

Can population-based tobacco-control policies change smoking behaviors of adolescents from all socio-economic groups? Findings from Australia: 1987–2005

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Abstract

Objective To examine whether socio-economic status (SES) was associated with changes in smoking prevalence among Australian adolescents during three phases of tobacco-control activity between 1987 and 2005.

Methods Triennial cross-sectional national studies of representative random samples of secondary students aged 12–17 years have been conducted since 1987. Numbers range from 19,203 in 1987 to 29,853 in 1996. Self-report anonymous surveys assessed cigarette use in the past month, week (current), and on at least three of the previous seven days (committed). Students' residential postcode was collected and the Index of Relative Socio-Economic Disadvantage (IRSD) associated with each postcode determined SES quartiles.

Results Between 1987 and 2005, smoking prevalence decreased in all SES groups. Tobacco-control activity level was associated with changes in smoking prevalence and whether changes were consistent across SES groups. In a period of low tobacco-control funding (1992–1996) and activity, smoking prevalence increased among 12- to 15-year-olds, the increase being greatest among low SES students. In a period of high tobacco-control activity (1997–2005) smoking decreased and reductions were generally consistent across SES groups.

Conclusions Well-funded, population-based tobacco-control programs can be effective in reducing smoking among students from all SES groups.

Keywords Smoking · Adolescents · Trends · Socio-economic status

Introduction

Smoking is not only the single largest cause of death in developed countries [1], it also contributes to the social gradient in mortality. Between 20% and 50% of the inverse social gradient in male mortality has been attributed to smoking [2–5]. Reducing social inequalities in mortality necessitates reducing smoking, particularly among lower socio-economic (SES) groups.

Population-based tobacco-control policies and programs have been adopted in many developed countries in order to reduce smoking [6], and smoking prevalence has generally decreased in these regions [7–10]. However, there is concern that reductions in smoking prevalence are not uniform across SES groups. It has been suggested that decreases in smoking prevalence have been greater among higher SES groups, widening the SES differences in adult-smoking prevalence [11–14].

Adolescents are an important target group for tobacco-control efforts. While there is increasing evidence suggesting that the inverse SES gradient in adult smoking is due to greater smoking uptake among adolescents from lower SES groups [15–21] not all studies have found this association [22–24], or have found it for only some groups [25] or ages [26]. Differences in the findings between studies may be due to the smoking outcome studied (e.g., ever smoking or weekly smoking), the measure of SES used (e.g., parental education or an area-based measure) and the time period adolescents were growing up in (e.g., in the 1970s or 1990s). While several studies have examined population-based trends in adolescents' smoking

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prevalence [5, 27–29], few have examined whether the changes in smoking prevalence are consistent across SES groups [30].

This article describes changes in smoking prevalence among Australian adolescents in different SES groups between 1987 and 2005. This period covers three distinct phases of tobacco-control activity in Australia. During the first phase (1984–1991), state-specific tobacco-control campaigns were developed and tobacco promotion restrictions were implemented at a state level. Across Australia, funding for tobacco-control increased to a peak of \$AUD 0.90 per capita in 1989/1990. During the second phase (1992–1996), funding levels fell to a low of \$AUD 0.34 per capita in 1993, and tobacco-control activity reduced considerably [31]. In the third phase (1997–2005), a coordinated national approach to tobacco control emerged [32] and funding levels increased to \$AUD 0.54 per capita in 1998. This third phase also saw an increase in legislation to: restrict smoking in public places, further restrict tobacco promotion, and to increase the tax levied on tobacco products [32]. In this article we use data from a triennial survey of secondary students to examine trends in smoking prevalence among adolescents in different SES groups over the entire period 1987–2005 and across years reflecting the three different tobacco-control phases in Australia.

Methods

Participants

We used cross-sectional data from a triennial survey of a representative sample of Australian secondary students undertaken between 1987 and 2005. Survey methods were the same in all years [27, 33–35]. The basic sampling design was a stratified two-stage probability sample, with schools selected at the first stage and students at the second. Schools were randomly sampled from each Australian State and Territory and the three main education sectors, to ensure proportional representation. Principals of selected schools were contacted and permission to conduct the survey obtained. If a school refused, it was replaced by the school nearest to them within the same education sector, which was selected (and kept in reserve) at the same time as the main sample. Participating schools provided the roll for year levels to be surveyed and the researchers randomly selected 80 students to be surveyed. Schools provided students from either Year levels 7–10 (age range: 12–15) or Year level 11 and 12 (age range: 16–17).

In each survey year, members of the research team administered the pencil-and-paper questionnaire to students on the school premises. If a student from the sample list was absent, a student from the equivalent year level on a

list of replacements was surveyed. Students from different year levels were surveyed in mixed groups of approximately 20 and answered the questionnaire anonymously. Individual students were informed of the survey and were free to not participate by either leaving the survey session or by sitting through the session and not completing the survey. Approximately 0.1% of selected students declined to participate. The Human Research Ethics Committee of The Cancer Council Victoria approved the study.

The number of schools and students taking part in the study in each survey year is shown in Table 1. In 1987, one state jurisdiction did not participate. The school acceptance rate has decreased over time but has stayed around 65% since 1999. Variation in school participation rates did not systematically co-vary with smoking prevalence (see Table 1).

Questionnaire measures

Questions on smoking behavior have been the same since the survey commenced, and were part of a larger survey assessing use of alcohol and, since 1996, use of illicit substances. Students answering “yes” to a question assessing cigarette use in the past four weeks were defined as monthly smokers. Cigarette use in the past week (current smokers) was assessed by students indicating the number of cigarettes consumed, if any, on each of the seven days preceding the survey. Committed smokers were those who had smoked on at least three of the preceding seven days. Students also reported their age, their gender, and residential postcode.

Socio-economic status

We used the area-based Index of Relative Socio-Economic Disadvantage (IRSD) as the measure of SES [36]. The Australian Bureau of Statistics determines the IRSD from 20 direct or indirect indicators of disadvantage obtained from census data. Indicators include the proportion of: unemployed males and females, one-parent families with dependent children, people over 15 with no qualifications, households renting etc. A score reflecting the degree to which that area is disadvantaged is given to each area. High scores reflect lower levels of disadvantage. A score for each postcode area in Australia has been developed and is used in this article.

The IRSD is available for census years (1986, 1991, 1996, 2001). Students' postcodes were matched to the postcode IRSD data as follows: 1986 IRSD to the 1987 survey data, 1991 IRSD to the 1990 and 1993 data, 1996 IRSD to the 1996 and 1999 data, and 2001 IRSD to the 2002 and 2005 data. The distribution of IRSD scores was examined for each survey year and quartiles determined.

Table 1 Numbers of participating schools and students in each survey year, Year 12 retention rates and smoking prevalence found at each survey

	1987	1990	1993	1996	1999	2002	2005
Number of schools participating	270	354	334	434	399	363	376
School co-operation rate (%)	85	88	85	77	65	65	63
Number of students surveyed ^a							
12–15	13,034	17,601	15,926	21,005	18,056	16,754	14,725
16–17	6,169	7,381	6,826	8,848	7,482	6,763	7,180
Total	19,203	24,982	22,752	29,853	25,538	23,517	21,905
Year 12 retention rate ^b (%)	53	64	77	71	72	75	75
Proportion of students smoking in previous week (current smokers)							
Total ^c (%)	18	18	20	20	19	14	9

^a Based on total number of students surveyed so includes students older than 17 and younger than 12

^b Source: Australian Bureau of Statistics (2000)

^c Students aged 12–17 years only

School retention rates

In Australia, it is a legal requirement that all students remain in school until the age of 15 (roughly Year 10). School retention rates indicate the proportion of students enrolling in the first year of secondary school remaining at school until Year 12. Over the study period, Year 12 retention rates increased from 53% in 1987 to 75% in 2002 and 2005 (see Table 1). The changing retention rates means that the characteristics of the student sample in Years 11 and 12 are likely to differ systematically across survey years.

Analyses

The statistical package STATA [37] was used for data analysis to accommodate the complex sample design. Within each SES group, logistic regression analyses examined whether the proportion of students involved with the different smoking behaviors changed between 1987 and 2005. In these analyses we compared 1987–2005 data. To determine whether the magnitude of change in smoking prevalence within each SES group was significantly different, data were modeled as a function of the two survey years, SES and their interaction. These analyses were repeated utilizing data from the two survey years that defined each of the three smoking-control phases, specifically: 1987 and 1990 for phase 1, 1990–1996 for phase 2, and 1996 and 2005 for phase 3. As the survey years did not coincide with the start of the different tobacco-control phases, except for phase 1, data from the survey year before the phase commenced was used as the baseline. Logistic regression also determined the association between SES and smoking within each survey year. For

these analyses, the lowest SES group formed the reference group. In all analyses sex, age and state were controlled. Due to changing school retention rates, data for 16- and 17-year-olds (students in Years 11 and 12) are analyzed separately from data for 12- to 15-year-olds. Data are weighted to reduce the influence of under- or over-sampling of any state, education sector, age, or sex grouping.

Results

Table 2 shows the proportion of younger and older students in each SES grouping who were monthly smokers, current smokers, and committed smokers at each survey year. For both age groups and all SES groups, the prevalence of monthly, current, and committed smoking increased, or did not change, between 1987 and 1996. After 1996, prevalence declined in all groups. The odds ratios (ORs) for the likelihood of being a monthly, current or committed smoker in 2005, compared to 1987, are shown in Table 2 for each SES group. There was a significant and substantial reduction in the likelihood of smoking among all SES groups for older and younger students between 1987 and 2005 (all $p < 0.01$). However, for younger students the reductions differed by SES (interactions $p < 0.01$), with reductions in all smoking behaviors greater for students from higher SES groups. Among older students, only the reductions in committed smoking differed across SES groups (interaction $p < 0.01$), and again reductions were greater among students from higher SES groups.

Table 3 shows for older and younger students in each SES level the absolute and relative change in prevalence of the different smoking behaviors over the three tobacco-control phases. There was no significant change between 1987 and 1990 for either younger or older students.

Table 2 Proportion of monthly smokers, current smokers and committed smokers in SES^a quartiles in each survey year from 1987 to 2005 for students aged 12 to 15 years and 16 to 17 years

SES quartiles	1987 (%)	1990 (%)	1993 (%)	1996 (%)	1999 (%)	2002 (%)	2005 (%)	Absolute difference 1987–2005	OR (95% CI) 1987–2005
<i>12–15 YEAR-OLDS</i>									
Monthly smokers (smoked in past month)									
Lowest	18	17	21	23	19	14	11	–7	0.57 (0.45–0.71)
Second	19	17	21	20	20	15	10	–9	0.45 (0.37–0.56)
Third	19	19	21	20	18	14	8	–11	0.37 (0.30–0.46)
Highest	21	20	20	21	17	13	8	–13	0.33 (0.25–0.43)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.008
Current smokers (smoked in past week)									
Lowest	15	14	18	19	16	12	8	–7	0.51 (0.40–0.65)
Second	16	14	17	16	16	11	7	–9	0.43 (0.34–0.55)
Third	16	15	17	16	15	11	6	–10	0.31 (0.25–0.40)
Highest	16	17	16	16	14	10	5	–11	0.30 (0.22–0.41)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.008
Committed smokers (smoked on three days in past week)									
Lowest	10	10	11	12	10	7	5	–5	0.51 (0.39–0.67)
Second	10	9	10	11	11	7	5	–5	0.45 (0.35–0.59)
Third	10	10	11	10	10	7	3	–7	0.28 (0.21–0.38)
Highest	11	10	9	10	8	6	3	–8	0.29 (0.21–0.41)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.004
<i>16–17 YEAR-OLDS</i>									
Monthly smokers (smoked in past month)									
Lowest	28	28	30	32	33	29	21	–7	0.65 (0.51–0.84)
Second	30	30	36	33	34	27	22	–8	0.67 (0.54–0.83)
Third	35	31	34	37	37	28	23	–12	0.55 (0.44–0.68)
Highest	35	33	34	37	35	27	21	–14	0.48 (0.39–0.59)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.10
Current smokers (smoked in past week)									
Lowest	25	25	25	28	27	25	16	–9	0.57 (0.43–0.77)
Second	25	26	30	29	28	23	17	–8	0.61 (0.49–0.77)
Third	30	27	30	31	32	23	17	–13	0.49 (0.39–0.62)
Highest	30	28	28	32	30	21	15	–15	0.45 (0.36–0.56)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.17
Committed smokers (smoked on three days in past week)									
Lowest	17	19	18	22	19	20	11	–6	0.61 (0.44–0.84)
Second	18	20	20	21	21	16	12	–6	0.60 (0.45–0.79)
Third	22	19	21	23	21	14	11	–11	0.43 (0.32–0.56)
Highest	21	20	21	23	20	14	8	–13	0.34 (0.26–0.45)
Year X SES interaction <i>p</i> -value									<i>p</i> = 0.008

^a SES quartiles derived from area-based (postcode) index of relative socio-economic disadvantage where higher scores indicate lower levels of disadvantage. In table, lowest indicates low socio-economic status and highest indicates high socio-economic status

Between 1990 and 1996 the proportion of younger and older students involved with smoking increased significantly. Among younger students, the increase in monthly and weekly smoking was greater among lower SES students (interactions $p < 0.05$). Between 1996 and 2005 the

prevalence of monthly and weekly smoking decreased significantly among both younger and older students, and these decreases were consistent across SES groups. For committed smoking, the interaction between year and SES was of borderline significance for students from both age

Table 3 Absolute and relative change in prevalence of monthly, current and committed smokers in each SES^a quartiles during different phases of tobacco-control activity in Australia for students aged 12–15 years and 16–17 years

SES quartiles	Absolute change			Relative change		
	1987–1990 Phase 1 (%)	1990–1996 Phase 2 %	1996–2005 Phase 3 (%)	1987–1990 Phase 1 OR (95% CI)	1990–1996 Phase 2 OR (95% CI)	1996–2005 Phase 3 OR (95% CI)
<i>12–15 YEAR-OLDS</i>						
Monthly smokers (smoked in past month)						
Lowest	–1	+6	–12	0.90 (0.74–1.10)	1.49 (1.25–1.77)	0.39 (0.32–0.48)
Second	–2	+3	–10	0.90 (0.75–1.08)	1.23 (1.05–1.45)	0.40 (0.33–0.49)
Third	0	+1	–12	0.95 (0.80–1.12)	1.15 (0.98–1.35)	0.33 (0.27–0.41)
Highest	–1	+1	–13	0.99 (0.83–1.18)	1.07 (0.90–1.27)	0.30 (0.24–0.38)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.866	<i>p</i> = 0.040	<i>p</i> = 0.23
Current smokers (smoked in past week)						
Lowest	–1	+5	–11	0.88 (0.72–1.07)	1.43 (1.20–1.70)	0.38 (0.31–0.46)
Second	–2	+2	–9	0.92 (0.75–1.14)	1.18 (1.00–1.41)	0.39 (0.32–0.48)
Third	–1	+1	–10	0.89 (0.74–1.08)	1.13 (0.95–1.35)	0.31 (0.24–0.39)
Highest	+1	–1	–11	1.11 (0.92–1.33)	0.99 (0.82–1.20)	0.27 (0.20–0.36)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.251	<i>p</i> = 0.037	<i>p</i> = 0.14
Committed smokers (smoked on three days in past week)						
Lowest	0	+2	–7	0.93 (0.75–1.15)	1.31 (1.08–1.60)	0.40 (0.31–0.50)
Second	–1	+2	–6	0.89 (0.71–1.12)	1.22 (1.01–1.49)	0.41 (0.32–0.52)
Third	0	0	–7	0.95 (0.76–1.19)	1.11 (0.91–1.36)	0.26 (0.20–0.35)
Highest	–1	0	–7	0.99 (0.79–1.24)	0.98 (0.77–1.25)	0.30 (0.21–0.42)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.92	<i>p</i> = 0.268	<i>p</i> = 0.06
<i>16–17 YEAR-OLDS</i>						
Monthly smokers (smoked in past month)						
Lowest	0	+4	–11	0.94 (0.76–1.18)	1.22 (0.99–1.50)	0.55 (0.43–0.69)
Second	0	+3	–11	1.02 (0.84–1.24)	1.12 (0.93–1.37)	0.58 (0.47–0.71)
Third	–4	+6	–14	0.84 (0.69–1.01)	1.29 (1.11–1.50)	0.50 (0.41–0.60)
Highest	–2	+4	–16	0.89 (0.73–1.09)	1.22 (1.01–1.47)	0.46 (0.37–0.56)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.536	<i>p</i> = 0.75	<i>p</i> = 0.37
Current smokers (smoked in past week)						
Lowest	0	+3	–12	0.99 (0.78–1.25)	1.14 (0.92–1.42)	0.50 (0.38–0.66)
Second	+1	+3	–12	1.04 (0.84–1.28)	1.13 (0.93–1.39)	0.52 (0.42–0.65)
Third	–3	+4	–14	0.85 (0.71–1.02)	1.20 (1.03–1.41)	0.47 (0.38–0.58)
Highest	–2	+4	–17	0.88 (0.71–1.09)	1.24 (1.01–1.53)	0.39 (0.31–0.48)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.495	<i>p</i> = 0.916	<i>p</i> = 0.31
Committed smokers (smoked on three days in past week)						
Lowest	+2	+3	–11	1.08 (0.84–1.39)	1.21 (0.95–1.53)	0.46 (0.34–0.62)
Second	+2	+1	–9	1.07 (0.84–1.37)	1.13 (0.89–1.43)	0.49 (0.37–0.65)
Third	–3	+4	–12	0.84 (0.69–1.03)	1.26 (1.07–1.49)	0.40 (0.31–0.51)
Highest	–1	+3	–15	0.96 (0.76–1.22)	1.16 (0.91–1.47)	0.30 (0.23–0.39)
Year X SES interaction <i>p</i> -value				<i>p</i> = 0.349	<i>p</i> = 0.837	<i>p</i> = 0.08

^a SES quartiles derived from area-based (postcode) index of relative socio-economic disadvantage where higher scores indicate lower levels of disadvantage. In table, lowest indicates low socio-economic status and highest indicates high socio-economic status

groups, suggesting that the decrease may not be consistent across SES groups.

The top section of Table 4 shows the likelihood of 12- to 15-year-olds from the different SES groups smoking in

each survey year. SES was only significantly associated with smoking in 1996 and 2005. In these years, students from the two highest SES groups were less likely to smoke than students from the lowest SES group. Among 16- and

Table 4 Odds Ratios and 95% confidence intervals for different smoking behaviors by SES^a quartiles for each survey year between 1987 and 2005: 12–15 year-olds (top of table) and 16–17 year-olds (bottom of table)

SES quartiles	1987 OR (95% CI)	1990 OR (95% CI)	1993 OR (95% CI)	1996 OR (95% CI)	1999 OR (95% CI)	2002 OR (95% CI)	2005 OR (95% CI)
<i>12–15 YEAR-OLDS</i>							
Monthly smokers (smoked in past month)							
Lowest	1	1	1	1	1	1	1
Second	1.05 (0.88–1.26)	1.06 (0.88–1.27)	1.02 (0.86–1.22)	0.86 (0.75–0.98)	1.06 (0.90–1.24)	1.06 (0.89–1.27)	0.84 (0.68–1.05)
Third	1.11 (0.94–1.31)	1.13 (0.94–1.35)	0.98 (0.83–1.17)	0.86 (0.75–0.98)	0.91 (0.78–1.06)	0.96 (0.79–1.16)	0.73 (0.58–0.91)
Highest	1.16 (0.93–1.43)	1.15 (0.96–1.38)	0.91 (0.76–1.08)	0.84 (0.72–0.98)	0.89 (0.71–1.10)	0.97 (0.78–1.22)	0.65 (0.50–0.86)
Current smokers (smoked in past week)							
Lowest	1	1	1	1	1	1	1
Second	0.98 (0.80–1.19)	1.02 (0.85–1.23)	0.95 (0.79–1.14)	0.83 (0.72–0.96)	1.04 (0.86–1.25)	1.00 (0.82–1.23)	0.83 (0.67–1.04)
Third	1.07 (0.90–1.27)	1.03 (0.85–1.25)	0.95 (0.80–1.12)	0.82 (0.71–0.95)	0.94 (0.79–1.10)	0.92 (0.73–1.16)	0.65 (0.50–0.85)
Highest	1.01 (0.82–1.25)	1.14 (0.95–1.37)	0.81 (0.67–0.98)	0.82 (0.68–0.97)	0.92 (0.74–1.14)	0.86 (0.66–1.11)	0.58 (0.41–0.82)
Committed smokers (smoked on three days in past week)							
Lowest	1	1	1	1	1	1	1
Second	0.96 (0.78–1.19)	0.92 (0.76–1.12)	0.89 (0.72–1.10)	0.84 (0.71–0.99)	1.06 (0.88–1.29)	1.03 (0.80–1.31)	0.85 (0.65–1.11)
Third	0.99 (0.80–1.23)	0.96 (0.78–1.18)	0.93 (0.76–1.12)	0.82 (0.68–0.98)	0.95 (0.78–1.16)	0.91 (0.70–1.18)	0.54 (0.39–0.73)
Highest	1.01 (0.78–1.31)	0.94 (0.77–1.16)	0.74 (0.58–0.94)	0.73 (0.58–0.93)	0.82 (0.62–1.07)	0.89 (0.63–1.28)	0.55 (0.38–0.80)
<i>16–17 YEAR OLDS</i>							
Monthly smokers (smoked in past month)							
Lowest	1	1	1	1	1	1	1
Second	1.02 (0.85–1.23)	1.11 (0.90–1.37)	1.33 (1.07–1.66)	1.01 (0.86–1.20)	1.02 (0.77–1.35)	0.91 (0.76–1.09)	1.07 (0.83–1.39)
Third	1.31 (1.05–1.63)	1.18 (0.96–1.45)	1.21 (0.97–1.51)	1.21 (1.02–1.43)	1.26 (0.98–1.61)	0.90 (0.73–1.12)	1.12 (0.89–1.42)
Highest	1.27 (1.04–1.56)	1.25 (1.01–1.53)	1.21 (1.00–1.45)	1.21 (1.02–1.43)	1.20 (0.92–1.56)	0.96 (0.75–1.21)	1.07 (0.79–1.44)
Current smokers (smoked in past week)							
Lowest	1	1	1	1	1	1	1
Second	1.02 (0.84–1.24)	1.07 (0.87–1.33)	1.27 (1.01–1.60)	1.06 (0.89–1.26)	1.10 (0.80–1.50)	0.88 (0.73–1.06)	1.08 (0.81–1.44)
Third	1.25 (1.00–1.56)	1.09 (0.89–1.34)	1.19 (0.94–1.50)	1.13 (0.95–1.34)	1.34 (1.02–1.76)	0.83 (0.66–1.04)	1.05 (0.80–1.38)
Highest	1.21 (0.99–1.49)	1.13 (0.90–1.41)	1.10 (0.91–1.34)	1.20 (1.00–1.44)	1.31 (0.99–1.73)	0.86 (0.66–1.12)	0.96 (0.69–1.33)
Committed smokers (smoked on three days in past week)							
Lowest	1	1	1	1	1	1	1
Second	1.08 (0.86–1.37)	1.07 (0.85–1.35)	1.19 (0.95–1.50)	0.99 (0.81–1.21)	1.19 (0.80–1.76)	0.77 (0.63–0.95)	1.08 (0.77–1.52)
Third	1.28 (1.01–1.62)	1.01 (0.82–1.25)	1.20 (0.94–1.53)	1.03 (0.85–1.25)	1.20 (0.88–1.62)	0.64 (0.50–0.81)	0.93 (0.66–1.32)
Highest	1.16 (0.91–1.47)	1.08 (0.85–1.37)	1.22 (0.98–1.52)	1.00 (0.81–1.24)	1.21 (0.88–1.68)	0.70 (0.53–0.92)	0.73 (0.49–1.07)

^a SES quartiles derived from area-based (postcode) index of relative socio-economic disadvantage where higher scores indicate lower levels of disadvantage. In table, lowest indicates low socio-economic status and highest indicates high socio-economic status

17-year-olds (bottom Table 4), once age, gender, and state were controlled, the only statistically significant associations between SES and smoking were found in 1987 for monthly smoking, and 2002 for committed smoking.

Discussion

Over the period 1987–2005, smoking prevalence among Australian adolescents at school has increased and decreased, with a large decrease between 1996 and 2005—a period coinciding with the third phase of tobacco-control activity in Australia. Importantly, the magnitude of the decreases in smoking prevalence between 1996 and 2005 did not differ significantly between SES groups for most indicators of tobacco involvement. These findings suggest that the tobacco-control policies adopted in the late 1990s and early 2000s were effective in reducing smoking among Australian secondary students from all SES groups.

Our study is based on data collected through school-based surveys. As school is compulsory until the age of 15, surveying students provides an effective means of collecting data from a representative sample of adolescents aged between 12 and 15 years. However, this method cannot capture students who leave school early and these students are likely to smoke [38]. Over the study period, Year 12 retention rates increased. In 1987, smoking prevalence was higher among older students from the highest SES group. This result is probably due to differential retention rates between SES groups, with students from low SES groups staying at school in the late 1980s being more academically oriented and less likely to smoke. The changing school retention rate suggests caution in interpreting trends between 1987 and 2005 for this older age group. However, as Year 12 retention rates were similar between 1996 and 2005, comparisons over this period are appropriate.

Changing school participation rates might also influence our findings. If schools with higher smoking rates or schools from particular SES levels were less likely to participate in recent survey years, our changing prevalence estimates may be a result of different student populations being surveyed. We have no evidence that schools from a particular SES level are more likely to refuse study participation.

We used an area-based measure of SES rather than an indicator specific to the family of the student surveyed (e.g., income or occupation of parent). Area-based measures provide an indicator of the average levels of socioeconomic advantage or disadvantage associated with a geographic area and it is possible that an individual's SES level may not match that of their area. Our SES measure (the IRSD) is derived from national census data and is

calculated initially at the collector district level (about 220 households) and then aggregated to larger geographic levels. Our indicator was aggregated to the postcode level which, based on data from the 2001 national census, contains, on average, about 3,230 dwellings. While using aggregated IRSD measures loses some sensitivity, their pattern of association with adult health behaviors is similar to that found when using the less aggregated IRSD measures [39]. Over the period of the study, there is likely to have been some change in the demographic profile of postcodes in Australia and there may have been some redistribution of postcode boundaries. To account for this, we used the IRSD scores derived from the national census conducted closest to each survey year in our study. Despite these limitations, we believe this study's findings for 12- to 15-year-olds and for 16- and 17-year-olds between 1996 and 2005 add to our understanding regarding the impact of population-based tobacco-control programs on inequalities in adolescent smoking. We used three indicators of smoking involvement: (i) monthly use, reflecting measures commonly used to assess adolescent smoking in the United States; (ii) weekly use, reflecting measures used in Australia and England; and (iii) committed smoking, reflecting regular tobacco use. Research has suggested that studies examining the association between SES and adolescent smoking use indicators reflecting at least weekly smoking as outcome measures [40].

The length of the study period means that it covered a time of changing tobacco-control activity in Australia. We divided this activity into three phases. In the first phase (1984–1991) tobacco advertising in the electronic media had been banned for over a decade, minimal health warnings were on all tobacco products, federal government offices were phasing in workplace smoking bans, and in 1989 smoking was banned on domestic air travel. By the late 1980s, dedicated tobacco-control campaigns had been established in a number of Australian States, and several States had legislated to increase tobacco license fees to help fund tobacco-control programs through the establishment of Health Promotion Foundations [41]. In 1990 cigarette advertising was banned in the print media. In the second phase (1992–1996) few new tobacco-control policies were adopted, funding for tobacco-control programs reduced considerably and mass media anti-smoking advertising was minimal [31]. Interestingly, this period coincided with increases in adolescent smoking prevalence, with our data suggesting that these increases were greater among younger students from lower SES groups. By 1996 there was a differential in smoking rates between younger adolescents from different SES groups, suggesting that the smoking behaviors of young adolescents from low SES groups are highly sensitive to the absence of tobacco-control activities.

The third phase of tobacco-control in Australia commenced in 1997, when a more co-ordinated and co-operative approach was adopted throughout Australia through the formation of a partnership between federal and state governments and interested non-government organizations. This produced the National Tobacco Strategy (NTS) [32] that took a broad population approach to tobacco-control and increased tobacco-control funding. The NTS included a national advertising campaign that graphically depicted negative health consequences of smoking, with all advertisements being connected through the same tagline at their beginning and end [42]. The advertisements were carefully designed to appeal to smokers aged between 18 and 40, to provide them with new information about relatively certain health effects of smoking, and showed the physical damage that smoking was doing now [32]. In addition, in a deliberate attempt to reach smokers from a lower SES background, placement of the advertisements was skewed toward television programs that attracted this audience [32]. The advertising reach of the NTS was three times greater than that of anti-smoking advertisements aired between 1991 and early 1997. The advertisements and tagline had high recall among Australian adolescents [43] and adolescents have been shown to perceive these types of advertisements as more effective than humorous, “normative behavior” or counter-industry anti-smoking advertisements [44, 45]. Between 1997 and 2005 all States adopted a legal age of 18 for purchasing cigarettes, increased penalties for selling cigarettes to people underage, and implemented legislation to prohibit smoking in certain enclosed public spaces, including enclosed shopping centers, restaurants and cafes during meal times. Complete bans on smoking in restaurants and cafes may be associated with a reduced uptake of smoking among adolescents [46]. In November 1999, the amount and method of levying tobacco excise changed, resulting in a real increase in the price of cigarettes [47]. Using 2006 dollars, a pack of cigarettes cost on average \$AUD 8.48 between November 1999 and December 2005, while costing \$AUD 4.85 between January 1991 and October 1999. There is some evidence to suggest that real increases in the price of cigarettes may be more effective in reducing smoking among adolescents from low SES backgrounds [42, 43, 48].

Studies suggesting that mainstream public health campaigns increase SES differentials in smoking have focused on adults [12]. Our study is one of the few to explore how these campaigns influence SES differentials in adolescent smoking. Our findings suggest that well-funded, population-based tobacco-control campaigns can be effective in reducing smoking among adolescents from all SES groups. However, as we found that SES had a significant inverse association with smoking prevalence among

12- to 15-year-old students in 2005, our data suggest that SES may now be a factor in smoking prevalence among young Australian adolescents. Since this differential was not seen in 2002 or 1999, it is only a recent phenomenon. It may be that the effect of tobacco-control policies is diminishing for adolescents from lower SES groups.

The current study used a multiple cross-sectional design to examine change in population estimates of smoking prevalence within different SES groups across three time periods that reflected different levels of tobacco-control investment. This approach has been used in studies examining similar research questions with regards to adult smoking [12, 49]. We acknowledge that our design cannot rule out the possibility that secular, social, or economic changes outside those promoted by tobacco-control policies may have influenced smoking prevalence. However, methodological issues and pragmatic concerns, including cost, contamination and population availability, limit the possibility of testing “whole-population” interventions using traditional individual-based designs like randomized controlled trial designs [50].

In conclusion, this study found that students from all SES groups were substantially less likely to be involved with smoking in 2005 than their same-age counterparts in the mid 1990s and that the magnitude of these reductions was similar across SES groups. In 2005, 8% of students aged between 12 and 15 years from the lowest SES group smoked in the week before the survey, compared to 5% of students in this age group from the highest SES group. If this low level of smoking among adolescents from all SES groups can be maintained as they grow to adulthood, the influence of smoking on differentials in health and tobacco-related mortality can be expected to reduce. However, to ensure that relative inequalities in smoking prevalence are minimized, efforts must be taken to ensure that tobacco-control strategies are relevant to, and effective with, people from all SES groups.

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