



The effects of the school environment on student health: A systematic review of multi-level studies



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ABSTRACT

Health outcomes vary between schools and it is theorised that this may be partly attributable to variation in the school environment. Existing systematic reviews have not drawn authoritative conclusions because of methodological limitations in the review or studies available. We identified 42 multi-level studies, ten of which were judged of sufficient quality to narratively synthesize. There was consistent evidence that schools with higher attainment and attendance than would be expected from student intake had lower rates of substance use. Findings on the influence of smoking/alcohol policies were mixed. Three studies examined the health effects variously associated with school campus area and observability, year structure, school size and pupil-to-teacher ratio with mixed findings. The studies reviewed support the potential influence of the school environment on student health.

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1. Introduction

Disparities in health are often shaped early in life during childhood and adolescence and sustained across the life course. Investing in early years therefore is vital to reducing health inequalities (Marmot, 2010). Health education delivered through the school curriculum and aiming to improve knowledge, develop skills and modify norms is now well-established in schools, addressing substance use, sexual behaviour, physical activity and diet. However, such interventions often have disappointing results (DiCenso et al., 2002; Faggiano et al., 2005; Foxcroft et al., 2002; Harden et al., 2001; Oliver et al., 2008; Thomas and Perera, 2006; Wells et al., 2003). A complementary approach is to modify the school environment to promote health, informed by the notion of 'school effects'.

Originating with the work of Rutter et al. (1979), educational researchers have found that a school's ethos, in terms of values, attitudes and organisation can explain differences in attainment and behaviour between schools (Arnot et al., 1998; Gaine and George, 1999; Gripps and Murphy, 1994; MacBeath and Mortimore, 2001; Scheerens, 2000). According to Macintyre et al. (2002), the effects of place on health can occur due to both 'compositional' (which people are found in a place) and 'contextual' factors (the characteristics of a place). Rutter's seminal

work on 'school effects' prompted further research to examine if certain institutional-level characteristics also influenced students' health-related behaviours (West, 2006).

In their theory of human functioning and school organisation, Markham and Aveyard (2003) suggested that to enable young people to choose health-promoting behaviours, schools should develop students' 'practical reasoning' (ability to understand one's own and others' perspectives and emotions) and sense of 'affiliation' (ability to form relationships). A school is theorised to enable students to fulfil these capacities through its 'instructional' and 'regulatory' orders, which, respectively, promote learning and behavioural norms. Students committed to these orders are more likely to choose healthy behaviours, whereas students disconnected from one or both orders are more likely to seek affiliation in anti-school peer groups and risk behaviours such as smoking. Schools' abilities to build commitment is theorised as depending on how flexibly they define 'boundaries', for example between staff and students, and how student-centred is the organisation and delivery ('framing') of schooling.

Existing syntheses have not been able to examine Markham and Aveyard's theory. An early review of the effects of anti-smoking policies on student smoking was hampered by its non-systematic design and inclusion of ecological studies alongside multi-level studies (Evans-Whipp et al., 2004). Multi-level studies, unlike ecological studies, enable proper examination of how features of the school as an institution as opposed to the compositional features of the student body affect student health

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outcomes. A review of school effects on smoking by Aveyard et al. (2004a) acknowledged the importance of multi-level evidence, but found few studies. It concluded that although smoking prevalence differed markedly between schools, it was not yet possible to determine whether this reflected compositional or institutional factors. This was because studies did not adequately adjust for the potentially confounding effects of families and neighbourhoods, or over-adjusted for factors which might actually mediate school-level effects on smoking, such as student attitudes to school and peer behaviours, so that it is impossible to determine for example whether null effects reflect an absence of school effects or that these are present but are mediated by factors for which adjustment is made. Another review of multi-level studies of school effects on a range of student outcomes did not involve systematic methods (Sellström and Bremberg, 2006). Reviews of school effects on drug use (Fletcher et al., 2008) and students' emotional health outcomes (Kidger et al., 2012) have included longitudinal studies examining individual-level measures of schooling alongside multi-level studies and do not fully examine whether the latter took an appropriate approach to confounding. Previous reviews have also included studies that rely on the same sources for data on school-level determinants and health outcomes; for example studies using school-level measures derived from aggregates of self-reports from the same individuals (usually students) providing outcome data. This can introduce 'same-source' bias whereby any associations found might merely reflect unmeasured characteristics of those providing the data (Duncan and Raudenbush, 1999). For example, students who are more likely to report negative relationships in school might also be more likely to report engagement in health risks.

Considering these limitations, we conclude a systematic review of multi-level studies of school health effects focused on studies which appropriately adjust for covariates and are not subject to same-source bias is now timely. Our review was done as part of a larger project mapping and synthesising evidence on how the school environment influences health (Bonell et al., 2011). In stage 1 of the project, we identified and descriptively mapped a broad array of literature on how the school environment may influence staff and student health. This map was then presented to academic, policy and youth stakeholders with whom we consulted to help define priorities for the second stage of the review.

In stage 2, we focused on student health and defined school environment more narrowly in terms of school organisation/management, teaching, pastoral care, discipline and/or physical environment. We chose not to focus on catering or physical exercise lessons because these areas are already well synthesised (Dobbins et al., 2009; Shepherd et al., 2001). Stage 2 involved several in-depth reviews, of which the review of multi-level studies reported here was undertaken to address the question: what are the effects of school-level measures of the environment (defined as above) on health and health inequalities among school students aged 4–18 years examined via multi-level quantitative designs?

2. Methods

Following a protocol (Bonell et al., 2011), in stage 1 we mapped references of articles judged as theorising or empirically examining: the influence on staff or student (aged 4–18) health of the school social and/or physical environment; interventions to address this (not including the provision of health education or health-related goods or services); and/or the processes underlying these. Sixteen bibliographic databases were searched between 30

July and 23 September 2010, with no limits on language or date: Australian Educational Index; British Educational Index; CAB Health (part of CAB Abstracts, now known as Global Health); The Campbell (C2) Library; CINAHL (the Cumulative Index to Nursing and Allied Health Literature); Cochrane Controlled Trials Database; Embase; ERIC (Education Resources Information Center); HMIC (Health Management Information Consortium); IBSS (International Bibliography of the Social Sciences); Medline; PsycInfo; Social Policy and Practice (includes Child Data & Social Care Online); Social Science Citation Index (Web of Knowledge); Sociological Abstracts; and Dissertation Abstracts/Index to Theses.

We conducted 'core' searches plus 'non-core' searches which we planned to screen more rapidly, although in practice we screened these equally carefully. Our first 'core' searches involved terms for setting (school), population (children), intervention/effect (intervention/school-level effects), outcomes (broad range of health outcomes). We conducted other 'core' searches with various phrases related to 'health promoting schools'. Our 'non-core' searches involved the same terms for school, child and health outcomes but other, broader terms related to intervention/school-level effect (available on request).

All references were uploaded into Eppi-Reviewer 4 software (Thomas et al., 2010) and duplicates removed. Stage-1 exclusion criteria (available on request) were used to screen references on title and abstract to produce the descriptive map for academic, policy and youth stakeholders. Pilot screening was conducted by two reviewers on a sample of 200 abstracts. The remaining references were divided between six reviewers and screened independently. After each reviewer screened 2000 references, a random sample of 200 was double screened by another reviewer to check consistency, with an acceptable threshold of less than one percent disagreement. We included 285 multi-level and ecological references in the final evidence map.

In stage 2, the aim was to review in-depth multi-level studies examining the effects on student (age 4–18) health or wellbeing of school-level measures of schools organisation/management, teaching, pastoral care, discipline and physical environment. We excluded ecological studies because these are vulnerable to unmeasured confounding and cross-level bias (Aveyard et al., 2004a). We included only those studies which drew on different sources for data on the school environment and health outcomes.

Drawing on full papers, two reviewers (CB, HW) double-screened all 285 references that were mapped in stage 1 as being multi-level and ecological studies of school health effects independently using the following exclusion criteria: (1) no school-level measures; (2) school-level measures from same source as health outcomes; (3) not a multi-level model analysis; (4) no relevant health outcomes; (5) other reason (i.e., full paper did not meet stage 1 inclusion criteria); and (6) not in English.

We extracted data from included studies on: research questions/hypotheses; study site and population; dataset; sampling; type of schools; data collection methods; analysis methods; results; school-level measures; levels included; and covariates. Data extraction tools (available on request) were piloted on a random sample of two reports by two reviewers (CB, HW). Subsequently, HW extracted data on context and methods of data collection while WP extracted data on methods of analysis and results, both checked by CB with any differences being settled by discussion. We also checked reference lists of included studies and contacted authors at this stage to identify other relevant studies.

We aimed to synthesise findings from only those studies that were judged of high quality, defined as adjusting for key potential confounders (gender plus individual or family socioeconomic status, ethnicity, family structure, or area deprivation or health)

and not adjusting for potential mediators. It was not possible to develop a comprehensive *a priori* list of potential confounders and mediators but case-by-case judgement was informed by a list developed by a previous review (Aveyard et al., 2004a). One reviewer (WP) applied these quality-assessment criteria, while another (CB) checked these assessments, with any differences being settled by discussion.

We assessed the potential for statistical meta-analysis of multi-level studies by noting which studies focused on similar combinations of school-level interventions/exposures and outcomes. We set a threshold of a minimum of three such studies being required to consider meta-analysis since meta-analysis of only two studies is unlikely to produce stable effect estimates (Valentine et al., 2010). Finding no homogenous triplets, we undertook a narrative synthesis. In our results, we summarise the findings reported by each study. In our discussion, we develop a narrative overview of findings, placing these in the context of study quality, setting and population, noting where studies of similar influences reported convergent or divergent findings, and assessing implications for Markham and Aveyard's theory of human functioning and school organisation.

3. Results

Database searches retrieved 82,775 references, of which 20,446 were duplicates. The remaining 62,329 references were screened on title and abstract, so that 1144 references were mapped (map available on request). Of the 285 references identified as ecological or multi-level studies in the evidence map, 236 were excluded based on the criteria in Fig. 1. In addition, five reports were duplicates and the full texts were not available for six. Studies that were excluded because they drew on information on school-level determinants from the same source as information on health outcomes examined a range of school-level factors such as aggregate student reports on attitudes to school and staff–student relationships. A further four reports were identified from reference-checking of reports included in the evidence map. Thus, 42 reports (of 34 datasets) were relevant multi-level studies. Of these 42 reports, 18 examined US samples, six were from Canada and six from the UK, three were from Norway, two each were from Australia, Israel and the Netherlands and one each were from Belgium, Germany, Spain and Thailand, with one reporting on data from the USA and Australia (Table 1). Eighteen studies focused on secondary/high schools; three on

middle and secondary/high schools; four on primary/junior/elementary schools; one on primary/junior/elementary and middle schools; four on primary/junior/elementary and secondary schools; two on middle schools; and two on high/junior high schools. Two reports did not indicate what kind of schools were researched (Akiba, 2010; Johnson and Hoffmann, 2000) and four reports only indicated from which grades research participants were drawn (Collins et al., 2008; Rountree and Clayton, 1999; Tobler et al., 2011; Wiium and Wold 2006, 2009).

Several studies drew on the same data but examined different outcomes: Aveyard et al., 2004b and Bisset et al., 2007; Wiium and Wold, 2006, 2009; West et al., 2004, 2010; Gastic, 2005 and Haley, 2007; Attar-Schwartz and Khoury-Kassabri, 2008 and Khoury-Kassabri et al., 2009; Kairouz and Adlaf, 2003 and Lothian, 2003; Kim, 1999 and Way, 2003; and Ishibashi, 2009 and Murnaghan et al., 2007. Table 2 reports which studies adjusted for gender plus some measure of individual or area social disadvantage; and which studies inappropriately adjusted for potential mediators. Table 1 reports which specific potential mediators studies adjusted for.

Our synthesis focuses on the ten studies that adjusted appropriately. The key findings from these studies, and their methodological approaches, are described in turn below and in Table 3, with a narrative synthesis provided in the discussion.

Aveyard et al. (2004b) report a cross-sectional study of students age 11–16 in secondary schools in the West Midlands, England. There was no significant association of school achievement (5 good 'GCSE' passes based on a five-year average) with regular smoking among pupils age 11–16, nor an association between average school truancy with pupils' regular smoking. However, there was an association of regular smoking with whether a school was classified as 'authoritative' or 'laissez faire', based on whether achievement and truancy were greater ('valued-added') or less than expected, taking account of students' social profile. Authoritative schools had significantly lower (OR=0.83 95% CI 0.73 to 0.95) and laissez faire schools had significantly higher (OR=1.13 95% CI 1.04 to 1.24) than average rates of regular smoking.

Bisset et al. (2007) used the same cross-sectional data as Aveyard et al. (2004b). No significant association was found between school achievement and pupils drinking alcohol at least once a month. Schools with higher levels of academic achievement were associated with lower rates of heavy drinking (OR=0.93 95% CI 0.89 to 0.97). There was no significant association of this achievement measure with regular illicit drug use. There was no association of school truancy with pupils drinking alcohol at least once a month, heavy drinking or regular illicit drug use. As with Aveyard et al. (2004b), a measure of 'value added' school culture was created, which was weakly but significantly associated with lower rates of drinking alcohol at least once a month (OR=0.87 95% CI 0.78 to 0.95), lower rates of heavy drinking (OR=0.91 95% CI 0.85–0.96) and lower rates of regular illicit drug use (OR=0.90 95% CI 0.82 to 0.98). There was also a significant interaction of value-added school culture with school grade for rates of heavy drinking ($\chi^2(2df)=10.41$ $p < 0.01$) with lower grades being associated with lower rates of heavy drinking for the same level of value added school culture (grade 7: OR=0.57; grade 9: OR=0.65; grade 11: OR=0.96).

Cradock et al. (2007) report a cross-sectional study of middle schools in Boston, USA. School campus area per student (coefficient=0.2244, $p < .001$), playground area per student (coefficient=0.347, $p < .05$) and the school building area per student (coefficient=2.1302, $p < .05$) were all significantly associated with higher levels of physical activity during school hours, as measured using accelerometers among students age 12–14.

Evans-Whipp et al. (2010) conducted a cross-sectional study of data from students age 11–16 in secondary schools in

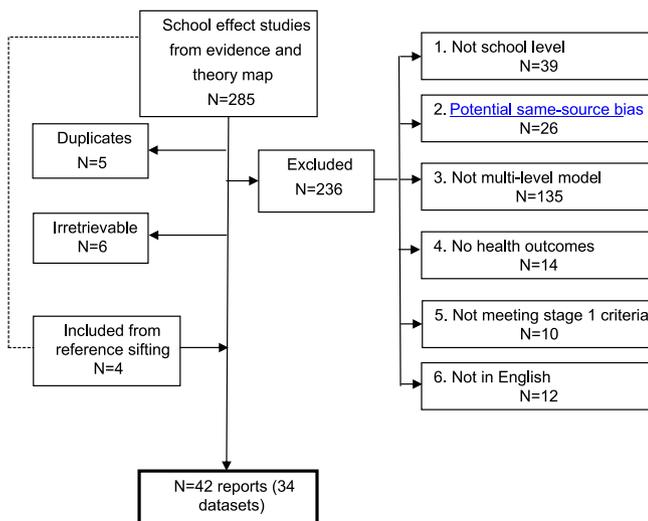


Fig. 1. Flow chart (stage 2)

Table 1
Design, sampling and inappropriate adjustments of multi-level studies.

Study	Design	Location	Age	No. schools at baseline	Mean students per school at baseline	Potential mediators adjusted for
Adams et al. (2009)	C	Illinois, USA	12–18	20 middle, 20 high	414	Student smoking in past 30 days
Akiba (2010)	C	USA	15	111	25	Student reported classroom disorder, clear and fair rules, academic achievement, student belonging, student–teacher bonding, perceived teacher support
Attar-Schwartz and Khoury-Kassabri (2008)	C	Israel	12–17	324	51	Student reported school discipline policies, teacher support, student participation; school and class size
Aveyard et al. (2004b)	C	West Midlands, UK	11–12, 13–14, 15–16	166	140	–
Bisset et al. (2007)	C	West Midlands, UK	11–12, 13–14, 15–16	166	–	–
Bradshaw et al. (2009)	C	Maryland, USA	9–14	76 elementary, 19 middle	233	Student mobility
Collins et al. (2008)	C	Kentucky, USA	13–14	159	145	Student reported attitudes to drugs, friends' drug use, academic failure, drug availability, perceived risk of drug use, commitment to school, school problems, school safety
Comeau, (2005)	Not clear	Eugene, Oregon, USA	11–14	8	134	Student reported deviant peer affiliations
Cradock et al., (2007)	C	Boston, USA	12–14	10	25	–
Evans-Whipp et al., (2010)	C	Victoria, Australia and Washington, USA	11–12, 13–14, 15–16	285	12	–
Gastic, (2005)	C	USA	12–18	100	43	Self-reported student delinquency in school, school connectedness, parental attitude about school safety, friends' attitude about school safety; principal reported student delinquency
Gladden, (2005)	C	Chicago, USA	13–14	283	53	Routinely reported student repeating grade, school type, student placed in special education
Grunseit et al.(2008)	C	New South Wales, Australia	13–15	60	36	Student reported learning problems, racism among students, perception of discipline policies, teaching, school response to racism, bullying
Haley, (2007)	C	USA	12–18 (same-sex-attracted sub-group)	125	145	Student reported health education, student repeated grade, suspension, attainment, student relations students with staff/students, school connectedness, perceived teacher fairness, school safety, staff caring
Haug et al. (2010)	C	Norway	13	68	20	Student interest in PE
Henry et al., (2009)	C	USA	13–14	349	125	–
Ishibashi (2009)	C	Prince Edward Island, Canada	17–18	10	397	Student participation in PE
Johnson and Hoffmann (2000)	L	USA	Baseline: 13–14, 15–16 Follow-up: 15–16, 17–18	13–14 cohort: 1,012 15–16 cohort: 1,397	13–14 cohort: 16 15–16 cohort: 10	Routinely reported school drop outs; student reported self-esteem, college plans, attainment, school misconduct, school attitude, parental educational support, school climate, negative peer associations
Kairouz and Adlaf, (2003)	C	Ontario, Canada	14–18	72	41	Student reported drinking attitudes and behaviours, school peer-group drinking
Khoury-Kassabri et al., (2009)	C	Israel	12–17	324	51	Student reported perception of school discipline policies, teacher support and response to violence, participation in school
Kim, (1999)	C	USA	13–14, 15–16	Unclear	Unclear	Student reported studying with friends, parent–staff contact, drinking at school, close friends dropping out of school
Kim, (2001)	C	USA	12–18	123	102	Student reported attainment, student attachment to school, friends' delinquency
Kumar et al., (2008)	C	Michigan USA	13–14, 15–16, 17–18	13–14 cohort: 244 15–16 cohort: 211 17–18 cohort: 200	13–14 cohort: 113 15–16 cohort: 104 17–18 cohort: 108	–
Leatherdale et al., (2010)	C	Ontario, Canada	10–14	30	79	Measured student overweight, student reported sports participation
Lothian (2003)	C	Ontario, Canada	12–18	198	65	Student reported self-esteem, school engagement, attainment
Ma, (2000)	C	New Brunswick, Canada	11–12	147	47	Student reported self-esteem, attainment, school discipline, academic expectations
Maes and Lievens, (1999)	C	Belgium	12–13, 16–17	29	111	Routinely reported student attainment, truancy, repeating classes; student reported school attitude, relationship with teachers

Table 1 (continued)

Study	Design	Location	Age	No. schools at baseline	Mean students per school at baseline	Potential mediators adjusted for
Malikaew et al., (2003)	C	Chiang Mai, Thailand	12	52	52	Routinely reported staff supervision, safety education, parents attend meetings, recorded violence, absenteeism, punishment rates
Markham et al., (2008)	L	West Midlands, UK	Baseline: 13–14 Follow-up: 14–15, 15–6	52	161	–
Moore et al., (2001)	C	Wales	15–16	55	25	Student reported school alienation
Monshouwer et al., (2007)	C	Netherlands	12–16	192	38	
Murnaghan et al., (2007)	C	Prince Edward Island, Canada	17–18	10	397	Student reported perception of smoking rules, friends' smoking
Pinilla et al., (2002)	C	Spain	13–14	30	63	Student reported interest in school, drinking, friend's smoking
Piontek et al., (2008)	C	Bavaria, Germany	10–21	40	70	
Rountree and Clayton, (1999)	C	Kentucky, USA	11–18	53	43	Student reported attachment to school, peer drinking, school drug/criminal culture
Tobler et al., (2011)	L	Chicago, USA	Baseline: 11–12 Follow-up: 13–14	61	43	
van der Horst et al. (2009)	C	Rotterdam, Netherlands	12–15	16	75	–
Way, (2003)	L	USA	13–20	877	Unclear	Student reported perceived discipline policies, fighting, streaming; routinely reported school attainment, drop out; teacher/student reported school disorder
West et al., (2004)	L	Glasgow, Scotland	Baseline: 11–12 Follow-up: 13–14, 15–16	43 secondary, 135 primary	19 (but 29–55 at follow-ups)	Student reported perceived school environment, engagement and involvement, teacher–pupil relationships
West et al., (2010)	L	Glasgow, Scotland	Baseline: 11–12 Follow-up: 13–14, 15–16, 18–19	43 secondary, 135 primary	19 (but 29–55 at follow-ups)	Student reported problems transitioning to school, disengagement, poor school ethos
Wiiium and Wold, (2006)	C	Norway	15	73	19	Student reported attitude to own and teacher smoking
Wiiium and Wold, (2009)	C	Norway	15	73	19	Student reported attainment, attitude to school, friend's smoking

C=cross-sectional; L=longitudinal

Washington State, USA and Victoria State, Australia. The study found no association of schools having comprehensive smoking bans, harsh penalties for smoking, schools having remedial penalties for smoking, smoking abstinence policies or smoking harm minimisation policies with the health outcomes: pupils smoking in the past 30 days, pupils smoking daily or perceptions of many students smoking on school grounds. One other determinant, strict enforcement of smoking policy, did not have a significant effect on pupils' smoking in the past 30 days or pupils smoking daily, but it was associated with reduced perceptions of how many students smoked on the school grounds (OR=0.45, 95% CI 0.25 to 0.82 $p < 0.009$).

Kumar et al. (2008) report a cross-sectional study of US public and private schools (age range not reported though it appears to involve a diverse sample). A simple set of models was reported for specific potential determinants with separate analyses conducted for each year-group. An attractive physical environment was not significantly associated with the following outcomes: twelfth graders (age 17–18) being drunk in the past 30 days; eighth graders' (age 13–14) marijuana use in the past 12 months; eighth graders' alcohol use in school in the past year; and eighth graders' use of cigarettes in the past 4 weeks in school. However, this exposure was associated with reduced alcohol use in school in the past year among tenth (age 15–16) graders (coefficient=−0.350 $p < 0.01$) and twelfth graders (coefficient=−0.350 $p < 0.01$). Neglected physical environment was not significantly associated with twelfth graders' cigarette use in the past 30 days. The total

number of unobservable and unsupervised places in and around school was not significantly associated with twelfth graders' marijuana use in the past 12 months, nor with twelfth graders' use of cigarettes in the past four weeks in school, but it was associated with twelfth graders' use of alcohol in school in the past year (coefficient=0.142, $p < 0.01$), tenth graders' use of alcohol in school in the past year (coefficient=0.142, $p < 0.01$) and tenth graders' use of marijuana and other illicit drugs in school in the past year (coefficient=0.100, $p < 0.05$).

Henry et al. (2009) report a cross-sectional study of rural junior and middle high schools in the USA. The authors reported that the following school-level factors were not associated with alcohol use among students age 13–14: whether eighth-graders are located within the same school as high-school students or are in separate schools, school size and pupil-to-teacher ratio.

Markham et al. (2008) reported that from a longitudinal study of secondary schools in the West Midlands, UK (students age 13–14 at baseline) a measure of 'value added' school environments, also used in Aveyard et al. (2004b) and Bisset et al. (2007), was associated with a reduction of borderline significance in smoking at least one cigarette per week at first follow-up age 14–15 (OR=0.85 95% CI 0.73 to 0.99 per SD increase in value added) and this became more significant at second follow-up at age 15–16 (OR=0.80 95% CI 0.71 to 0.91 per SD increase in value added). There was no significant interaction of the 'value added' measure with whether pupils were regular smokers at baseline.

Table 2
Data and adjustment of multi-level studies.

Wiium and Wold (2009)		×
Wiium and Wold (2006)		×
West et al. (2004, 2010)	×	×
Way (2003)	×	×
Tobler et al. (2011)	×	
Rountree and Clayton (1999)	×	×
Piontek et al. (2008)	×	
Pinilla et al. (2002)		×
Murnaghan et al. (2007)	×	×
Moore et al. (2001)		×
Monshouwer et al. (2007)	×	
Markham et al. (2008)	×	
Malikaew et al. (2003)		×
Maes and Lievens (1999)		×
Ma (2000)	×	×
Lothian (2003)	×	×
Leatherdale et al. (2010)		×
Kumar et al. (2008)	×	
Kim (2001)	×	×
Kim (1999)		×
Khoury – Kassabri et al. (2009)	×	×
Kairouz and Adlaf (2003)	×	×
Johnson and Hoffmann (2000)	×	×
Ishibashi (2009)	×	×
Henry et al. (2009)	×	
Haug et al., (2010)	×	×
Haley (2007)	×	×
Grunseit et al. (2008)	×	×
Gladden (2005)	×	×
Gastic (2005)	×	×
Evans – Whipp et al. (2010)	×	
Craddock et al. (2007)	×	
Comeau (2005)		×
Collins et al. (2008)	×	×
Bradshaw et al. (2009)	×	×
Bisset et al. (2007)	×	
Aveyard et al. (2004b)	×	
Attar – Schwartz and Khoury – Kassabri (2008)	×	×
Akiba (2010)	×	×
Adams et al. (2009)	×	×

Studies adjusted for gender plus some measure of individual or area social disadvantage
 Studies inappropriately adjusted for potential mediators

Monshouwer et al. (2007) report a cross-sectional study of Dutch secondary schools, finding a strong association between school type and episodic heavy drinking among students aged 12–16. When compared to young people in pre-vocational education schools, those in lower general secondary education were less likely to drink heavily (OR=0.69 95% CI 0.57 to 0.83) and those in upper general secondary education were even less likely to do so (OR=0.40 95% CI 0.32 to 0.51) while those in pre-university education were least likely to of all (OR=0.26 95% CI 0.20 to 0.33). It is important to highlight, however, that although school type was classed as a determinant, the type of school students were enrolled in was determined from tests taken at the end of primary schooling. Therefore, students were likely to be systematically different in different types of school, and so school effects were likely to be heavily confounded by individual-level factors despite adjustments. Whether a school permitted alcohol use at school on special occasions was not significantly associated with heavy drinking and neither was a school's level of sanctioning if students were caught with alcohol at school.

Piontek et al. (2008) report a cross-sectional study of secondary schools in Bavaria, Germany, finding that school type was not significantly associated with smoking in the previous 30 days among students age 10–21. However, it should be noted that the school type coefficient seemed to indicate a misspecification of the model because only a single coefficient was reported for a categorical variable with four categories. While a complete smoking ban for students at/around school was significantly associated with reduced smoking (OR=0.62 95% CI 0.42 to 0.92), neither an extensive smoking ban for adults at/around school, student smoking being monitored regularly at/around school, nor a school smoking policy involving constructive sanctions were associated with smoking in the previous 30 days. Given the apparent misspecification of school type in the model, we cannot exclude the possibility that this association was residually confounded by school type.

Tobler et al. (2011) report on a longitudinal study of middle-school students in grades 6 at baseline (age 11–12) in the USA. Their main analytical model contained many appropriate covariates but it also over-adjusted for a potential mediators ('student academic problems'), and so the base model was used to extract data. This study used a similar measure of 'value added' to Aveyard et al. (2004b), Bisset et al. (2007b) and Markham et al. (2008), but was calculated using 3-year averages. For follow-up in grade 8, when compared to schools in the range of –1 to +1SD, 'value added' school environments (1SD or more above the mean) were associated with reduced rates of alcohol drinking in the past 30 days (OR=0.60 95% CI 0.42 to 0.88) as well as being associated with reduced drinking of five or more alcoholic drinks on one occasion in the last two weeks (OR=0.44 95% CI 0.23 to 0.84), smoked a cigarette in the past 30 days (OR=0.48 95% CI 0.26 to 0.86) and having used marijuana in the past 30 days (OR=0.29 95% CI 0.15 to 0.57), as well as being involved in a group fight in the last month (OR=0.69 95% CI 0.50 to 0.96). Value-attenuated schools (1SD below the mean) did not have significantly different rates of any of the above outcomes to other schools.

4. Discussion

We identified 42 reports of multi-level studies of school-level health effects (from 34 datasets) where school-level measures drew on different information sources than health outcomes. We confined our narrative synthesis of results to 10 studies which appropriately adjusted for covariates. These studies addressed some aspects of our research question more than others. In terms of school-level influences: the studies of value-added education

Table 3
Data extraction of high-quality multi-level studies (health outcomes).

Study	Health outcome	Mean prevalence of outcome % (SD)	Intra-class correlation coefficient	School-level determinants	Effect (95% CI or P)
Aveyard et al., 2004b	Smoking at least one cigarette per week, self-report			School achievement 5A–C GCSEs based on 5 year average (1994–1998) % of pupils achieving those grades	OR=1.01 (0.95, 1.07) for 10% increase in 5A–C rate
	Smoking at least one cigarette per week, self-report			School truancy based on 5 year average (1994–1998) of % of half-days lost through pupil absence School categorisation - based on value added measure (calculated by regressing attainment and truancy rates on 5 indicators of student profile; school residuals then used in a principal components analysis to create measure of value added). Authoritative—1SD above average; laissez-faire—1SD below average; indeterminate—all others	OR=1.01 (0.92, 1.10) for 1% increase in truancy rate Authoritative OR=0.83 (0.73, 0.95); Laissez-faire: OR=1.13 (1.04, 1.24)
Bisset et al., 2007	Drinking alcohol at least once a month (grade 7 pupils), self-report			School achievement 5A–C GCSEs measured as above	OR=0.94 (0.88,1.01)
	Drinking alcohol at least once a month (grade 7 pupils), self-report			School truancy measured as above	OR=0.96 (0.85,1.08)
	Drinking > =10 units of alcohol per week, self-report			Value added measure—calculated as above	OR=0.87 (0.78, 0.95)
	Drinking > =10 units of alcohol per week, self-report			School achievement 5A–C GCSEs as measured above	OR=0.93 (0.89, 0.97)
	Drinking > =10 units of alcohol per week, self-report			School truancy as measured above	OR=0.99 (0.92, 1.07)
	Drinking > =10 units of alcohol per week, self-report			Value added as measured above	OR=0.91 (0.85–0.96)
Cradock et al., 2007	Physical activity during school hours, accelerometer	No info	No info	Days per week of PE	OR grade 7=0.57; grade 9=0.65; grade 11=0.96 ($p < 0.01$)
	Physical activity during school hours, accelerometer	"	"	Campus area per student	OR=0.97 (0.92, 1.03)
	Physical activity during school hours, accelerometer	"	"	Days per week of PE	OR=1.06 (0.96, 1.17)
	Physical activity during school hours, accelerometer	"	"	School building area per student	OR=0.90 (0.82, 0.98)
	Physical activity during school hours, accelerometer	"	"	Days per week of PE	OR grade 7=0.78; grade 9=0.75; grade 11=0.79 ($p > 0.05$)
	Physical activity during school hours, accelerometer	"	"	Days per week of PE	Coef=0.135 ($p < 0.01$)
Evans-Whipp et al., 2010	Smoking in past 30 days, self-report	Washington: 9.5% Victoria: 18.5%	No info	Comprehensive smoking ban	Coef=0.2244 ($p < 0.001$)
	Daily smoking, self-report	Washington: 2.3% Victoria: 7.1%	"	Harsh penalties for smoking	Coef=0.08234 ($p > 0.05$)
	Perceptions of many students smoking on school grounds, self-report	Washington: 34.9% Victoria: 63.8%	"	Remedial penalties for smoking	Coef=0.347 ($p < 0.05$)
Henry et al., 2009	Alcohol use (mean of 4 standardised items—index), self-report	(Not % prev—index created from standardised items) Within school: 0.00 (0.87) Between school: 0.02 (0.20)	0.05	Strict enforcement of smoking policy	Coef=0.1257 ($p < 0.01$)
				Smoking abstinence policy	Coef=2.1302 ($p < 0.05$)
				Smoking harm minimization policy	Coef=0.0904 ($p > 0.05$)
				Comprehensive smoking ban	OR=0.86
				Harsh penalties for smoking	OR=0.99
				Remedial penalties for smoking	OR=1.15
Kumar et al., 2008	12th grade cigarette use in the past 30 days, self-report	12th grade: 27% (SD 0.45)	No info	Smoking abstinence policy	OR=0.78
				Smoking harm minimization policy	OR=0.93
				Number of students in school	OR=1.09
				Pupil-to-teacher ratio	OR=0.95
				Whether 8th graders in same school as high school students	OR=1.02
					OR=1.10
Henry et al., 2009	Alcohol use (mean of 4 standardised items—index), self-report	(Not % prev—index created from standardised items) Within school: 0.00 (0.87) Between school: 0.02 (0.20)	0.05	Strict enforcement of smoking policy	OR=0.70
				Smoking abstinence policy	OR=0.95
				Smoking harm minimization policy	OR=1.01
				Comprehensive smoking ban	OR=1.39
				Harsh penalties for smoking	OR=0.72
				Remedial penalties for smoking	OR=1.16
Kumar et al., 2008	12th grade cigarette use in the past 30 days, self-report	12th grade: 27% (SD 0.45)	No info	Strict enforcement of smoking policy	OR=0.45
				Smoking abstinence policy	OR=.89
				Smoking harm minimization policy	OR=1.18
				Number of students in school	Coef=0.00
				Pupil-to-teacher ratio	Coef=0.00
				Whether 8th graders in same school as high school students	Coef=0.01
Kumar et al., 2008	12th grade cigarette use in the past 30 days, self-report	12th grade: 27% (SD 0.45)	No info	Type of school (public/private)	Estimates not reported for this "control" variable
				Number of students in school	Estimates not reported for this "control" variable

Table 3 (continued)

	12th graders being drunk in the past 30 days, self-report	12th grade: 32% (SD 0.47)	''	Neglected physical environment	12th grade Coef= -0.149 ($p > 0.05$)
	8th grade marijuana use in the past 12 months, self-report	8th grade: 15% (SD 0.35) 12th grade: 36% (SD 0.48)	''	Attractive physical environment	12th grade Coef=0.061 ($p > 0.05$)
	12th grade marijuana use in the past 12 months, self-report	8th grade: 15% (SD 0.35) 12th grade: 36% (SD 0.48)	''	Total number of unobservable and unsupervised places in and around school	12th grade Coef=0.043 ($p > 0.05$)
	Alcohol use in school in the past year, self-report	8th grade: 3% (SD 0.18) 10th grade: 8% (SD 0.27) 12th grade: 9% (SD 0.28)	''	Attractive physical environment	8th grade Coef=0.001 ($p > 0.05$); 10th grade Coef= -0.350 ($p < 0.01$); 12th grade Coef= -0.350 ($p < 0.01$)
	Use of marijuana and other illicit drugs in school in the past year, self-report	10th grade 9% (SD 0.28)	''	Total number of unobservable and unsupervised places in and around school	10th grade Coef=0.142 ($p < 0.01$); 12th grade Coef=0.142 ($p < 0.01$)
	Use of cigarettes in the past 4 weeks in school, self-report	8th grade: 5% (SD 0.23) 12th grade: 12% (SD 0.45)	''	Total number of unobservable and unsupervised places in and around school	10th grade Coef=0.100 ($p < 0.05$)
Markham et al., 2008	Smoking at least one cigarette per week, self-report	No info	No info	Attractive physical environment	8th grade Coef=0.234 ($p > 0.05$)
				Total number of unobservable and unsupervised places in and around school	12th grade Coef=0.158 ($p > 0.05$)
				Value added education measure—calculated as per Aveyard et al., 2004b using 5-year average GCSE attainment and truancy (1995–1999), 5 indicators of social profile	1SD increase in value added score: 1st follow-up OR=0.85 (0.73,0.99); 2nd follow-up OR=0.80 (0.71,0.91)
				Interaction of value-added education with whether pupil was of regular smoking status at baseline	Not significant
Monshouwer et al., 2007	5+ drinks on one occasion during the last 4 weeks, self-report	39.7%	0.085	School type	Lower general secondary education OR=0.69 (0.57,0.83); upper general secondary education OR=0.40 (0.32,0.51); pre-university education OR=0.26 (0.20,0.33). Reference category=pre-vocational education OR=1.11 (0.92,1.34)
				Alcohol use permitted at school on special occasions	
				Level of sanctioning if caught using alcohol at school	Medium OR=0.95 (0.75,1.22); high OR=1.01(0.77,1.32). Reference category=low
Piontek et al., 2008	Smoking on any of the previous 30 days, self-report	23.0%	No info	School type (Hauptschulen: Low level, Realschulen: Intermediate level, Gymnasien: High level, Gesamtschulen: Intermediate and high level)	Coef= -0.17 ($p > 0.05$)
				Complete smoking ban for students at/ around school	Coef= -0.48 ($p < 0.05$)
				Extensive smoking ban for adults at/ around school	Coef= -0.06 ($p > 0.05$)
				Student smoking monitored regularly at/ around school	Coef=0.25 ($p > 0.05$)
				School smoking policy implements constructive smoking-related sanctions	Coef=0.10 ($p > 0.05$)
Tobler et al., 2011	Grade 8 drank alcohol on 1+ occasions in the last 30 days, self-report	6th grade: 6.57% 8th grade: 22.97%	No info	Value added school culture measure—calculated as per Aveyard et al. 2004 above but regressing three-year averages of school achievement for reading and mathematics and school truancy on 5 measures of social profile.	Value added OR=0.60 (0.42, 0.88); value attenuated OR=0.96 (0.63, 1.47). Reference category=normative
	Grade 8 drank 5 or more alcoholic drinks on 1+ occasions in the last 2 weeks, self-report	6th grade: 3.40% 8th grade: 8.92%	''		Value added OR=0.44 (0.23, 0.84); value attenuated OR=0.90 (0.47, 1.70). Reference category=normative
	Grade 8 smoked a cigarette in the last month, self-report	6th grade: 1.29% 8th grade: 9.89%	''		Value added OR=0.48 (0.26, 0.86); value attenuated OR=0.72 (0.37, 1.39). Reference category=normative
	Grade 8 used marijuana in the last 30 days, self-report	6th grade: 1.72% 8th grade: 12.10%	''		Value added OR=0.29 (0.15, 0.57); value attenuated OR=0.98 (0.57, 1.69). Reference category=normative
	Grade 8 involved in a group fight in the last month, self-report	6th grade: 24.73% 8th grade: 30.58%	''		Value added OR=0.69 (0.50, 0.96); value attenuated OR=1.02 (0.68, 1.51). Reference category=normative

are intended as indicators of teaching and of pastoral support; the studies of school policies can be regarded as examining both how schools are managed and how they instil discipline; the studies of schools' campus area and observable versus unobservable

places are examining aspects of physical environment. The studies excluded from our synthesis because they over-adjusted for potential mediators examined a broader range of school-level determinants, for example including: teacher practices (Gastic,

2005); staffing structures (Bradshaw et al., 2009); researcher or student-assessed social environment (West et al., 2004); support for parents (Kim, 1999); and primary–secondary transitions (West et al., 2010).

The synthesised studies generally reported on measures of health behaviours (such as substance use and fighting) rather than biological end-points. Self-reported substance use was a predominant though not exclusive focus of these studies. Studies excluded from our synthesis because of over-adjustment examined a very similar array of health outcomes. Additional outcomes assessed included: dental care (Maes and Lievens, 1999); obesity (van der Horst et al., 2009); and mental health (West et al., 2010). Synthesised studies did not generally report sub-group analyses relevant to assessing health inequalities. The only study examining subgroup effects was by Markham et al. (2008), which found that in secondary schools in the West Midlands, there was no significant interaction of the school-level measure of value added education with whether pupils were regular smokers at baseline.

4.1. Narrative synthesis of findings

We found consistent evidence from cross-sectional (Aveyard et al., 2004b; Bisset et al., 2007) and longitudinal studies (Markham et al., 2008; Tobler et al., 2011) of middle schools in the USA and secondary schools in the UK that in schools where attainment was higher than would be expected from the social profile of students, and truancy was lower, lower rates of substance use are observed. The study by Tobler et al. (2011) is particularly valuable not only in providing longitudinal evidence and examining an outcome concerning group-fighting in addition to substance use, but also in examining the extent to which these effects appear to be relevant not only to predominantly white, English adolescents but also ethnic-minority young people from low-income families in US cities. Gross rates of attainment and truancy were not generally associated with student health outcomes and the authors of these reports interpret that this means what matters is the *value that schools add* rather than gross rates of attainment and truancy, which largely reflect the characteristics of students at intake rather than what the school as an institution provides.

Selection bias is unlikely to explain these results since this would require schools with both high value-added scores and high rates of substance use, and conversely schools with low value-added and low substance use, to have differentially tended not to participate. Reverse causality is also unlikely given that two of the studies were longitudinal and all of the studies used year-on-year averages of attainment and truancy data so that the data on exposures and outcomes reflected the experiences of different students. However, confounding might explain these results if unmeasured or incompletely measured student or neighbourhood factors were associated both with value-added scores and with student health outcomes. As Aveyard et al. (2004b) suggest, the most obvious source of confounding arises from some families discouraging their children from engaging in risk behaviours and sending their children to effective schools. However, Aveyard et al. (2004b) explain that published data did not at that time enable parents to assess schools' 'added value', which did not correlate with gross attainment. The two longitudinal studies also adjusted for baseline measures of the risk behaviours being examined. Although these baseline risk behaviours might themselves be influenced by school-level factors these do not represent cases of over-adjustment for factors on the causal pathway because of the timing of the assessments. Nonetheless, we would suggest future studies of school health effects adjust for students' engagement in risk behaviours *prior to their entry* into the school, as did two studies which we nonetheless excluded from narrative

synthesis because of their adjusting for variables judged as potential mediators of school effects (West et al., 2004, 2010).

These studies' findings are offered by the authors themselves as evidence in supporting of the theory of human functioning and school organisation. The authors suggest that their measures of whether schools had higher than expected attainment and lower than expected truancy (i.e., 'value-added') are proxies for institutional culture. They suggest that authoritative schools are more likely to ensure student commitment and personal development, and less likely to invest in 'anti-school' risk behaviours such as smoking. We agree that these studies provide some evidence in support of the theory of human functioning and school organisation. However, these studies used routine data to develop simple measures of these school-level factors and so cannot provide insight into the complex social processes that underlie Markham and Aveyard's theory. Other studies might shed some light on this. Factors such as strong leadership, student involvement, high expectations and frequent evaluation and praise are reported to explain school differences in attainment (Gaine and George, 1999; Gripps and Murphy, 1994; MacBeath et al., 1992; Scheerens, 2000).

Markham and Aveyard's theory would not predict restrictive school policies to have much impact on risk behaviours and findings on the influence of policies were indeed mixed. A German cross-sectional study of secondary schools reported a complete smoking ban for students at/around school was significantly associated with reduced smoking, although monitoring of students' smoking and sanction types for those caught was not associated with reduced smoking (Piontek et al., 2008). However, a cross-sectional survey of secondary schools in the USA and Australia found no association between various forms of school smoking policies with any measures of student smoking (Evans-Whipp et al., 2010). These differences may reflect a 'ceiling' effect for the impact of smoking bans, which have already been implemented across school in the USA and Australia but not in Germany where student smoking has traditionally been tolerated. The finding from a cross-sectional study of Dutch secondary schools that whether a school permitted alcohol use at school on special occasions, as well as the school's level of sanctioning if students were caught using alcohol at school, were not associated with heavy drinking among students is likely to reflect such a policy being unlikely to have much power given the limited number of special occasions when alcohol use would be considered possible (Monshouwer et al., 2007). All three studies relied on cross-sectional data but reverse causality is unlikely because of the stability of policies from year to year. However, as with the studies of value-added discussed above, confounding by unmeasured student, neighbourhood or school factors is a potential source of bias.

We also reviewed evidence from one cross-sectional study which reported that students in US middle schools with a larger total campus size and playground areas per student have higher rates of student accelerometer-measured physical activity during school hours (Cradock et al., 2007). Our review also found evidence from one cross-sectional study of US high school students that the number of unobservable and unsupervised places in and around school was associated with 10th and 12th-graders' use of alcohol in school and 10th graders use of marijuana in school in the previous 12 months but not 12th-graders overall use of marijuana in the past year nor 12th-graders cigarette smoking in school in the previous month. An attractive school environment was associated with 10th and 12th-graders use of alcohol in school in the past year but not with whether 8th graders used marijuana in the past year or used alcohol in school in the past year or smoked cigarettes in school in the past month, or whether 12th-graders were drunk in the past 30 days. The authors conclude these results suggest that schools may be effective in addressing risk behaviours that occur inside school

but may not have much impact on behaviours outside school (Kumar et al., 2008).

Finally, Henry et al., (2009) reported that from a cross-sectional study the following school-level factors were not associated with alcohol use among students age 13–14 in high, junior–high and middle schools in rural USA: whether eighth-graders are located within the same school as high school students or are in separate schools, school size and pupil-to-teacher ratio. Reverse causality is unlikely to explain the results of any of these studies because of the enduring nature of the school-level measures but confounding by unmeasured individual or neighbourhood factors might account for the association. Our interpretation of Markham and Aveyard's theory is that it would predict some effects of attractive school environment and student–staff ratio in these last two studies.

4.2. Deviations from protocol and other limitations

There were three deviations from the protocol published online (Bonell et al., 2011). First, because of lack of time we decided not undertake forward citation checking. Second, because of recruitment delays, we did not, in our initial sifting of references, have three reviewers working in parallel comparing screening results in batches. Instead, sifting was done by the principal investigator (CB) working in parallel with two researchers separately. The principal investigator (CB) and each reviewer double screened three sets of 50 references until at least 99% agreement (rather than 95% as per the protocol) was reached. Third, we did not systematically extract report authors' conclusions about results because we concluded these would not inform our review and synthesis. In other cases we did not strictly depart from protocol but nonetheless changed our plans. Our protocol is only explicit about not excluding reports based on language of publication in our initial mapping in stage one, which we followed. However, we did exclude twelve reports not written in English in our in-depth review in stage two. These non-English reports all had abstracts available in English and from these we judged that there was little chance of them having employed multi-level modelling to examine school effects.

Our review was subject to other limitations. We did not undertake any hand-searching of journals or web-searches because the relevant literature was spread over a breadth of sources. We focused our in-depth review on studies of student but not staff health. This was a pragmatic decision taken in order to ensure we had a manageable number of reports. This is nonetheless an important area of research. The heterogeneity of the studies we included meant that we could not undertake statistical meta-analysis and were confined to narrative synthesis. We did not pre-specify which student health outcomes should be treated as primary and secondary. As a result our narrative synthesis might run the risk of over-interpreting statistically significant findings that may reflect the multiplicity of outcomes being reviewed. To counter this we have tried within our narrative synthesis to give equal weight to findings of no significant statistical associations. Finally, like other systematic reviews, ours is vulnerable to publication bias.

4.3. Implications for research and policy

We identified only ten multi-level studies which appropriately adjusted for covariates. More studies are urgently required to understand the effects of schools' social and physical environment on student health. Most of the best-conducted multi-level studies were undertaken in the USA and UK so there is also a need to increase the range of settings examined to explore how school effects vary with local context. Future studies should broaden the health outcomes examined beyond substance use. Where possible

they should use longitudinal designs collecting baseline data on young people and their families *prior to entry to the school* to reduce confounding not least of the effects of secondary and primary schools (Goldstein and Sammons, 1997). There is also a paucity of studies examining the effects of school type and different models of schooling on health outcomes. In the UK, USA and elsewhere there is now an increasing diversification of school types so this should also be a priority for future research in this area. In the UK for example there are a range of new institutions such as academies, free schools and studio schools funded and accountable to central not local government, often delivering alternative models of schooling (Ball, 2008). Multi-level studies must also however avoid reifying the school effect and should also assess the contributions of particular classes, year-groups and teachers.

There is evidence from several well-conducted multi-level studies that schools which 'add value' in terms of students' attainment and attendance can reduce rates of substance use and violence, providing some support for the theory of human functioning and school organisation. Evidence from these multi-level studies suggests that specific health focused school rules and policies are unlikely to be an effective means of reducing substance use in isolation from broader changes to the school environment. One study found that students in schools with larger campuses and playgrounds reported higher rates of physical activity in school. There was more mixed evidence on other school-level factors such as site attractiveness and staff–student ratio.

Future trials of school environment interventions, particularly those modifying school ethos and policies on teaching, behaviour and discipline, should examine the effectiveness of increasing student engagement, attainment and attendance and their health effects. Broader educational policies and school funding need to provide the incentives and resources to ensure that schools are able to promote student health and wellbeing. Informed by the findings from the multi-level studies we have reviewed, this would include ensuring that education policies do not inadvertently disengage some students from school and promote a 'counter culture' of substance use among these disengaged group (Fletcher et al., 2009). Research suggests that the marketization of schooling and incentive structures such as league tables in the UK and 'No Child Left Behind' monitoring systems in the USA can increase inequalities in schooling (Haney, 2006) and create perverse incentives for schools to neglect students pastoral welfare and focus inordinate attention on 'key marginal' students who are 'borderline' regarding whether they will contributing positively to schools' overall attainment targets, therefore reducing support for those not on course to achieve this (Bonell et al. 2011).

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