smoking has not decreased in lower socioeconomic groups despite strong national tobacco policy. Therefore new preventive efforts targeted at adolescents with socioeconomic adversities should be considered. It is also possible that hardship in the lowest socioeconomic groups has increased over time. Societal changes, such as globalization, increases in long-term unemployment and decreases in social security benefits may have widened the gap between socioeconomic groups in the 21st century [38]. Decreasing socioeconomic health disparities is an important public health objective, as socioeconomic health disparities increase individual suffering and inflict burden on public healthcare and economy [28].

Methodological considerations

This study has several strengths: it is based on a nationwide population-based time trend study with a large sample size consisting of Finnish 8th and 9th graders ($n = 761,278$) and a high participation rate (43–82% of the whole age cohort of the country). The school sample of this age group is comprehensive as basic education is compulsory for everyone under the age of 16 in Finland. The measurement of smoking, sampling and timing of the study were held constant over the study years. This study addressed both absolute and relative socioeconomic differences, which are both important when studying changes in socioeconomic disparities over time [39].

This study has also some limitations. Self-report data is susceptible to errors, such as recall bias and mischievous responding. Especially parental education can be difficult for an adolescent to recall, which may have caused the proportion of missing responses on that question to be higher than on other questions. However, the proportions of missing responses on all questions studied were very small and thus did not affect the results. Mischievous responding is another source of error in studies relying on self-report data.

Mischievous responders are defined as 'youths who provide extreme, and potentially untruthful, responses to multiple questions' [40]. The degree of mischievous responding was not assessed in this study. However, there is no reason to assume that mischievous responding had changed over time.

Conclusion

The socioeconomic differences in adolescent smoking increased in Finland between years 2000 and 2015. Although the overall proportion of frequent smoking decreased over the study period, no similar decrease was observed among adolescents with the most socioeconomic adversities. Similarly, although the overall prevalence of lifelong nonsmoking increased, this was not observed among adolescents with most socioeconomic adversities. Socioeconomic adversities should be considered in the prevention of adolescent smoking.

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Table 1. Lifelong nonsmoking, frequent smoking and socioeconomic characteristics among Finnish boys and girls in the 8th and 9th grades of comprehensive school.

	Boys (n=381527)	Girls (n=376814)	p
Age (mean (sd))	15.4 (0.7)	15.3 (0.6)	<0.001
Lifelong nonsmoking (%)			< 0.001
yes	53.6	55.5	
no	44.8	43.4	
missing	1.7	1.1	
Frequent smoking (%)			<0.001
yes	21.7	20.0	
no	76.7	78.9	
missing	1.7	1.1	
Lives with both parents (%)			<0.001
yes	74.4	73.7	
no	23.3	25.1	
missing	2.3	1.2	
Both parents only basic education (%)			<0.001
yes	5.6	5.9	
no	86.8	87.5	
missing	7.6	6.6	
Parental unemployment past year (%)			<0.001
no	70.9	69.9	
one parent	23.6	25.6	
both parents	3.2	3.3	
missing	2.3	1.2	

Table 2. Lifelong nonsmoking and frequent smoking over time among Finnish boys and girls in the 8th and 9th grades of comprehensive school. (OR (95% CI))^a

	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015
BOYS							
Lifelong nonsmoking	1.2 (1.2–1.3)	1.6 (1.5–1.6)	1.8 (1.8–1.9)	1.8 (1.7–1.8)	1.9 (1.8–1.9)	2.0 (1.9–2.0)	3.2 (3.0–3.3)
Frequent smoking	0.8 (0.8–0.8)	0.7 (0.6–0.7)	0.6 (0.6–0.6)	0.6 (0.6–0.6)	0.6 (0.6–0.6)	0.5 (0.5–0.6)	0.4 (0.3–0.4)
GIRLS							
Lifelong nonsmoking	1.3 (1.2–1.3)	1.6 (1.5–1.6)	1.8 (1.7–1.8)	1.9 (1.8–1.9)	1.9 (1.8–1.9)	2.3 (2.3–2.4)	3.8 (3.6–3.9)
Frequent smoking	0.8 (0.8–0.9)	0.7 (0.7–0.7)	0.6 (0.5–0.6)	0.6 (0.5–0.6)	0.6 (0.5–0.6)	0.5 (0.4–0.5)	0.3 (0.3–0.3)

^a Time period 2000–2001 used as a reference category.

Table 3. Lifelong nonsmoking and frequent smoking by socioeconomic adversities among Finnish boys and girls in the 8th and 9th grades of comprehensive school. (OR (95% CI))

	Lifelong nonsmoking	Frequent smoking
BOYS		
Family structure		
both parents	ref	ref
not living with both parents	0.6 (0.6–0.6)	2.1 (2.0–2.1)
Both parents with low education		
no	ref	ref
yes	0.7 (0.7–0.7)	1.7 (1.6–1.7)
Parental unemployment		
neither parent	ref	ref
one parent	0.8 (0.8–0.8)	1.4 (1.4–1.5)
both parents	0.5 (0.5–0.5)	2.6 (2.5–2.7)
GIRLS		
Family structure		
both parents	ref	ref
not living with both parents	0.5 (0.5–0.5)	2.2 (2.1–2.2)
Both parents with low education		
no	ref	ref
yes	0.7 (0.7–0.8)	1.6 (1.5–1.6)
Parental unemployment		
neither parent	ref	ref
one parent	0.7 (0.7–0.7)	1.5 (1.5–1.6)
both parents	0.6 (0.5–0.6)	2.3 (2.2–2.4)

Table 4. Frequent smoking and lifelong nonsmoking over time by cumulative socioeconomic adversity among Finnish boys and girls in the 8th and 9th grades of comprehensive school. (% (n/N))

	2000–2001	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015
FREQUENT SMOKING BOYS								
Number of sociodemographic adversities								
0	24.3 (4924/20280)	20.7 (5546/26737)	16.5 (4683/28427)	15.1 (4611/30572)	16.2 (4767/29479)	15.6 (4120/26408)	12.9 (2900/22457)	8.6 (972/11238)
1	31.1 (3964/12728)	28.8 (4251/14775)	25.2 (3827/15212)	22.8 (3332/14605)	24.0 (3575/14917)	22.6 (3437/15241)	19.7 (2960/15016)	13.3 (1090/8195)
2	40.8 (1916/4696)	38.2 (1913/5005)	32.2 (1567/4874)	31.6 (1415/4478)	31.3 (1461/4664)	31.3 (1589/5076)	28.4 (1559/5495)	18.6 (586/3158)
3	46.5 (418/898)	43.4 (371/854)	42.7 (367/859)	42.3 (302/714)	44.3 (295/666)	42.6 (377/886)	37.8 (335/886)	27.9 (150/538)
4	67.3 (74/110)	63.8 (83/130)	58.8 (70/119)	72.7 (96/132)	74.1 (106/143)	77.3 (136/176)	63.8 (143/224)	64.5 (127/197)
FREQUENT SMOKING GIRLS								
Number of sociodemographic adversities								
0	22.2 (4287/19334)	19.3 (4807/24767)	16.3 (4373/26882)	13.2 (3895/29410)	13.5 (3871/28625)	13.1 (3341/25437)	10.0 (2189/21970)	6.3 (712/11269)
1	30.4 (3875/12767)	27.7 (4027/14563)	24.4 (3707/15168)	21.4 (3304/15445)	21.2 (3358/15846)	20.3 (3178/15644)	17.0 (2599/15316)	11.2 (958/8577)
2	39.3 (2039/5188)	37.6 (2017/5360)	34.1 (1930/5662)	30.8 (1557/5062)	29.9 (1518/5085)	29.2 (1691/5785)	24.3 (1502/6170)	17.5 (624/3556)
3	43.6 (422/968)	41.1 (395/960)	41.9 (371/885)	37.4 (280/749)	38.0 (290/764)	36.9 (398/1078)	30.1 (321/1068)	25.6 (168/656)
4	52.9 (45/85)	57.0 (53/93)	61.8 (55/89)	58.2 (57/98)	63.7 (65/102)	65.0 (106/163)	59.3 (102/172)	55.4 (51/92)
LIFELONG NONSMOKING BOYS								
Number of sociodemographic adversities								
0	45.4 (9209/20280)	51.3 (13708/26737)	57.8 (16431/28427)	60.7 (18559/30572)	60.1 (17708/29479)	62.0 (16370/26408)	64.1 (14404/22457)	74.2 (8338/11238)
1	39.7 (5052/12728)	43.8 (6465/14775)	48.8 (7423/15212)	52.2 (7617/14605)	51.8 (7730/14917)	54.0 (8237/15241)	56.3 (8457/15016)	66.9 (5479/8195)
2	32.7 (1535/4696)	35.5 (1778/5005)	41.6 (2027/4874)	43.0 (1924/4478)	44.2 (2060/4664)	45.0 (2283/5076)	48.0 (2639/5495)	60.2 (1902/3158)
3	30.1 (270/898)	30.3 (259/854)	33.4 (287/859)	32.3 (230/714)	34.5 (230/666)	34.1 (302/886)	39.6 (351/886)	50.9 (274/538)

4	20.9 (23/110)	21.5 (28/130)	19.3 (23/119)	13.6 (18/132)	11.2 (16/143)	13.6 (24/176)	21.4 (48/224)	23.4 (46/197)
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LIFELONG NONSMOKING GIRLS

Number of
sociodemographic
adversities

0	46.9 (9066/19334)	53.7 (13392/24946)	59.3 (15949/26882)	62.2 (18301/29410)	63.1 (18063/28625)	64.6 (16436/25437)	70.5 (15499/21970)	79.8 (8989/11269)
1	40.7 (5193/12767)	44.5 (6478/14563)	49.1 (7442/15168)	52.2 (8057/15445)	53.0 (8404/15846)	54.5 (8532/15644)	60.5 (9267/15316)	71.4 (6122/8577)
2	33.8 (1755/5188)	35.7 (1913/5360)	41.1 (2327/5662)	41.2 (2085/5062)	44.1 (2241/5085)	44.9 (2597/5785)	50.8 (3136/6170)	62.1 (2208/3556)
3	30.8 (298/968)	31.7 (304/960)	33.9 (300/885)	36.6 (274/749)	38.2 (292/764)	40.1 (432/1078)	45.0 (481/1068)	53.2 (349/656)
4	23.5 (20/85)	24.7 (23/93)	24.7 (22/89)	21.4 (21/98)	21.6 (22/102)	23.3 (38/163)	24.4 (42/172)	25.0 (23/92)

Table 5. Frequent smoking and lifelong nonsmoking over time by cumulative socioeconomic adversity among Finnish boys and girls in the 8th and 9th grades of comprehensive school. (OR (95 % CI))^a

	2000–2001	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015
FREQUENT SMOKING BOYS								
Number of sociodemographic adversities								
1	1.4 (1.3–1.5)	1.5 (1.5–1.6)	1.7 (1.6–1.8)	1.7 (1.6–1.8)	1.6 (1.6–1.7)	1.6 (1.5–1.7)	1.7 (1.6–1.8)	1.6 (1.5–1.8)
2	2.2 (2.0–2.3)	2.4 (2.2–2.5)	2.4 (2.3–2.6)	2.6 (2.4–2.8)	2.4 (2.2–2.5)	2.5 (2.3–2.6)	2.7 (2.5–2.9)	2.4 (2.2–2.7)
3	2.7 (2.4–3.1)	2.9 (2.5–3.4)	3.8 (3.3–4.3)	4.2 (3.6–4.8)	4.2 (3.6–4.9)	4.1 (3.6–4.7)	4.1 (3.6–4.8)	4.2 (3.5–5.2)
4	6.7 (4.4–10.0)	6.7 (4.7–9.5)	7.1 (4.9–10.3)	15.6 (10.5–23.1)	16.3 (11.0–24.2)	18.1 (12.7–25.9)	13.1 (9.9–17.5)	22.8 (16.6–31.4)
FREQUENT SMOKING GIRLS								
Number of sociodemographic adversities								
1	1.5 (1.5–1.6)	1.6 (1.5–1.7)	1.7 (1.6–1.8)	1.8 (1.7–1.9)	1.7 (1.6–1.8)	1.7 (1.6–1.8)	1.8 (1.7–2.0)	1.9 (1.7–2.1)
2	2.3 (2.1–2.4)	2.5 (2.4–2.7)	2.7 (2.5–2.8)	2.9 (2.7–3.1)	2.7 (2.5–2.9)	2.7 (2.6–2.9)	2.9 (2.7–3.1)	3.2 (2.8–3.6)
3	2.7 (2.4–3.1)	2.9 (2.6–3.4)	3.7 (3.2–4.2)	4.0 (3.4–4.6)	3.9 (3.4–4.5)	3.9 (3.4–4.4)	3.9 (3.4–4.5)	5.2 (4.3–6.2)
4	3.9 (2.5–6.0)	5.5 (3.6–8.3)	8.2 (5.3–12.6)	9.4 (6.3–14.2)	11.4 (7.6–17.1)	12.2 (8.8–16.9)	13.2 (9.7–18.0)	19.2 (12.6–29.4)
LIFELONG NONSMOKING BOYS								
Number of sociodemographic adversities								
1	0.8 (0.8–0.8)	0.7 (0.7–0.8)	0.7 (0.7–0.7)	0.7 (0.7–0.7)	0.7 (0.7–0.7)	0.7 (0.7–0.7)	0.7 (0.7–0.7)	0.7 (0.7–0.8)
2	0.6 (0.5–0.6)	0.5 (0.5–0.6)	0.5 (0.5–0.5)	0.5 (0.5–0.5)	0.5 (0.5–0.6)	0.5 (0.5–0.5)	0.5 (0.5–0.5)	0.5 (0.5–0.6)
3	0.5 (0.4–0.6)	0.4 (0.4–0.5)	0.4 (0.3–0.4)	0.3 (0.3–0.4)	0.3 (0.3–0.4)	0.3 (0.3–0.4)	0.4 (0.3–0.4)	0.4 (0.3–0.4)
4	0.3 (0.2–0.5)	0.3 (0.2–0.4)	0.2 (0.1–0.3)	0.1 (0.1–0.2)	0.1 (0.0–0.1)	0.1 (0.1–0.1)	0.2 (0.1–0.2)	0.1 (0.1–0.2)
LIFELONG NONSMOKING GIRLS								
Number of sociodemographic adversities								

1	0.8 (0.7–0.8)	0.7 (0.7–0.7)	0.7 (0.6–0.7)	0.7 (0.6–0.7)	0.7 (0.6–0.7)	0.7 (0.6–0.7)	0.6 (0.6–0.7)	0.6 (0.6–0.7)
2	0.6 (0.5–0.6)	0.5 (0.4–0.5)	0.5 (0.4–0.5)	0.4 (0.4–0.4)	0.5 (0.4–0.5)	0.4 (0.4–0.5)	0.4 (0.4–0.5)	0.4 (0.4–0.4)
3	0.5 (0.4–0.6)	0.4 (0.3–0.5)	0.3 (0.3–0.4)	0.4 (0.3–0.4)	0.4 (0.3–0.4)	0.4 (0.3–0.4)	0.3 (0.3–0.4)	0.3 (0.2–0.3)
4	0.3 (0.2–0.6)	0.3 (0.2–0.4)	0.2 (0.1–0.4)	0.2 (0.1–0.3)	0.2 (0.1–0.3)	0.2 (0.1–0.2)	0.1 (0.1–0.2)	0.1 (0.1–0.1)

^a Adolescents in the same time period living with both parents, with at least one parent with higher than basic education and both parents employed used as a reference category.