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Clustering of substance use and sexual risk behaviour in adolescence: analysis of two cohort studies

Short title: A cohort analysis of risk behaviour clustering during adolescence

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ABSTRACT

Objectives We aimed to examine whether changes in health-risk behaviour rates alters the relationships between behaviours during adolescence, by comparing clustering of risk behaviours at different time points.

Design Comparison of two cohort studies, the Twenty-07: Health in the Community study (1987/1990 study) and the 11-16/16+ Study: Young People's Health (1999/2003 study).

Setting Central Clydeside Conurbation around Glasgow City.

Participants Young people who agreed to participate in the Twenty-07 and 11-16/16+ studies and who completed surveys on health behaviours.

Primary and secondary outcomes measures We analysed data on risk behaviours collected at age 15 (started smoking prior to age 14, monthly drinking, ever used illicit drugs and sexual intercourse prior to age 16) and at ages 18-19 (current smoking, excessive drinking, ever used illicit drugs and multiple sexual partners), by gender and social class.

Results Drinking, illicit drug use and risky sexual behaviour (but not smoking) increased between the earlier and later cohort, especially among females. We found strong associations between substance use and sexual risk behaviour during early and late adolescence, with few differences between cohorts, or by gender or social class. Adjusted odds ratios for associations between each substance and sexual risk behaviour were around 2.00. The only significant between-cohort difference was a stronger association between female early adolescent smoking and early sexual initiation in the 1999/2003 cohort.

Conclusions We found that despite increasing health-risk behaviour rates during the 1990s, associations between substance use and sexual risk behaviour remained strong, in the early 2000s, in both younger *and* older adolescents, irrespective of gender or social class. These data further support the need for improved policies, strategies and interventions to prevent multiple risk behaviour in young people.

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INTRODUCTION

Adolescence is a critical period of development, when 'risky' health behaviours may be adopted. These impact on current and future health and wellbeing,(1;2) and are increasingly difficult to modify later in life.(3) There is evidence that some health risk behaviours tend to cluster in adolescence (4-9). A particular focus has been on relationships between substance use and sexual behaviour. In addition to direct effects of certain substances on sexual decisions (10) this may reflect a predisposition towards risky behaviours in some individuals (11) since not only alcohol and illicit drugs, but also smoking, are strongly associated with adolescent sexual risk behaviour.(12)

There is some evidence that relationships between substance use and sexual behaviour vary by socio-demographic group and culture. Most studies have found stronger associations among females than males (4;6;10;13), although some report no gender differences.(7;14) However, we are unaware of studies which have examined whether associations vary according to either age or socioeconomic status (SES). The authors of one study which found *no* relationship between early initiation of sexual intercourse and substance use among deprived African-American adolescents suggest this unusual finding might indicate these behaviours have different cultural meanings among certain groups.(15) Another study found weaker associations between substance use and sexual initiation in the US than Europe. Its authors suggest the difference might have resulted from lower substance use rates in their US sample or international differences in acceptability of adolescent substance use or sexual behaviour.(7)

The present study, based on two adolescent cohorts, born 12 years apart in the same geographic area, the West of Scotland, examines associations between substance use and sexual risk behaviour. Unlike some studies which have used composite substance use measures (4;7), we examine relationships between each of smoking, drinking and illicit drug use, and sexual risk behaviour. Most similar studies have been conducted in the USA, but results might vary according to cultural context.(7;9) Historical context is another potentially important influence on health-risk behaviour clustering, but absent from previous studies. Our cohorts were adolescents in the late 1980s and late 1990s/early new millennium respectively. This was a period of considerable social change, including massive increases in young people's involvement

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in the night-time economy.(16) Significant increases in some adolescent health-risk behaviours over this period have been documented (17;18) and are evident in comparisons of our cohorts. Rates of drinking, illicit drug use and risky sexual behaviour were greater in the later cohort, with increases generally larger among females than males but few differences according to SES.(19;20) It is possible that as the prevalence (and so normative nature) of behaviours changes, so might their clustering. The one study to examine between-country differences suggested higher substance use rates may have resulted in stronger associations with sexual risk behaviour.(7) However, if clustering reflects a predisposition towards risky behaviours in some individuals (11), then we might expect clustering to be less evident in periods when such behaviours are more prevalent.

In our study we conducted analyses on health-risk behaviours in both early (age 15) and late adolescence (age 18-19), since it is possible that associations between substance use and risky sexual behaviour change with age. We examined the associations at two different time points, to see if they differed by period. We also examined differences according to gender, which previous studies have shown to impact on associations between substance use and sexual risk behaviour, and SES, which has tended not to be addressed in previous studies.

METHODS

Study population

We used data collected at ages 15 and 18-19 from two West of Scotland studies: the *'Twenty-07 Study: Health in the Community'* (henceforth referred to as the 1987/1990 study/cohort)(21) and the *'11-16/16+ Study: Young People's Health' (*henceforth the 1999/2003 study/cohort*)* (22). Ethical approval was received from the NHS for the 1987/1990 study and from Glasgow University for the 1999/2003 study.

The 1987/1990 study began in 1987, and was located in the Central Clydeside Conurbation around Glasgow. At baseline, 1009 15-year olds (65% issued sample) were recruited, with no significant gender or social class differences compared with the source population (23); 908 (90%) participated at follow-up in

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1990. At both stages, respondents were interviewed in their homes by trained interviewers using paper questionnaires.

The 1999/2003 study cohort, also located in the Central Clydeside Conurbation was recruited in 1994 during their final primary school year, aged 11 (93% response). Full details of the sampling strategy are available.(24) The cohort was followed up during secondary schooling, aged 15 in 1999 (N=2196, 85% of the baseline sample) using self-completion questionnaires, and post-school, at ages 18-19 in 2002-4 (henceforth 2003) when 1258 respondents (49% of baseline) were interviewed using computer-assisted interviews in survey centres or participants' homes. Fieldwork for this stage took longer than that of the 1987/1990 study, resulting in a sample which was slightly older with a broader age distribution.

Definitions

Smoking: In both studies, interviewers asked respondents aged 18-19 whether they were current, ex or never smokers, allowing derivation of a dichotomous late adolescence 'current smoker' variable. Current and ex-smokers were also asked the age when they first tried smoking; all reporting 13 years or less were defined as 'started smoking below age 14'.

Drinking: In both studies, respondents were asked at age 18-19 about alcohol intake using a past week drinking grid (Web Appendix). From this, a dichotomous variable was derived representing drinking over weekly recommended alcohol limits (hereafter called 'excessive drinking': ≥ 22 units in the past week for males, ≥ 15 for females) (25). At age 15, respondents were asked about drinking frequency. Those drinking 'at least once a month' (1978/1990 study) and 'about once a month' (1999/2003 study) or more were defined as 'monthly drinkers at age 15'.

Illicit drug use: At age 15 and again at 18-19, respondents in both studies were provided with lists of illicit drugs (Web Appendix) and asked if they had experience of any.

Multiple partners and early sexual initiation: In both studies, at age 18-19, all reporting opposite sex experience were asked about number of sexual partners ever, used to derive a dichotomous '3+ sexual partners' variable. They were also asked age at first sexual intercourse with someone of the opposite sex,

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allowing derivation of a variable representing 'early sexual initiation' (age <16 years vs ≥16 or hasn't happened).

Social class was derived from head of household occupation. This information was collected at baseline, in the 1987/1990 study via parental interview, and in the 1999/2003 study via parental self-completion questionnaire (supplemented, where necessary, by information provided by respondents during interviews with research nurses which we have shown to be reliable).(26) Social class was dichotomised into non-manual and manual groupings.

Analysis

Analyses for each cohort were restricted to those participating in both data collection waves. Attrition in the 1987/1990 study was slightly greater among manual class respondents. At each wave of the 1999/2003 study attrition was greater among respondents from manual class backgrounds, with lower teacher-rated ability and educational involvement and from reconstituted/lone-parent households. Attrition-based weights were constructed for both studies.(22;27) Because these were based on those present at all waves, their effect is to reduce the size of the 1999/2003 study age 18-19 dataset to 1006 respondents. We further restricted analyses to those with no missing behavioural or social class data (no respondent had missing gender or age data) (Table 1).

We used Poisson regression to compare mean numbers of behaviours between cohorts separately for early and late adolescence, and for males and females (adjusted for social class), and manual and non-manual groups (adjusted for gender). Analyses relating to late adolescence also adjusted for age at interview, previously shown to be important.(20) This was not done for early adolescent behaviours because these data were not all obtained at the age 18-19 interview (footnote to Table 1). We included terms to identify any interactions by cohort and gender/social class.

We used logistic regression to calculate odds ratios (ORs) and associated confidence intervals (CIs) for the relationships between each substance and having had three or more sexual partners in late adolescence. We adjusted for: social class and age; and then social class, age and other substance use. We did this

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separately for the 1987/1990 and 1999/2003 studies and within that by gender (all models adjusting for age and social class) and by social class (adjusting for age and gender). Additional analyses included terms to identify interactions by cohort and, within each cohort, by gender or social class. We used similar models (without age adjustment) to examine relationships between early adolescent substance use and early sexual initiation.

RESULTS

Time-trends in multiple risk behaviour frequencies

As previously reported (19;20), rates of drinking, illicit drug use and sexual risk behaviour were considerably higher in the later cohort (Table 1). As would therefore be expected, the proportion reporting no late adolescent risk behaviours decreased from 42.6% in the 1987/1990 cohort to 24.1% in the 1999/2003 cohort, whilst that reporting multiple late adolescent risk behaviours increased markedly, with 4.7% of the earlier and 12.2% of the later cohort reporting all four (Web Table 1). Similarly, 57.2% of the 1987/1990 cohort, but 26.7% of the 1999/2003 cohort, reported no early adolescent substance use or sexual initiation, while all four early adolescent risk behaviours were reported by 1.7% of the earlier and 9.6% of the later cohort.

These changes were more pronounced in females. Thus, increases in mean numbers of late adolescent risk behaviours were greater among females (0.75 versus 1.56; age and social class adjusted $p<0.001$), than males (1.50 versus 1.93; adjusted $p=0.048$); the cohort-by-gender interaction was highly significant (adjusted $p<0.001$) (Web Table 1). Mean numbers of early adolescent risk behaviours increased significantly among both females and males (0.51 versus 1.56 and 0.84 versus 1.55, respectively; both adjusted $p<0.001$), but again the increase was greater among females (cohort-by-gender interaction adjusted $p<0.001$). Contrasting with these gender differences, increases in both late and early adolescent risk behaviours were very similar in those from non-manual compared with manual social class backgrounds (Web Table 1).

Relationships between substance use and sexual risk behaviour

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Associations between late adolescent substance use and multiple sexual partners and between early adolescent substance use and early sexual initiation were strong. This was true for both cohorts, for both males and females, and for both social class groups.

In the 1987/1990 cohort, associations unadjusted for other substance use, between late adolescent substance use and multiple sexual partners, were slightly lower in respect of current smoking (male OR 3.43, 95% CI 2.21 to 5.32 ; female OR 2.61, 95% CI 1.34 to 5.06) than either excessive drinking (male OR 4.79, 95% CI 3.00 to 7.64; female OR 3.54, 95% CI 1.57 to 7.98) or having used illicit drugs (male OR 4.38, 95% CI 2.85 to 6.73, female OR 3.76, 95% CI 1.92 to 7.37) (Table 2). In the 1999/2003 cohort, the equivalent associations were all weaker among males, but unchanged or stronger among females, although none of the interactions with cohort were significant. However, in this later cohort, the gender difference in the strength of association between illicit drug use and multiple sexual partners (male OR 2.71, 95% CI 1.80 to 4.09; female OR 6.72, 95% CI 4.41 to 10.26) was significant (drugs-by-gender interaction p=0.003).

After adjustment for other substance use, associations between use of each substance and multiple sexual partners in late adolescence attenuated by around one-third, resulting in ORs of around 2.00-3.00 (Figure 1a). Associations were generally similar for males and females and similar for both studies. However, the relationship between illicit drug use and multiple sexual partners in the 1999/2003 cohort continued to be stronger among females than males (p for interaction = 0.002).

Similar results were obtained in models of associations between early adolescent substance use and early sexual initiation (Table 3; Figure 1b). In models unadjusted for other substance use, relationships between each substance and early sexual initiation weakened slightly over time among males, but strengthened among females. This trend was particularly marked for the relationship between having started smoking below age 14 and early sexual initiation (female OR 1.46, 95% CI 0.67 to 3.18 in 1987/1990; OR 6.40, 95% CI 3.94 to 10.39 in 1999/2003, p for cohort interaction=0.002). As in late adolescence, in the 1999/2003 cohort there was a significant gender difference (p=0.005) in the association between illicit drug use and sexual behaviour, which was stronger among females. After adjusting for other substance use, associations between each substance and early sexual initiation were attenuated by up to one half, with the greatest

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attenuation occurring among females in the later cohort, giving ORs of around 2.00 (Figure 1b). As in the unadjusted analyses, the relationship between early smoking and early sexual initiation among females was stronger in the later than the earlier cohort (p for cohort interaction=0.022), and the relationship between early illicit drug use and early sexual initiation in the later cohort was stronger among females than males (p for gender interaction=0.023).

Associations between substance use and risky sexual behaviour in both late and early adolescence were similar for participants from both social class groups in both cohorts. This was true for associations unadjusted for other substance use (Web Table 2; Web Table 3) and for those adjusted for other substance use (Figure 2). The one exception was that the relationship between early illicit drug use and early sexual initiation was weaker in manual compared with non-manual social class groups in the later cohort (drugs-by-class interaction p=0.016; Figure 2b).

DISCUSSION

Our comparison of two cohorts revealed a large increase in the proportion of young people reporting early and late adolescent multiple risk behaviours between 1987/1990 and 1999/2003. Increases were particularly marked among females, but broadly similar in both social class groups. We found strong associations, both between early substance use and early sexual initiation, and between late adolescent substance use and having had multiple sexual partners. These relationships were broadly similar for males and females and between social class groups. Despite much higher rates of drinking, drug use and risky sexual behaviour (but not smoking) in the later cohort, relationships between use of each substance and risky sexual behaviour showed little or no change over time.

Increasing proportions reporting multiple health-risk behaviours are to be expected, given higher rates of all individual risk behaviours, except smoking, in the later cohort.(19;20) However, they are particularly concerning given suggestions that certain behavioural combinations might operate synergistically to increase health risks. Thus smoking plus drinking dramatically increases risk of certain cancers,(28) while sexual behaviour plus drinking or illicit drug use may result in less informed decisions, more unprotected sex, risk of violence or subsequent regret.(4;10;14;29)

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Most,(4;6;10;13) but not all (7;14) previous studies have found stronger associations between adolescent substance use and sexual behaviour among females. This may be because sexual experience in adolescence is more normative for males and so less tied to other risk behaviours (13) or it may reflect different attitudes towards sexual behaviour among male compared with female adolescents.(29) We found no gender differences in relationships between early or late adolescent substance use and risky sexual behaviour in our earlier cohort. However, the association between illicit drug use and sexual risk behaviour in both early and late adolescence was stronger among females than males in our later cohort. Had we found stronger relationships in our earlier cohort that disappeared or weakened over time, we might have attributed this to the gender convergence in adolescent sexual risk behaviour (30) or changing attitudes towards female sexuality.(31) The findings we did obtain are hard to explain.

Our study has a number of strengths. We compared two cohorts of young people from the same geographic area and life-stage, surveyed using (near) identical questions, 13 years apart. To our knowledge, this is the first study to examine time-trends in associations between substance use and sexual behaviour. We also examined these associations in both early *and* late adolescence and by gender and social class, the latter of which has not, to our knowledge, been previously investigated. However, there are some limitations. The follow-up rate in the 1999/2003 study was quite low, with greater non-response among certain groups. Although accounted for via weighted analyses, we may not have fully compensated for differential loss to follow-up of adolescents with more 'risky' patterns of behaviour. The questions included for each cohort were equivalent for all behaviours except alcohol intake, which included a more detailed drinking grid in the 1999/2003 study, possibly encouraging increased reporting. Parental occupational data, used to derive social class, were also collected in different ways, but there is little reason to think the methods would impact in such a way as to produce bias. Finally, interviewer-administered questionnaires (from which all behavioural data were obtained apart from those relating to early adolescent drinking and drug use in the 1999/2003 study) have been shown to lead to under-reporting of behaviours compared with self-administered instruments (32), so possibly impacting on the strength of the observed associations.

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Conclusions

Despite increases in adolescent multiple risk behaviour during the 1990s, the strength of associations between substance use and sexual risk behaviour remained largely similar. These findings have several public health implications. National and local governmental policy and strategies should reflect the strong relationships between adolescent risk behaviours and support broader and more integrated approaches to prevention and treatment.(33-35) For example, sexual health clinics could routinely opportunistically offer advice and counselling for alcohol and illicit drug use.(36) Clustering of adolescent health-risk behaviours partly reflects shared underlying determinants.(11;33) Thus a holistic preventive approach, addressing broad determinants of risk behaviours, from individual through to societal influences, is needed. Strong associations between early adolescent substance use and sexual initiation mean preventive measures should be implemented at younger ages, possibly during primary school. Such a holistic approach would require effective cross-sector government collaboration, especially between education and health departments. Finally, given that substance use and sexual risk behaviour appear to be strongly associated across social class groups, preventive approaches to risk behaviour should include both universal and targeted approaches, described by Marmot as proportionate universalism,(37) to ensure equitable improvement in adolescent health and wellbeing.

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Authors' contributions

All authors contributed to the analysis plan and questions addressed in the paper and to the interpretation of the results. CJ drafted the paper and is guarantor. HS contributed to the design of *11-16/16+* and its data collection, cleaned data from both studies and conducted the analyses. HS and SH critically revised the paper and all authors gave approval for the final version to be published.

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Competing interests

The authors have no competing interests

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Table 1 Demographic characteristics, substance use and risky sexual behaviour in late and early adolescence in both cohorts

Analyses of later adolescent substance use and multiple sexual partners					Analyses of earlier adolescent substance use and early sexual initiation				
	1987/1990 cohort		1999/2003 cohort			1987/1990 cohort		1999/2003 cohort	
Mean age (SD)	18 years 7 months (3.9 months)		19 years 3 months (6.4 months)		**Mean age (SD)**	15 years 8 months (3.8 months)		15 years 5 months (3.7 months)	
	N	**%**	**N**	**%**		**N**	**%**	**N**	**%**
Total	**887**	**100**	**910**	**100**	**Total**	**884**	**100**	**933**	**100**
Gender					**Gender**				
Male	418	47.1	454	49.9	Male	416	47.0	473	50.7
Female	469	52.9	456	50.1	Female	468	53.0	460	49.3
Social class					**Social class**				
Non-manual	378	42.6	410	45.1	Non-manual	375	42.4	408	43.8
Manual	509	57.4	499	54.9	Manual	509	57.6	525	56.2
Current smoker*					**Started smoking at age <14***				
Yes	298	33.6	308	33.9	Yes	193	21.9	195	20.9
No	589	66.4	602	66.1	No	691	78.1	738	79.1
Excessive drinking*†					**Monthly drinking at age 15‡**				
Yes	181	20.4	295	32.4	Yes	175	19.8	600	64.3
No	706	79.6	615	67.6	No	709	80.2	333	35.7
Ever used illicit drugs*					**Ever illicit drugs at age 15‡**				
Yes	288	32.5	532	58.5	Yes	85	9.6	391	41.9
No	599	67.5	378	41.5	No	799	90.4	542	58.1
3+ sexual partners*					**Sex at age <16***				
Yes	212	23.9	453	49.8	Yes	139	15.7	265	28.4
No	675	76.1	456	50.2	No	745	84.3	668	71.6

* Information obtained at age 18-19 interview.

† Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.

‡ Information obtained at age 15 interview (1978/1990 study) or self-completion questionnaire (1999/2003 study).

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Table 2 Rates of multiple (3+) sexual partners in late adolescence according to substance use and associated odds ratios (unadjusted for other substance use) in each cohort, by gender

	1987/1990 cohort					1999/2003 cohort					
	<3 sexual partners		3+ sexual partners			<3 sexual partners		3+ sexual partners			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	*p-value of interaction by cohort*
MALES											
Current smoking											
No	192	78.0	87	50.6	1.00	161	77.8	134	54.5	1.00	
Yes	54	22.0	85	49.4	3.43 (2.21 to 5.32)	46	22.2	112	45.5	2.61 (1.71 to 3.97)	0.371
Excessive drinking†											
No	198	80.5	88	51.2	1.00	158	76.0	122	49.6	1.00	
Yes	48	19.5	84	48.8	4.79 (3.00 to 7.64)	50	24.0	124	50.4	3.42 (2.25 to 5.20)	0.414
Ever used illicit drugs											
No	174	70.7	61	35.5	1.00	95	45.9	59	24.0	1.00	
Yes	72	29.3	111	64.5	4.38 (2.85 to 6.73)	112	54.1	187	76.0	2.71 (1.80 to 4.09)	0.124
FEMALES											
Current smoking											
No	292	68.1	18	45.0	1.00	202	81.5	104	50.0	1.00	
Yes	137	31.9	22	55.0	2.61 (1.34 to 5.06)	46	18.5	104	50.0	4.29 (2.79 to 6.58)	0.203
Excessive drinking†											
No	391	90.9	30	75.0	1.00	208	83.9	127	61.1	1.00	
Yes	39	9.1	10	25.0	3.54 (1.57 to 7.98)	40	16.1	81	38.9	3.55 (2.27 to 5.56)	0.953
Ever used illicit drugs											
No	344	80.0	20	51.3	1.00	171	69.0	52	25.1	1.00	
Yes	86	20.0	19	48.7	3.76 (1.92 to 7.37)	77	31.0	155	74.9	6.72 (4.41 to 10.26)	0.144

p-values of interactions by gender: within 1987/1990 cohort - current smoking by gender p=0.465, excessive drinking by gender p=0.742, ever illicit drugs by gender p=0.795; within 1999/2003 cohort – current smoking by gender p=0.145, excessive drinking by gender p=0.841, ever illicit drugs by gender p=0.003.

*Adjusted for social class and age.

†Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.

OR = odds ratios; CI = confidence interval.

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Table 3 Rates of early sexual initiation according to early adolescent use and associated odds ratios (unadjusted for other substance use) in each cohort, by gender

	1987/1990 cohort					1999/2003 cohort					p-value of interaction with cohort
	No early sexual initiation		Early sexual initiation			No early sexual initiation		Early sexual initiation			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
MALES											
Started smoking age <14											
No	261	83.9	61	58.7	1.00	288	87.3	92	64.3	1.00	
Yes	50	16.1	43	41.3	3.64 (2.20 to 6.02)	42	12.7	51	35.7	3.45 (2.14 to 5.58)	0.879
Monthly drinking age 15											
No	252	80.8	62	59.6	1.00	148	44.8	32	22.4	1.00	
Yes	60	19.2	42	40.4	3.00 (1.84 to 4.92)	182	55.2	111	77.6	2.74 (1.74 to 4.32)	0.780
Ever used illicit drugs age 15											
No	287	92.3	76	73.1	1.00	210	63.8	60	42.0	1.00	
Yes	24	7.7	28	26.9	4.11 (2.24 to 7.54)	119	36.2	83	58.0	2.42 (1.61 to 3.65)	0.159
FEMALES											
Started smoking age <14											
No	343	79.0	25	71.4	1.00	295	87.3	63	51.6	1.00	
Yes	91	21.0	10	28.6	1.46 (0.67 to 3.18)	43	12.7	59	48.4	6.40 (3.94 to 10.39)	0.002
Monthly drinking age 15											
No	370	85.3	25	71.4	1.00	138	40.9	15	12.3	1.00	
Yes	64	14.7	10	28.6	2.32 (1.04 to 5.14)	199	59.1	107	87.7	4.93 (2.75 to 8.84)	0.133
Ever used illicit drugs age 15											
No	407	94.0	29	82.9	1.00	237	70.1	34	27.9	1.00	
Yes	26	6.0	6	17.1	3.09 (1.16-8.21)	101	29.9	88	72.1	6.17 (3.87 to 9.83)	0.218

p-values of interactions by gender: within 1987/1990 cohort – started smoking age <14 by gender p=0.047, monthly drinking age 15 by gender p=0.710, ever illicit drugs age 15 by gender p=0.564; within 1999/2003 cohort – started smoking age <14 by gender p=0.134, monthly drinking age 15 by gender p=0.118, ever illicit drugs age 15 by gender p=0.005.

*Adjusted for social class.

OR = odds ratio; CI = confidence interval.

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Figure 1 Associations, by gender and cohort, between (a) late adolescent substance use and having had three or more sexual partners and (b) early adolescent substance use and early sexual initiation.

*Adjusted for age and class

† p-value of gender by illicit drug use interaction in 2003 = 0.002

‡ Adjusted for class

§p-value of cohort interaction for smoking prior to age 14 among females = 0.022

¶p-value of gender by illicit drug use interaction in 2003 = 0.023

OR = odds ratios; CI = confidence intervals

Figure 2 Associations, by social class and cohort, between (a) late adolescent substance use and having had three or more sexual partners and (b) early adolescent substance use and early sexual initiation.

*Adjusted for age and gender

†Adjusted for gender

‡p-value of class by illicit drug use interaction in 2003 = 0.016

OR = odds ratios; CI = confidence intervals

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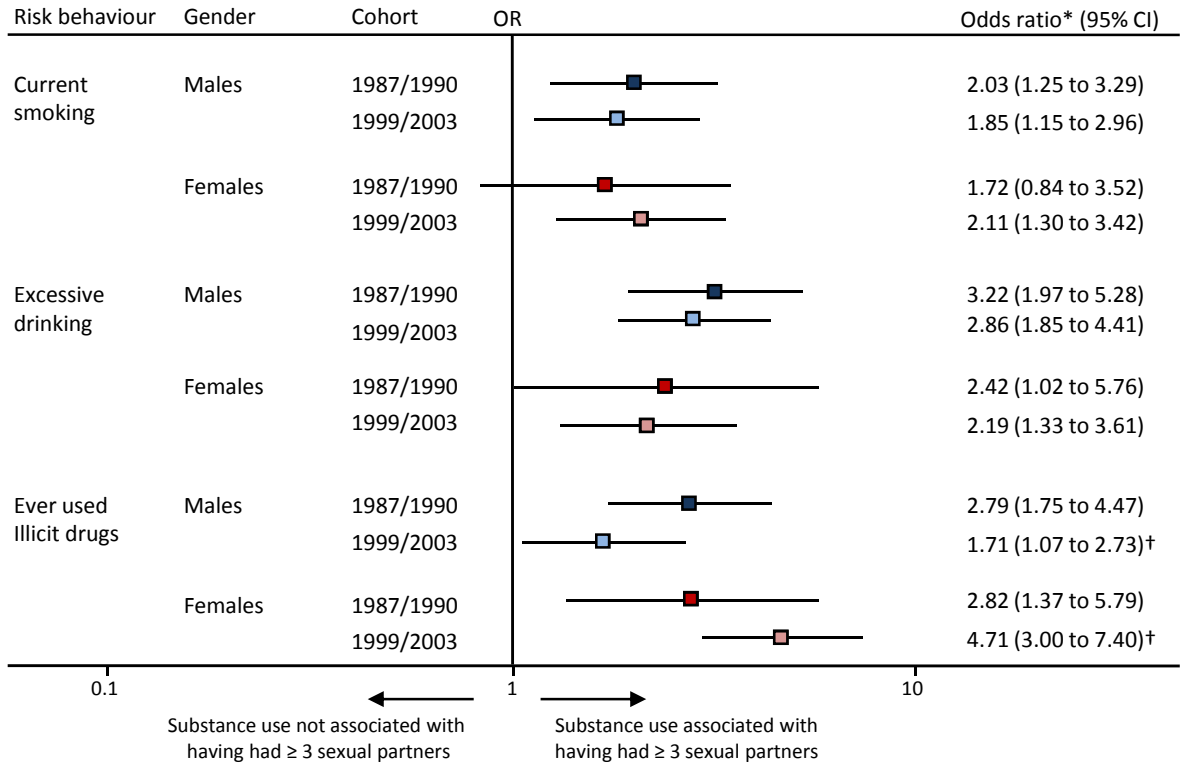
Figure 1

(a)



(b)

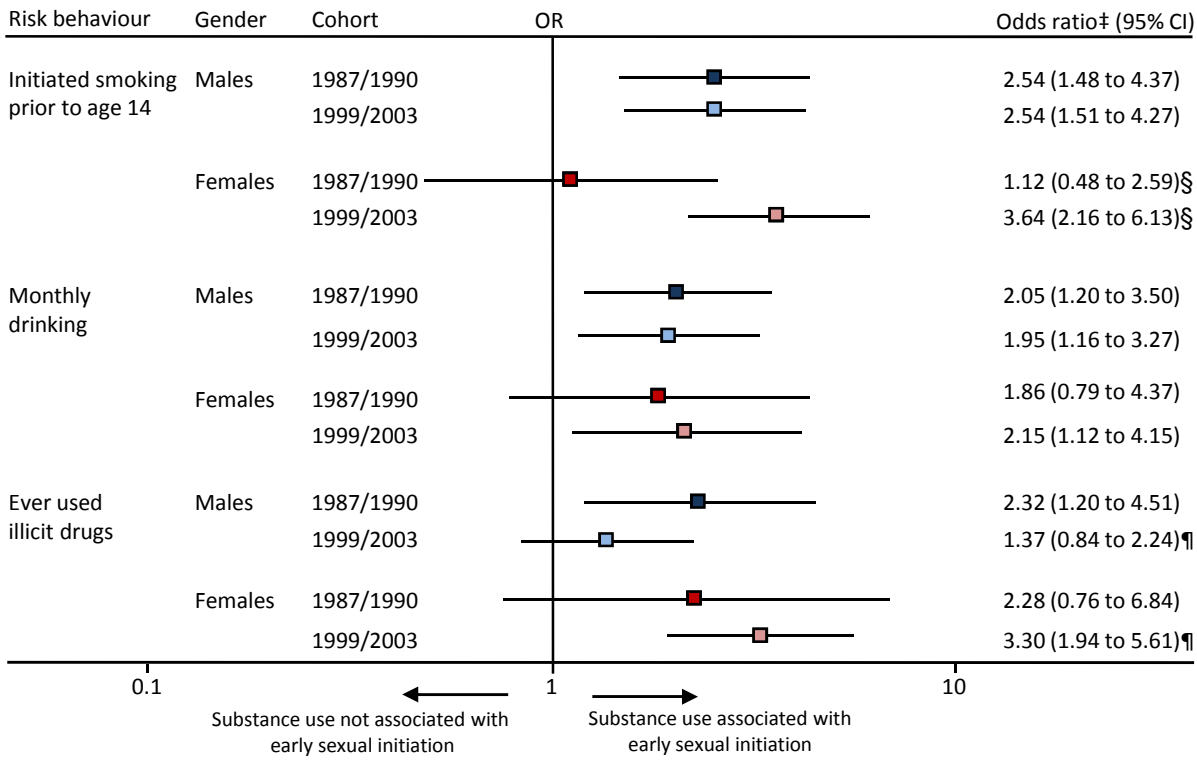


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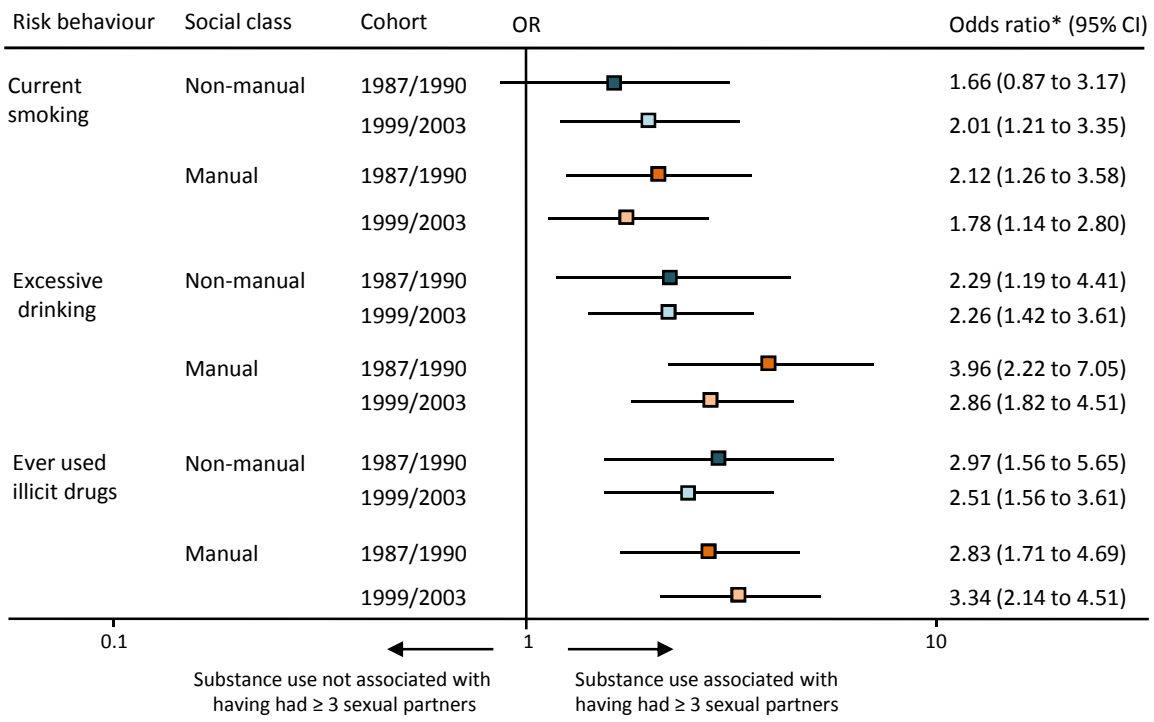
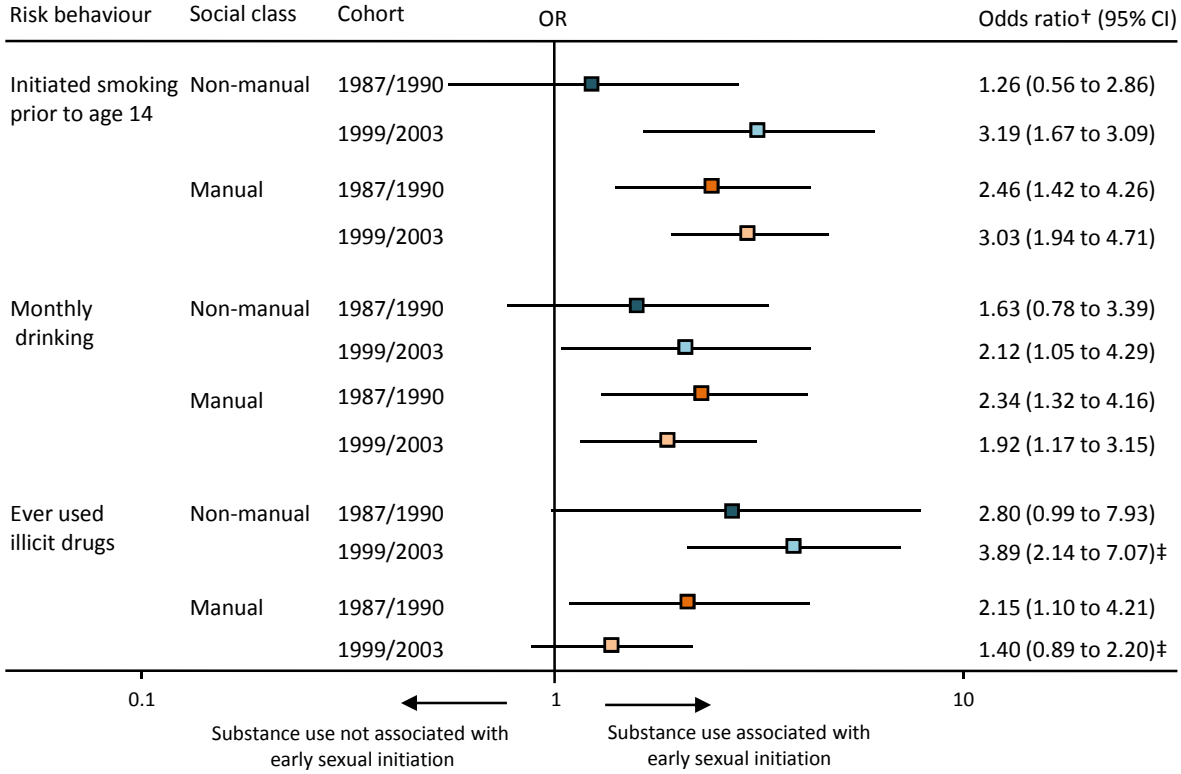
Figure 2

(a)



(b)



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Web Appendix Description of the past-week drinking grids and lists of illicit drugs provided to respondents

Drinking grids

At age 18-19, both studies included past-week drinking grids to measure alcohol use. In the 1987/1990 study this asked about: pints, glasses, bottles and measures of beer, lager, shandy, stout and cider; wine; fortified wine; spirits; and other drinks. The grid in the 1999/2003 study was more detailed and asked about: pints, small, large and very large cans and bottles and small and large glasses of shandy; normal or strong beer, lager or stout; normal or strong cider; babycham; wine or champagne; cocktails, mixers, breezers or alcopops; spirits or liqueurs; (flavoured) schnapps; buckfast, eldorado or sanatogen; sherry, martini, taboo or port; MD20/20; and other drinks.

Illicit drugs lists

At age 15 ('early adolescence'), respondents in both studies were provided with the following list of illicit drugs: cannabis; LSD; barbiturates; glues, solvents, dry-cleaning fluids; fuels or gas; amphetamines; opium; morphine; heroin; cocaine; crack; PCP; magic mushrooms. The 1987/1990 study age 15 list also included barbiturates; opium; morphine; and PCP. The 1999/2003 study age 15 list also included temazepam and ecstasy.

At age 18-19 ('late adolescence'), respondents in both cohorts were provided with the following list, comprising: cannabis; LSD; temazepam; tranquillisers; glues, sprays, gas, dry cleaning fluid; amphetamine; amyl or butile nitrite; heroin; methadone; temgesic; cocaine; crack; ecstasy; magic mushrooms; morphine or opium. The list given to the 1987/1990 cohort also included other barbiturates and PCP.

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Web Table 1 Proportion reporting none, one, two, three or four behaviours and mean number of behaviours in early and late adolescence within each cohort, with β (adjusted as appropriate) for the increase in means between 1987/1990 and 1999/2003, overall and among males vs females and those from non-manual vs manual backgrounds

	Late adolescence substance and 3+ sexual partners								Early adolescent substance use and early sexual initiation							
	Cohort	None (%)	One (%)	Two (%)	Three (%)	Four (%)	Mean N behaviours	β (p-value)	p-value cohort by gender/ social class interaction	None (%)	One (%)	Two (%)	Three (%)	Four (%)	Mean N behaviours	β (p-value)	p-value cohort by gender/ social class interaction
Overall																	
	1987/1990	42.6	24.4	17.2	11.0	4.7	1.10	0.34*	-	57.2	26.2	10.1	4.8	1.7	0.67	0.81†	-
	1999/2003	24.1	20.5	24.2	19.0	12.2	1.75	(< 0.001)		26.7	26.0	22.0	15.7	9.6	1.55	(<0.001)	
By gender																	
Males	1987/1990	32.5	20.6	19.4	19.1	8.4	1.50	0.12‡		51.3	24.9	13.4	7.4	2.9	0.84	0.59§	
	1999/2003	17.4	21.2	25.2	22.7	13.5	1.93	(0.048)		26.3	26.1	23.7	15.0	8.9	1.55	(<0.001)	
									<0.001								<0.001
Females	1987/1990	51.7	27.9	15.3	3.8	1.5	0.75	0.65‡		62.3	27.2	7.2	2.6	0.6	0.51	1.08§	
	1999/2003	30.7	19.7	23.2	15.4	11.0	1.56	(< 0.001		27.2	25.9	20.3	16.3	10.2	1.56	(< 0.001)	
By social class																	
Non-manual	1987/1990	46.4	22.2	16.4	10.0	5.0	1.05	0.27¶		58.9	26.5	10.1	2.9	1.6	0.61	0.75**	
	1999/2003	29.0	22.4	22.0	17.6	9.0	1.56	(< 0.001)		32.8	27.1	21.3	12.2	6.6	1.33	(<0.001)	
									0.155								0.281
Manual	1987/1990	39.9	26.1	17.9	11.8	4.3	1.14	0.40¶		55.8	26.0	10.2	6.3	1.8	0.71	0.85**	
	1999/2003	20.0	19.0	26.2	20.0	14.8	1.90	(< 0.001)		21.9	25.1	22.9	18.3	11.8	1.73	(<0.001)	

* Adjusted for age, gender and class.
†Adjusted for gender and class.
‡Adjusted for age and class.
§Adjusted for class.
¶Adjusted for age and gender.
**Adjusted for gender.

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Web Table 2 Rates of multiple (3+) sexual partners in late adolescence according to substance use and associated odds ratios (unadjusted for other substance use) for each cohort, by social class

	1987/1990 cohort					1999/2003 cohort					*p-value of interaction with cohort*
	<3 sexual partners		3+ sexual partners			<3 sexual partners		3+ sexual partners			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
NON-MANUAL											
Current smoking											
No	229	74.6	35	48.6	1.00	199	84.0	105	60.3	1.00	
Yes	78	25.4	37	51.4	3.18 (1.80-5.63)	38	16.0	69	39.7	3.34 (2.10-5.31)	*0.813*
Excessive drinking†											
No	252	82.4	37	51.4	1.00	186	78.5	91	52.3	1.00	
Yes	54	17.6	35	48.6	3.93 (2.16-7.12)	51	21.5	83	47.7	3.30 (2.13-5.11)	*0.472*
Ever used illicit drugs											
No	230	75.2	26	36.6	1.00	139	58.6	47	27.0	1.00	
Yes	76	24.8	45	63.4	4.60 (2.59-8.19)	98	41.4	127	73.0	3.84 (2.49-5.93)	*0.405*
MANUAL											
Current smoking											
No	255	69.1	70	50.0	1.00	165	75.0	133	47.7	1.00	
Yes	114	30.9	70	50.0	3.13 (1.94-5.05)	55	25.0	146	52.3	3.37 (2.28-5.00)	*0.191*
Excessive drinking†											
No	337	91.3	81	57.9	1.00	181	82.3	158	56.6	1.00	
Yes	32	8.7	59	42.1	5.08 (2.93-8.79)	39	17.7	121	43.4	3.66 (2.38-5.63)	*0.247*
Ever used illicit drugs											
No	287	78.0	55	39.3	1.00	128	58.2	63	22.6	1.00	
Yes	81	22.0	85	60.7	3.99 (2.50-6.35)	92	41.8	216	77.4	4.73 (3.18-7.04)	*0.727*

p-values of interactions by social class: within 1987/1990 cohort - current smoking by class p=0.674, excessive drinking by class p=0.349, ever illicit drugs by class p=0.749; within 1999/2003 cohort – current smoking by class p=0.983, excessive drinking by class p=0.672, ever illicit drugs by class p=0.379.

*Adjusted for age and gender.

†Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.

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Web Table 3 Rates of early sexual initiation according to early adolescent substance use and associated odds ratios (unadjusted for other substance use) for each cohort, by social class

	1987/1990 cohort					1999/2003 cohort					
	No early sexual initiation		Early sexual initiation			No early sexual initiation		Early sexual initiation			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	*p-value of interaction with cohort*
NON-MANUAL											
Started smoking age <14											
No	272	82.2	31	68.9	1.00	295	92.5	58	65.2	1.00	
Yes	59	17.8	14	31.1	1.96 (0.96-3.98)	24	7.5	31	34.8	6.58 (3.61-12.01)	*0.010*
Monthly drinking age 15											
No	262	79.2	28	63.6	1.00	145	45.5	13	14.6	1.00	
Yes	69	20.8	16	36.4	2.13 (1.09-4.18)	174	54.5	76	85.4	4.83 (2.58-9.02)	*0.080*
Ever used illicit drugs age 15											
No	313	94.8	36	80.0	1.00	234	73.1	26	29.2	1.00	
Yes	17	5.2	9	20.0	3.92 (1.59-9.67)	86	26.9	63	70.8	6.87 (4.06-11.63)	*0.429*
MANUAL											
Started smoking age <14											
No	333	80.2	55	58.5	1.00	288	82.5	97	55.1	1.00	
Yes	82	19.8	39	41.5	3.29 (1.96-5.50)	61	17.5	79	44.9	4.01 (2.66-6.05)	*0.277*
Monthly drinking age 15											
No	360	86.7	59	62.8	1.00	141	40.4	34	19.3	1.00	
Yes	55	13.3	35	37.2	3.32 (1.95-5.64)	208	59.6	142	80.7	2.92 (1.89-4.51)	*0.723*
Ever used illicit drugs age 15											
No	382	92.0	69	73.4	1.00	214	61.5	68	38.6	1.00	
Yes	33	8.0	25	26.6	3.73 (2.01-6.89)	134	38.5	108	61.4	2.62 (1.80-3.82)	*0.369*

p-values of interactions by social class: within 1987/1990 cohort – started smoking age <14 by class p=0.284, monthly drinking age 15 by class p=0.301, ever illicit drugs age 15 by class p=0.949; within 1999/2003 cohort – started smoking age <14 by class p=0.149, monthly drinking age 15 by class p=0.159, ever illicit drugs age 15 by class p=0.005.
*Adjusted for gender.

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Clustering of substance use and sexual risk behaviour in adolescence: analysis of two cohort studies

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Clustering of substance use and sexual risk behaviour in adolescence: analysis of two cohort studies

Short title: A cohort analysis of risk behaviour clustering during adolescence

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ABSTRACT

Objectives We aimed to examine whether changes in health-risk behaviour rates alters the relationships between behaviours during adolescence, by comparing clustering of risk behaviours at different time points.

Design Comparison of two cohort studies, the Twenty-07 S: Health in the Community study ('earlier cohort', surveyed in 1987 and /1990 study) and the 11-16/16+ Study: Young People's Health ('later cohort', surveyed 1999 and /2003 study).

Setting Central Clydeside Conurbation around Glasgow City.

Participants Young people who agreed to participated in the Twenty-07 and 11-16/16+ studies and who completed surveys on health behaviours at time of recruitment and/or follow-upages 15 and 18-19.

Primary and secondary outcomes measures We analysed data on risk behaviours collected at age 15in both early adolescence (started smoking prior to age 14, monthly drinking and, ever used illicit drugs at age 15 and sexual intercourse prior to age 16) and at ages 18-19late adolescence (age 18-19 current smoking, excessive drinking, ever used illicit drugs and multiple sexual partners), by gender and social class.

Results Drinking, illicit drug use and risky sexual behaviour (but not smoking) increased between the earlier and later cohort, especially among females. We found strong associations between substance use and sexual risk behaviour during early and late adolescence, with few differences between cohorts, or by gender or social class. Adjusted odds ratios for associations between each substance and sexual risk behaviour were around 2.00. The only significant between-cohort difference was a stronger association between female early adolescent smoking and early sexual initiation in the 1999/2003later cohort. Also, In the later cohort the relationships between illicit drug use and each ofboth early sexual initiation and multiple sexual partners in late adolescence were significantly stronger among females than males in the later cohort.

Conclusions Despite changes in rates, relationships between adolescent risk behaviours remain strong, irrespective of gender and social class. This indicates a need for improved risk behaviour prevention in young people, perhaps through a holistic approach, that addresses the broad shared determinants of various risk behaviours.

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INTRODUCTION

Adolescence is a critical period of development, when 'risky' health behaviours may be adopted. These impact on current and future health and wellbeing,(1;2) and are increasingly difficult to modify later in life.(3) There is evidence that some health risk behaviours tend to cluster in adolescence (4-9). A particular focus has been on relationships between substance use and sexual behaviour. In addition to direct effects of certain substances on sexual decisions (10) this may reflect a predisposition towards risky behaviours in some individuals (11) since not only alcohol and illicit drugs, but also smoking, are strongly associated with adolescent sexual risk behaviour.(12)

There is some evidence that relationships between substance use and sexual behaviour vary by socio-demographic group and culture. Most studies have found stronger associations among females than males (4;6;10;13), although some report no gender differences.(7;14) However, we are unaware of studies which have examined whether associations vary according to either age or socioeconomic status (SES). The authors of one study which found *no* relationship between early initiation of sexual intercourse and substance use among deprived African-American adolescents suggest this unusual finding might indicate these behaviours have different cultural meanings among certain groups.(15) Another study found weaker associations between substance use and sexual initiation in the US than Europe. Its authors suggest the difference might have resulted from lower substance use rates in their US sample or international differences in acceptability of adolescent substance use or sexual behaviour.(7)

The present study, based on two adolescent cohorts, born 12 years apart in the same geographic area, the West of Scotland, examines associations between substance use and sexual risk behaviour. Unlike some studies which have used composite substance use measures (4;7), we examine relationships between each of smoking, drinking and illicit drug use, and sexual risk behaviour. Most similar studies have been conducted in the USA, but results might vary according to cultural context.(7;9) Historical context is another potentially important influence on health-risk behaviour clustering, but absent from previous studies. Our cohorts were adolescents in the late 1980s and late 1990s/early new millennium respectively. This was a period of considerable social change, including massive increases in young people's involvement

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in the night-time economy.(16) Significant increases in some adolescent health-risk behaviours over this period have been documented (17;18) and are evident in comparisons of our cohorts. Rates of drinking, illicit drug use and risky sexual behaviour were greater in the later cohort, with increases generally larger among females than males but few differences according to SES.(19;20) It is possible that as the prevalence (and so normative nature) of behaviours changes(21), so might their clustering. The one study to examine between-country differences suggested higher substance use rates may have resulted in stronger associations with sexual risk behaviour.(7) However, if clustering reflects a predisposition towards risky behaviours in some individuals (11), then we might expect clustering to be less evident in periods when such behaviours are more prevalent.

In our study we conducted analyses on health-risk behaviours in both early adolescence (collected at age 15) and late adolescence (collected at age 18-19), since it is possible that associations between substance use and risky sexual behaviour change with age. We examined the associations at two different time points, to see if they differed by period. We also examined differences according to gender, which previous studies have shown to impact on associations between substance use and sexual risk behaviour, and SES, which has tended not to be addressed in previous studies.

METHODS

Study population

We used data collected at ages 15 and 18-19 from two West of Scotland studies: the *'Twenty-07 Study: Health in the Community'* (henceforth referred to as the ~~1987/~~'earlier~~y~~' ~~1990~~ study/cohort)(22) and the *'11-16/16+ Study: Young People's Health' (*henceforth the 'later'~~1999/2003~~ study/cohort*)* (23). Ethical approval was received from the NHS for the ~~1987/1990~~earlier~~y~~ study and from Glasgow University for the ~~1999/2003~~later study.

The ~~1987/1990~~earlier~~y~~ study began in 1987, and was located in the Central Clydeside Conurbation around Glasgow. At baseline, 1009 15-year olds (65% issued sample) were recruited, with no significant gender or social class differences compared with the source population (24); 908 (90%) participated at follow-up in

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1990. At both stages, respondents were interviewed in their homes by trained interviewers using paper questionnaires.

The ~~1999/2003~~later ~~study~~ cohort, also located in the Central Clydeside Conurbation was recruited in 1994 during their final primary school year, aged 11 (93% response). Full details of the sampling strategy are available.(25) The cohort was followed up during secondary schooling, aged 15 in 1999 (N=2196, 85% of the baseline sample) using self-completion questionnaires, and post-school, at ages 18-19 in 2002-4 (henceforth 2003) when 1258 respondents (49% of baseline) were interviewed using computer-assisted interviews in survey centres or participants' homes. Fieldwork for this stage took longer than that of the ~~1987/1990~~earlier study, resulting in a sample which was slightly older with a broader age distribution.

Definitions

Smoking: In both studies, interviewers asked respondents aged 18-19 whether they were current, ex or never smokers, allowing derivation of a dichotomous late adolescence 'current smoker' variable. Current and ex-smokers were also asked the age when they first tried smoking; all participants reporting 13 years or less were defined as 'started smoking below age 14'.

Drinking: In both studies, respondents were asked at age 18-19 about alcohol intake using a past week drinking grid (Web Appendix). From this, a dichotomous variable was derived representing drinking over weekly recommended alcohol limits (hereafter called 'excessive drinking': ≥ 22 units in the past week for males, ≥ 15 for females) (26). At age 15, respondents were asked about drinking frequency. Those drinking 'at least once a month' (in the ~~1978/1990~~earlier~~y~~ study) and 'about once a month' (in the ~~1999/2003~~later study) or more were defined as 'monthly drinkers at age 15'.

Illicit drug use: At age 15 and again at 18-19, respondents in both studies were provided with lists of illicit drugs (Web Appendix) and asked if they had experience of any.

Multiple partners and early sexual initiation: In both studies, at age 18-19, all participants reporting opposite sex experience were asked about number of sexual partners ever, used to derive a dichotomous '3+ sexual partners' variable. They were also asked age at first sexual intercourse with someone of the

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opposite sex, allowing derivation of a variable representing 'early sexual initiation' (age <16 years vs ≥16 or hasn't happened).

Social class was derived from head of household occupation. This information was collected at baseline, in the ~~1987/1990~~earlier~~y~~ study via parental interview, and in the ~~1999/2003~~later study via parental self-completion questionnaire (supplemented, where necessary, by information provided by respondents during interviews with research nurses which we have shown to be reliable).(27) Social class was dichotomised into non-manual and manual groupings.

Analysis

Analyses for each cohort were restricted to those participating in both data collection waves. Attrition in the earlier ~~1987/1990~~ study was slightly greater among manual class respondents. At each wave of the ~~1999/2003~~later study attrition was greater among respondents from manual class backgrounds, with lower teacher-rated ability and educational involvement and from reconstituted/lone-parent households. Attrition-based weights were constructed for both studies.(23;28) Because these were based on those present at all waves, their effect is to reduce the size of the ~~1999/2003~~later study age 18-19 dataset to 1006 respondents. We further restricted analyses to those with no missing behavioural or social class data (no respondent had missing gender or age data) (Table 1).

We used Poisson regression to compare mean numbers of behaviours between cohorts separately for early and late adolescence, and for males and females (adjusted for social class), and manual and non-manual groups (adjusted for gender). In our ~~A~~analyses relating to late adolescence we also adjusted for age at interview, previously shown to be important.(20) This was not done for early adolescent behaviours because these data were not all obtained at the age 18-19 interview (footnote to Table 1). We included terms to identify any interactions by cohort and gender/social class.

We used logistic regression to calculate odds ratios (ORs) and associated confidence intervals (CIs) for the relationships between each substance and having had three or more sexual partners in late adolescence. We adjusted for: social class and age; and then social class, age and other substance use. We did this

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separately for the ~~1987/1990~~earlier and ~~1999/2003~~later studies and within that by gender (all models adjusting for age and social class) and by social class (adjusting for age and gender). Additional analyses included terms to identify interactions by cohort and, within each cohort, by gender or social class. We used similar models (without age adjustment) to examine relationships between early adolescent substance use and early sexual initiation.

RESULTS

Time-trends in multiple risk behaviour frequencies

As previously reported (19;20), rates of drinking, illicit drug use and sexual risk behaviour were considerably higher in the later cohort (Table 1). As would therefore be expected, the proportion reporting no late adolescent risk behaviours decreased from 42.6% in the ~~1987/1990~~earlier cohort to 24.1% in the ~~1999/2003~~later cohort, whilst that reporting multiple late adolescent risk behaviours increased markedly, with 4.7% of the earlier and 12.2% of the later cohort reporting all four (Web Table 1). Similarly, 57.2% of the ~~1987/1990~~earlier cohort, but 26.7% of the ~~1999/2003~~later cohort, reported no early adolescent substance use or sexual initiation, while all four early adolescent risk behaviours were reported by 1.7% of the earlier and 9.6% of the later cohort.

These changes were more pronounced in females. Thus, increases in mean numbers of late adolescent risk behaviours were greater among females (0.75 versus 1.56; age and social class adjusted p<0.001), than males (1.50 versus 1.93; adjusted p=0.048); the cohort-by-gender interaction was highly significant (adjusted p<0.001) (Web Table 1). Mean numbers of early adolescent risk behaviours increased significantly among both females and males (0.51 versus 1.56 and 0.84 versus 1.55, respectively; both adjusted p<0.001), but again the increase was greater among females (cohort-by-gender interaction adjusted p<0.001). Contrasting with these gender differences, increases in mean numbers of both late and early adolescent risk behaviours were very similar in those from non-manual compared with manual social class backgrounds (Web Table 1).

Relationships between substance use and sexual risk behaviour

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Associations between late adolescent substance use and multiple sexual partners and between early adolescent substance use and early sexual initiation were strong. This was true for both cohorts, for both males and females, and for both social class groups.

In the ~~1987/1990~~earlier cohort, associations unadjusted for other substance use, between late adolescent substance use and multiple sexual partners, were slightly lower in respect of current smoking (male OR 3.43, 95% CI 2.21 to 5.32 ; female OR 2.61, 95% CI 1.34 to 5.06) than either excessive drinking (male OR 4.79, 95% CI 3.00 to 7.64; female OR 3.54, 95% CI 1.57 to 7.98) or having used illicit drugs (male OR 4.38, 95% CI 2.85 to 6.73, female OR 3.76, 95% CI 1.92 to 7.37) (Table 2). In the ~~1999/2003~~later cohort, the equivalent associations were all weaker among males, but unchanged or stronger among females, although none of the interactions with cohort were significant. However, in this later cohort, the gender difference in the strength of association between illicit drug use and multiple sexual partners (male OR 2.71, 95% CI 1.80 to 4.09; female OR 6.72, 95% CI 4.41 to 10.26) was significant (drugs-by-gender interaction p=0.003).

After adjustment for other substance use, associations between use of each substance and multiple sexual partners in late adolescence attenuated by around one-third, resulting in ORs of around 2.00-3.00 (Figure 1a). Associations were generally similar for males and females and similar for both studies. However, the relationship between illicit drug use and multiple sexual partners in the ~~1999/2003~~later cohort continued to be stronger among females than males (p for interaction = 0.002).

Similar results were obtained in models of associations between early adolescent substance use and early sexual initiation (Table 3; Figure 1b). In models unadjusted for other substance use, relationships between each substance and early sexual initiation weakened slightly over time among males, but strengthened among females. This trend was particularly marked for the relationship between having started smoking below age 14 and early sexual initiation (female OR 1.46, 95% CI 0.67 to 3.18 in 1987/1990; OR 6.40, 95% CI 3.94 to 10.39 in 1999/2003, p for cohort interaction=0.002). As in late adolescence, in the ~~1999/2003~~later cohort there was a significant gender difference (p=0.005) in the association between illicit drug use and sexual behaviour, which was stronger among females. After adjusting for other substance use, associations between each substance and early sexual initiation were attenuated by up to one half, with the greatest

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attenuation occurring among females in the later cohort, giving ORs of around 2.00 (Figure 1b). As in the unadjusted analyses, the relationship between early smoking and early sexual initiation among females was stronger in the later than the earlier cohort (p for cohort interaction=0.022), and the relationship between early illicit drug use and early sexual initiation in the later cohort was stronger among females than males (p for gender interaction=0.023).

Associations between substance use and risky sexual behaviour in both late and early adolescence were similar for participants from both social class groups in both cohorts. This was true for associations unadjusted for other substance use (Web Table 2; Web Table 3) and for those adjusted for other substance use (Figure 2). The one exception was that the relationship between early illicit drug use and early sexual initiation was weaker in manual compared with non-manual social class groups in the later cohort (drugs-by-class interaction p=0.016; Figure 2b).

DISCUSSION

Our comparison of two cohorts revealed a large increase in the proportion of young people reporting early and late adolescent multiple risk behaviours between 1987/1990 and 1999/2003. Increases were particularly marked among females, but broadly similar in both social class groups. We found strong associations, both between early substance use and early sexual initiation, and between late adolescent substance use and having had multiple sexual partners. These relationships were broadly similar for males and females and between social class groups. Despite much higher rates of drinking, drug use and risky sexual behaviour (but not smoking) in the later cohort, relationships between use of each substance and risky sexual behaviour showed little or no change over time.

Increasing proportions reporting multiple health-risk behaviours are to be expected, given higher rates of all individual risk behaviours, except smoking, in the later cohort.(19;20) However, they are particularly concerning given suggestions that certain behavioural combinations might operate synergistically to increase health risks. Thus smoking plus drinking dramatically increases risk of certain cancers,(29) while sexual behaviour plus drinking or illicit drug use may result in less informed decisions, more unprotected sex, risk of violence or subsequent regret.(4;10;14;30)

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Most (4;6;10;13) but not all (7;14) previous studies have found stronger associations between adolescent substance use and sexual behaviour among females. This may be because sexual experience in adolescence is more normative for males and so less tied to other risk behaviours (13) or it may reflect different attitudes towards sexual behaviour among male compared with female adolescents (30). We found no gender differences in relationships between early or late adolescent substance use and risky sexual behaviour in our earlier cohort. However, the association between illicit drug use and sexual risk behaviour in both early and late adolescence was stronger among females than males in our later cohort. Had we found stronger relationships in our earlier cohort that disappeared or weakened over time, we might have attributed this to the gender convergence in adolescent sexual risk behaviour (31) or changing attitudes towards female sexuality (32). The findings we did obtain are hard to explain.

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Our study has a number of strengths. We compared two cohorts of young people from the same geographic area and life-stage, surveyed using (near) identical questions, 13 years apart. To our knowledge, this is the first study to examine time-trends in associations between substance use and sexual behaviour. We also examined these associations in both early *and* late adolescence and by gender and social class, the latter of which has not, to our knowledge, been previously investigated. However, there are some limitations. The follow-up rate in the ~~1999/2003~~later study was quite low, with greater non-response among certain groups. Although accounted for via weighted analyses, we may not have fully compensated for differential loss to follow-up of adolescents with more 'risky' patterns of behaviour. The questions included for each cohort were equivalent for all behaviours except alcohol intake, which included a more detailed drinking grid in the 1999/2003 study, possibly encouraging increased reporting. Parental occupational data, used to derive social class, were also collected in different ways, but there is little reason to think the methods would impact in such a way as to produce bias. Ideally, we would have used unprotected sex as a measure of sexual risk behaviour in ~~older~~late adolescence, but, unfortunately, the two studies did not include equivalent questions ~~data~~ on contraception or condom use at age 18-19. We therefore relied on number of sexual partners as an alternative proxy for 'risky' sexual behaviour. Finally, interviewer-administered questionnaires (from which all behavioural data were obtained apart from those relating to early adolescent drinking and drug use in the ~~1999/2003~~later study) have been shown to lead to

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under-reporting of behaviours compared with self-administered instruments (33), so possibly impacting on the strength of the observed associations.

Consideration should also be given to the generalisability of our findings. It is possible that prevalence of adolescent risk behaviours, in particular illicit drug use, may be higher in Glasgow City than in some other areas of Scotland and the UK. However, the increase in risk behaviours observed by ourselves has also been reported in other studies and there is no reason to believe that Glasgow would differ from other large urban areas in respect of associations between adolescent sexual risk behaviour and substance use.

Conclusions

Despite increases in adolescent multiple risk behaviour during the 1990s, the strength of associations between substance use and sexual risk behaviour remained largely similar. These findings have several public health implications. National and local governmental policy and strategies should reflect the strong relationships between adolescent risk behaviours and support broader and more integrated approaches to prevention and treatment.(34-36) For example, sexual health clinics could routinely opportunistically offer advice and counselling for alcohol and illicit drug use.(37) Clustering of adolescent health-risk behaviours partly reflects shared underlying determinants.(11;34) Thus a holistic preventive approach, addressing broad determinants of risk behaviours, from individual through to societal influences, is needed. Strong associations between early adolescent substance use and sexual initiation mean preventive measures should be implemented at younger ages, possibly during primary school. Such a holistic approach would require effective cross-sector government collaboration, especially between education and health departments. Finally, given that substance use and sexual risk behaviour appear to be strongly associated across social class groups, preventive approaches to risk behaviour should include both universal and targeted approaches, described by Marmot as proportionate universalism,(38) to ensure equitable improvement in adolescent health and wellbeing.

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What is already known on this subject?

There is growing evidence that adolescent substance use and sexual risk behaviour are associated. However, less is known about how these associations differ by gender and socioeconomic status, or, given the increase in health-risk behaviour in the past two decades, whether these associations have changed over time.

What this study adds?

We found that despite increasing health-risk behaviour rates during the 1990s, associations between substance use and sexual risk behaviour remained strong, in the early 2000s, in both ~~younger~~ early *and* ~~older~~ late adolescen~~ts~~ce, irrespective of gender or social class. These data further support the need for improved policies, strategies and interventions to prevent multiple risk behaviour in young people.

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Authors' contributions

All authors contributed to the analysis plan and questions addressed in the paper and to the interpretation of the results. CJ drafted the paper and is guarantor. HS contributed to the design of *11-16/16+* and its data collection, cleaned data from both studies and conducted the analyses. HS and SH critically revised the paper and all authors gave approval for the final version to be published.

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Competing interests

The authors have no competing interests

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Table 1 Demographic characteristics, substance use and risky sexual behaviour in late and early adolescence in both cohorts

Analyses of later adolescent substance use and multiple sexual partners					Analyses of earlier adolescent substance use and early sexual initiation				
	1987/1990 ('earlier') cohort		1999/2003 ('later') cohort			1987/1990 ('earlier') cohort		1999/2003 ('later') cohort	
Mean age (SD)	18 years 7 months (3.9 months)		19 years 3 months (6.4 months)		**Mean age (SD)**	15 years 8 months (3.8 months)		15 years 5 months (3.7 months)	
	N	**%**	**N**	**%**		**N**	**%**	**N**	**%**
Total	**887**	**100**	**910**	**100**	**Total**	**884**	**100**	**933**	**100**
Gender					**Gender**				
Male	418	47.1	454	49.9	Male	416	47.0	473	50.7
Female	469	52.9	456	50.1	Female	468	53.0	460	49.3
Social class					**Social class**				
Non-manual	378	42.6	410	45.1	Non-manual	375	42.4	408	43.8
Manual	509	57.4	499	54.9	Manual	509	57.6	525	56.2
Current smoker*					**Started smoking at age <14***				
Yes	298	33.6	308	33.9	Yes	193	21.9	195	20.9
No	589	66.4	602	66.1	No	691	78.1	738	79.1
Excessive drinking*†					**Monthly drinking at age 15‡**				
Yes	181	20.4	295	32.4	Yes	175	19.8	600	64.3
No	706	79.6	615	67.6	No	709	80.2	333	35.7
Ever used illicit drugs*					**Ever illicit drugs at age 15‡**				
Yes	288	32.5	532	58.5	Yes	85	9.6	391	41.9
No	599	67.5	378	41.5	No	799	90.4	542	58.1
3+ sexual partners*					**Sex at age <16***				
Yes	212	23.9	453	49.8	Yes	139	15.7	265	28.4
No	675	76.1	456	50.2	No	745	84.3	668	71.6

* Information obtained at age 18-19 interview.
† Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.
‡ Information obtained at age 15 interview (earlier cohort) or self-completion questionnaire (later cohort).

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Table 2 Rates of multiple (3+) sexual partners in late adolescence according to substance use and associated odds ratios (unadjusted for other substance use) in each cohort, by gender

	1987/1990 ('earlier') cohort					1999/2003 ('later') cohort					
	<3 sexual partners		3+ sexual partners			<3 sexual partners		3+ sexual partners			*p-value of interaction by cohort*
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
MALES											
Current smoking											
No	192	78.0	87	50.6	1.00	161	77.8	134	54.5	1.00	
Yes	54	22.0	85	49.4	3.43 (2.21 to 5.32)	46	22.2	112	45.5	2.61 (1.71 to 3.97)	0.371
Excessive drinking†											
No	198	80.5	88	51.2	1.00	158	76.0	122	49.6	1.00	
Yes	48	19.5	84	48.8	4.79 (3.00 to 7.64)	50	24.0	124	50.4	3.42 (2.25 to 5.20)	0.414
Ever used illicit drugs											
No	174	70.7	61	35.5	1.00	95	45.9	59	24.0	1.00	
Yes	72	29.3	111	64.5	4.38 (2.85 to 6.73)	112	54.1	187	76.0	2.71 (1.80 to 4.09)	0.124
FEMALES											
Current smoking											
No	292	68.1	18	45.0	1.00	202	81.5	104	50.0	1.00	
Yes	137	31.9	22	55.0	2.61 (1.34 to 5.06)	46	18.5	104	50.0	4.29 (2.79 to 6.58)	0.203
Excessive drinking†											
No	391	90.9	30	75.0	1.00	208	83.9	127	61.1	1.00	
Yes	39	9.1	10	25.0	3.54 (1.57 to 7.98)	40	16.1	81	38.9	3.55 (2.27 to 5.56)	0.953
Ever used illicit drugs											
No	344	80.0	20	51.3	1.00	171	69.0	52	25.1	1.00	
Yes	86	20.0	19	48.7	3.76 (1.92 to 7.37)	77	31.0	155	74.9	6.72 (4.41 to 10.26)	0.144

p-values of interactions by gender: within earlier cohort - current smoking by gender p=0.465, excessive drinking by gender p=0.742, ever illicit drugs by gender p=0.795; within later cohort – current smoking by gender p=0.145, excessive drinking by gender p=0.841, ever illicit drugs by gender p=0.003.

*Adjusted for social class and age.

†Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.

OR = odds ratios; CI = confidence interval.

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Table 3 Rates of early sexual initiation according to early adolescent use and associated odds ratios (unadjusted for other substance use) in each cohort, by gender

	1987/1990 ('earlier') cohort					1999/2003 ('later') cohort					
	No early sexual initiation		Early sexual initiation			No early sexual initiation		Early sexual initiation			p-value of interaction with cohort
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
MALES											
Started smoking age <14											
No	261	83.9	61	58.7	1.00	288	87.3	92	64.3	1.00	
Yes	50	16.1	43	41.3	3.64 (2.20 to 6.02)	42	12.7	51	35.7	3.45 (2.14 to 5.58)	0.879
Monthly drinking age 15											
No	252	80.8	62	59.6	1.00	148	44.8	32	22.4	1.00	
Yes	60	19.2	42	40.4	3.00 (1.84 to 4.92)	182	55.2	111	77.6	2.74 (1.74 to 4.32)	0.780
Ever used illicit drugs age 15											
No	287	92.3	76	73.1	1.00	210	63.8	60	42.0	1.00	
Yes	24	7.7	28	26.9	4.11 (2.24 to 7.54)	119	36.2	83	58.0	2.42 (1.61 to 3.65)	0.159
FEMALES											
Started smoking age <14											
No	343	79.0	25	71.4	1.00	295	87.3	63	51.6	1.00	
Yes	91	21.0	10	28.6	1.46 (0.67 to 3.18)	43	12.7	59	48.4	6.40 (3.94 to 10.39)	0.002
Monthly drinking age 15											
No	370	85.3	25	71.4	1.00	138	40.9	15	12.3	1.00	
Yes	64	14.7	10	28.6	2.32 (1.04 to 5.14)	199	59.1	107	87.7	4.93 (2.75 to 8.84)	0.133
Ever used illicit drugs age 15											
No	407	94.0	29	82.9	1.00	237	70.1	34	27.9	1.00	
Yes	26	6.0	6	17.1	3.09 (1.16-to 8.21)	101	29.9	88	72.1	6.17 (3.87 to 9.83)	0.218

p-values of interactions by gender: within earlier cohort – started smoking age <14 by gender p=0.047, monthly drinking age 15 by gender p=0.710, ever illicit drugs age 15 by gender p=0.564; within later cohort – started smoking age <14 by gender p=0.134, monthly drinking age 15 by gender p=0.118, ever illicit drugs age 15 by gender p=0.005.

*Adjusted for social class.

OR = odds ratio; CI = confidence interval.

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Figure 1 Associations, by gender and cohort, between (a) late adolescent substance use and having had three or more sexual partners and (b) early adolescent substance use and early sexual initiation.

"Earlier" cohort = 1987/1990 cohort; "Later" cohort = 1999/2003 cohort

*Adjusted for age and class

† p-value of gender by illicit drug use interaction in 2003 = 0.002

‡ Adjusted for class

§p-value of cohort interaction for smoking prior to age 14 among females = 0.022

¶p-value of gender by illicit drug use interaction in 2003 = 0.023

OR = odds ratios; CI = confidence intervals

Figure 2 Associations, by social class and cohort, between (a) late adolescent substance use and having had three or more sexual partners and (b) early adolescent substance use and early sexual initiation.

"Earlier" cohort = 1987/1990 cohort; "Later" cohort = 1999/2003 cohort

*Adjusted for age and gender

†Adjusted for gender

‡p-value of class by illicit drug use interaction in 2003 = 0.016

OR = odds ratios; CI = confidence intervals

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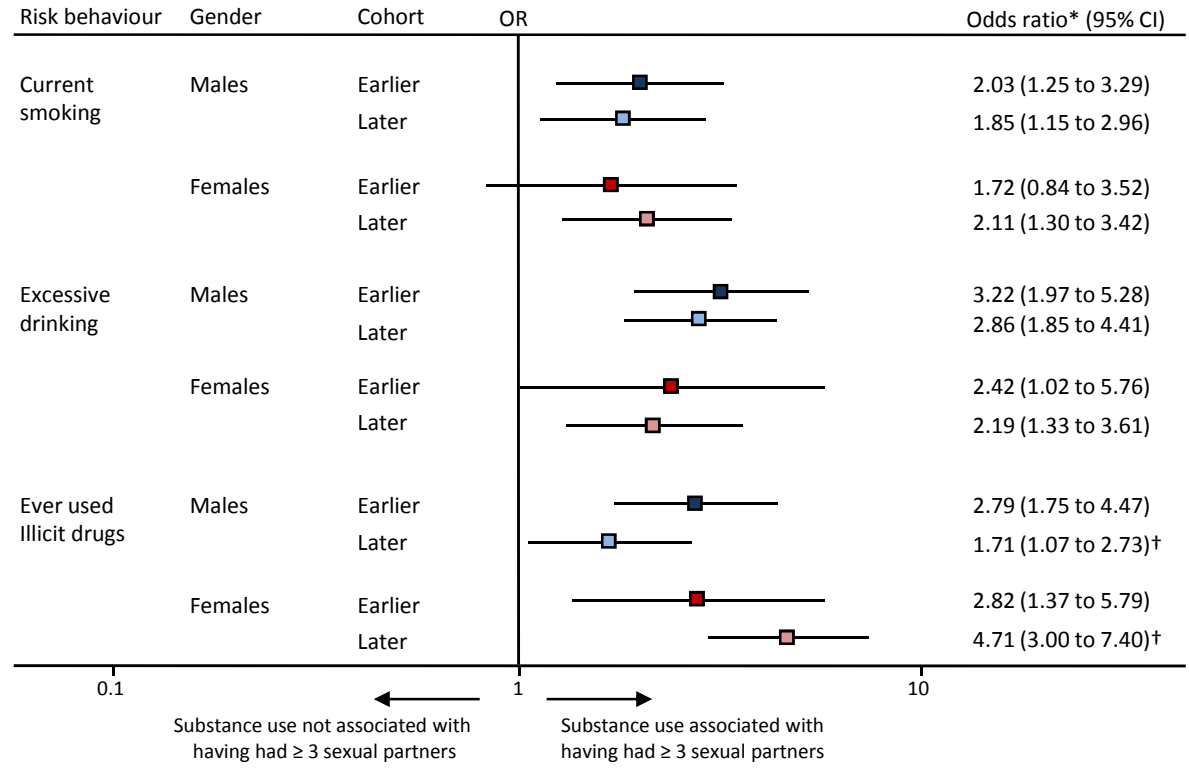
Figure 1

(a)



(b)

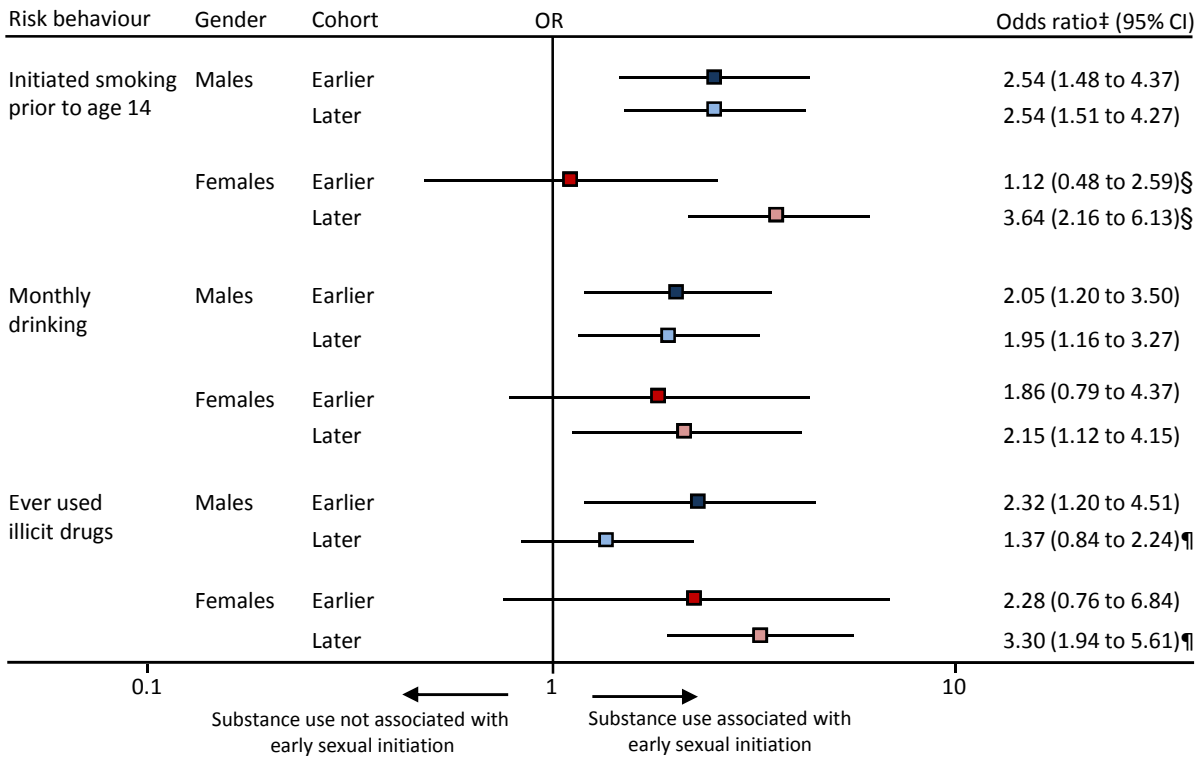


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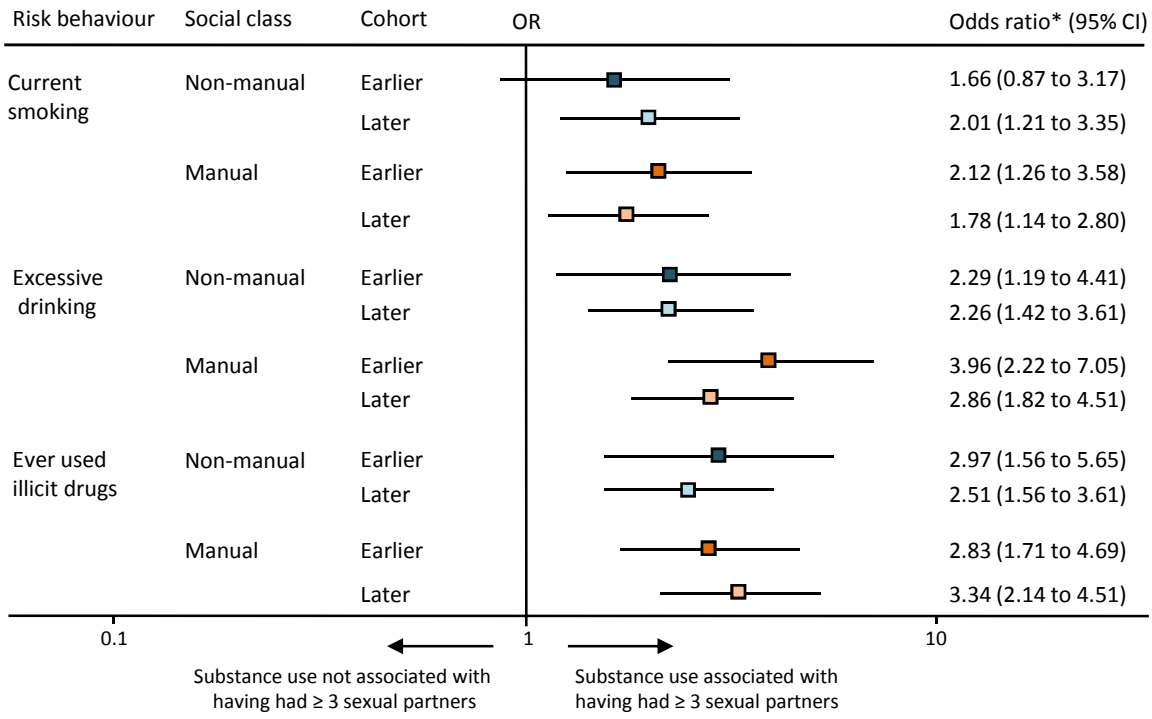
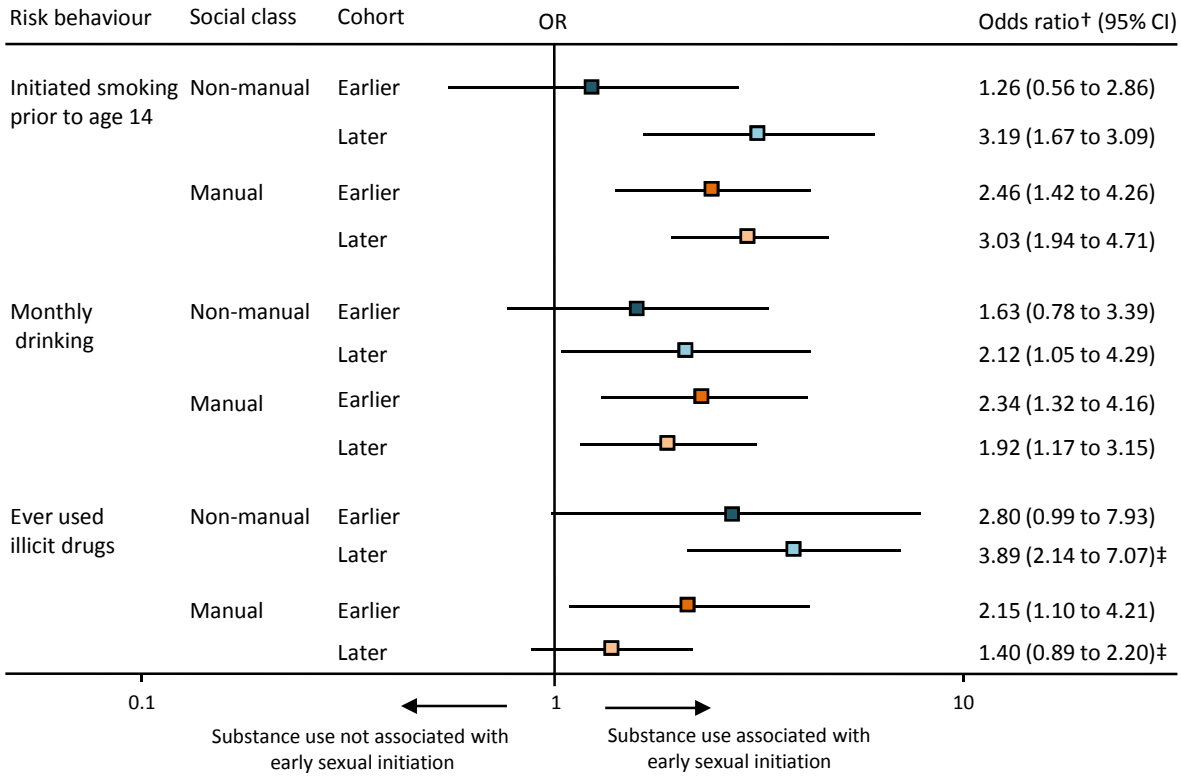
Figure 2

(a)



(b)



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Web Appendix Description of the past-week drinking grids and lists of illicit drugs provided to respondents

Drinking grids

At age 18-19, both studies included past-week drinking grids to measure alcohol use. In the 1987/1990 study this asked about: pints, glasses, bottles and measures of beer, lager, shandy, stout and cider; wine; fortified wine; spirits; and other drinks. The grid in the 1999/2003 study was more detailed and asked about: pints, small, large and very large cans and bottles and small and large glasses of shandy; normal or strong beer, lager or stout; normal or strong cider; babycham; wine or champagne; cocktails, mixers, breezers or alcopops; spirits or liqueurs; (flavoured) schnapps; buckfast, eldorado or sanatogen; sherry, martini, taboo or port; MD20/20; and other drinks.

Illicit drugs lists

At age 15 ('early adolescence'), respondents in both studies were provided with the following list of illicit drugs: cannabis; LSD; barbiturates; glues, solvents, dry-cleaning fluids; fuels or gas; amphetamines; opium; morphine; heroin; cocaine; crack; PCP; magic mushrooms. The 1987/1990 study age 15 list also included barbiturates; opium; morphine; and PCP. The 1999/2003 study age 15 list also included temazepam and ecstasy.

At age 18-19 ('late adolescence'), respondents in both cohorts were provided with the following list, comprising: cannabis; LSD; temazepam; tranquillisers; glues, sprays, gas, dry cleaning fluid; amphetamine; amyl or butile nitrite; heroin; methadone; temgesic; cocaine; crack; ecstasy; magic mushrooms; morphine or opium. The list given to the 1987/1990 cohort also included other barbiturates and PCP.

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Web Table 1 Proportion reporting none, one, two, three or four behaviours and mean number of behaviours in early and late adolescence within each cohort, with β (adjusted as appropriate) for the increase in means between 1987/1990 (the 'earlier' cohort) and 1999/2003 (the 'later' cohort), overall and among males vs females and those from non-manual vs manual backgrounds

		Late adolescence substance and 3+ sexual partners								Early adolescent substance use and early sexual initiation							
	Cohort	None (%)	One (%)	Two (%)	Three (%)	Four (%)	Mean N behaviours	β (p-value)	p-value cohort by gender/ social class interaction	None (%)	One (%)	Two (%)	Three (%)	Four (%)	Mean N behaviours	β (p-value)	p-value cohort by gender/ social class interaction
Overall																	
	1987/1990	42.6	24.4	17.2	11.0	4.7	1.10	0.34*	-	57.2	26.2	10.1	4.8	1.7	0.67	0.81†	-
	1999/2003	24.1	20.5	24.2	19.0	12.2	1.75	(< 0.001)		26.7	26.0	22.0	15.7	9.6	1.55	(<0.001)	
By gender																	
Males	1987/1990	32.5	20.6	19.4	19.1	8.4	1.50	0.12‡		51.3	24.9	13.4	7.4	2.9	0.84	0.59§	
	1999/2003	17.4	21.2	25.2	22.7	13.5	1.93	(0.048)		26.3	26.1	23.7	15.0	8.9	1.55	(<0.001)	
									<0.001								<0.001
Females	1987/1990	51.7	27.9	15.3	3.8	1.5	0.75	0.65‡		62.3	27.2	7.2	2.6	0.6	0.51	1.08§	
	1999/2003	30.7	19.7	23.2	15.4	11.0	1.56	(< 0.001		27.2	25.9	20.3	16.3	10.2	1.56	(< 0.001)	
By social class																	
Non-manual	1987/1990	46.4	22.2	16.4	10.0	5.0	1.05	0.27¶		58.9	26.5	10.1	2.9	1.6	0.61	0.75**	
	1999/2003	29.0	22.4	22.0	17.6	9.0	1.56	(< 0.001)		32.8	27.1	21.3	12.2	6.6	1.33	(<0.001)	
									0.155								0.281
Manual	1987/1990	39.9	26.1	17.9	11.8	4.3	1.14	0.40¶		55.8	26.0	10.2	6.3	1.8	0.71	0.85**	
	1999/2003	20.0	19.0	26.2	20.0	14.8	1.90	(< 0.001)		21.9	25.1	22.9	18.3	11.8	1.73	(<0.001)	

* Adjusted for age, gender and class.

†Adjusted for gender and class.

‡Adjusted for age and class.

§Adjusted for class.

¶Adjusted for age and gender.

**Adjusted for gender.

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Web Table 2 Rates of multiple (3+) sexual partners in late adolescence according to substance use and associated odds ratios (unadjusted for other substance use) for each cohort, by social class

	1987/1990 ('earlier') cohort					1999/2003 ('later') cohort					*p-value of interaction with cohort*
	<3 sexual partners		3+ sexual partners			<3 sexual partners		3+ sexual partners			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
NON-MANUAL											
Current smoking											
No	229	74.6	35	48.6	1.00	199	84.0	105	60.3	1.00	
Yes	78	25.4	37	51.4	3.18 (1.80-5.63)	38	16.0	69	39.7	3.34 (2.10-5.31)	*0.813*
Excessive drinking†											
No	252	82.4	37	51.4	1.00	186	78.5	91	52.3	1.00	
Yes	54	17.6	35	48.6	3.93 (2.16-7.12)	51	21.5	83	47.7	3.30 (2.13-5.11)	*0.472*
Ever used illicit drugs											
No	230	75.2	26	36.6	1.00	139	58.6	47	27.0	1.00	
Yes	76	24.8	45	63.4	4.60 (2.59-8.19)	98	41.4	127	73.0	3.84 (2.49-5.93)	*0.405*
MANUAL											
Current smoking											
No	255	69.1	70	50.0	1.00	165	75.0	133	47.7	1.00	
Yes	114	30.9	70	50.0	3.13 (1.94-5.05)	55	25.0	146	52.3	3.37 (2.28-5.00)	*0.191*
Excessive drinking†											
No	337	91.3	81	57.9	1.00	181	82.3	158	56.6	1.00	
Yes	32	8.7	59	42.1	5.08 (2.93-8.79)	39	17.7	121	43.4	3.66 (2.38-5.63)	*0.247*
Ever used illicit drugs											
No	287	78.0	55	39.3	1.00	128	58.2	63	22.6	1.00	
Yes	81	22.0	85	60.7	3.99 (2.50-6.35)	92	41.8	216	77.4	4.73 (3.18-7.04)	*0.727*

p-values of interactions by social class: within 1987/1990 cohort - current smoking by class p=0.674, excessive drinking by class p=0.349, ever illicit drugs by class p=0.749; within 1999/2003 cohort – current smoking by class p=0.983, excessive drinking by class p=0.672, ever illicit drugs by class p=0.379.

*Adjusted for age and gender.

†Defined as ≥ 22 units in the past week for males, ≥ 15 units for females.

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Web Table 3 Rates of early sexual initiation according to early adolescent substance use and associated odds ratios (unadjusted for other substance use) for each cohort, by social class

	1987/1990 ('earlier') cohort					1999/2003 ('later') cohort					*p-value of interaction with cohort*
	No early sexual initiation		Early sexual initiation			No early sexual initiation		Early sexual initiation			
	N	%	N	%	OR (95% CI)*	N	%	N	%	OR (95% CI)*	
NON-MANUAL											
Started smoking age <14											
No	272	82.2	31	68.9	1.00	295	92.5	58	65.2	1.00	
Yes	59	17.8	14	31.1	1.96 (0.96-3.98)	24	7.5	31	34.8	6.58 (3.61-12.01)	*0.010*
Monthly drinking age 15											
No	262	79.2	28	63.6	1.00	145	45.5	13	14.6	1.00	
Yes	69	20.8	16	36.4	2.13 (1.09-4.18)	174	54.5	76	85.4	4.83 (2.58-9.02)	*0.080*
Ever used illicit drugs age 15											
No	313	94.8	36	80.0	1.00	234	73.1	26	29.2	1.00	
Yes	17	5.2	9	20.0	3.92 (1.59-9.67)	86	26.9	63	70.8	6.87 (4.06-11.63)	*0.429*
MANUAL											
Started smoking age <14											
No	333	80.2	55	58.5	1.00	288	82.5	97	55.1	1.00	
Yes	82	19.8	39	41.5	3.29 (1.96-5.50)	61	17.5	79	44.9	4.01 (2.66-6.05)	*0.277*
Monthly drinking age 15											
No	360	86.7	59	62.8	1.00	141	40.4	34	19.3	1.00	
Yes	55	13.3	35	37.2	3.32 (1.95-5.64)	208	59.6	142	80.7	2.92 (1.89-4.51)	*0.723*
Ever used illicit drugs age 15											
No	382	92.0	69	73.4	1.00	214	61.5	68	38.6	1.00	
Yes	33	8.0	25	26.6	3.73 (2.01-6.89)	134	38.5	108	61.4	2.62 (1.80-3.82)	*0.369*

p-values of interactions by social class: within 1987/1990 cohort – started smoking age <14 by class p=0.284, monthly drinking age 15 by class p=0.301, ever illicit drugs age 15 by class p=0.949; within 1999/2003 cohort – started smoking age <14 by class p=0.149, monthly drinking age 15 by class p=0.159, ever illicit drugs age 15 by class p=0.005.
*Adjusted for gender.

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