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Research Paper

Substance-general and substance-specific influences on adolescent vaping, smoking, alcohol consumption, and illicit drug use: context, inequalities, and putative determinants

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ABSTRACT

Background: Using substances before the age of 15 is a key antecedent of substance use treatment later in life. Since the turn of the 21st century, adolescents' lives have changed considerably, presenting new risk and protective factors. Identifying factors and contexts associated with use of specific substances among contemporary adolescents is therefore a key public health priority.

Methods: We investigated vaping, smoking, alcohol consumption, and illicit drug use, in 30,920 adolescents aged 12–15 attending 100 schools and living across 1539 neighbourhoods in the south of England. Cross-classified multi-level models were used to evaluate the relative importance of school and neighbourhood contexts, before investigating putative determinants of substance use.

Results: A school-only context yielded the best model fit and explained the most variance across substances (ICC range 5.8% to 8.5%). Several patterns pertaining to inequalities in substance use emerged (e.g., age positively associated with greater odds of any substance use, particularly illicit drugs), although the magnitude and direction of associations varied by substance and subgroup. Findings allude to coping-related motives (e.g., concomitant internalising symptoms) as potential risk factors for vaping, smoking, and alcohol consumption. Strong parental and teacher relationships and school-based factors (e.g., happiness with attainment) were protective against all substances.

Conclusion: Differences between schools matter more than differences between neighbourhoods for adolescent substance use. Our results reveal both substance-general and substance-specific putative determinants, highlighting the need for tailored approaches that target shared and unique drivers of use. Such strategies should also account for sociodemographic differences.

Introduction

Adolescence is a critical developmental period and can be a turning point during which occasional substance use can become more frequent, potentially leading to more problematic use in time (Jordan & Andersen, 2017). In England, 12,418 young people were in contact with substance use treatment services between April 2022 and March 2023 – a 10% increase from the previous year (Office for Health Improvement & Disparities, 2024). Early onset of substance use, prior to age 15, is a key risk for requiring substance use treatment (Office for Health Improvement & Disparities, 2024). Whilst the literature on risk factors for adolescent substance use is vast, research often focuses on identifying risk factors for one specific substance or composite indicators of substance use, with alcohol, tobacco, and cannabis dominating the field. This focus may obscure substance general and substance specific putative determinants, with important implications for intervention, particularly around the use of e-cigarettes, which are increasing in popularity among adolescents. Identifying determinant factors and contexts associated with specific substances among contemporary adolescents is therefore a key public health priority.

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Sociodemographic disparities in adolescent substance use

Rates of adolescent substance use generally increase with age, in terms of both experimentation and continued use (NHS Digital, 2024). This is particularly true for alcohol, tobacco, and cannabis. However, recent evidence suggests that younger adolescents are more likely to use e-cigarettes than older adolescents (Villanueva-Blasco et al., 2025). The gender gap in adolescent substance use has narrowed in recent years, with rising rates of substance use in girls (R.K. McHugh et al., 2018), which for some substances (smoking, vaping, alcohol consumption; L. Charrier et al., 2024), have overtaken rates among boys. Transgender and gender diverse adolescents show high rates of substance use, including alcohol (approx. 20–30%), tobacco use (ranging from 10–60%), and e-cigarette use (17–27%) (Fahey et al., 2023). Studies in adult populations suggest that gender and sexual minority groups are more likely to use substances than cisgender and heterosexual groups (M. Cotaina et al., 2022; Shokoohi et al., 2022), though there is limited research comparing substance use across these groups during adolescence.

There is a lack of consistent evidence regarding inequalities in adolescent substance use, across indicators of disadvantage such as ethnicity, socioeconomic circumstances (SEC), and special educational needs (SEN). Wider literature generally indicates an increased likelihood of alcohol use and e-cigarette use for White adolescents compared to those from minoritised ethnic groups (Weaver et al., 2011; Rahmandar & Gribben, 2022; Dai et al., 2021). However, evidence is inconsistent for tobacco and illicit substances (Karamanos et al., 2022; Read et al., 2018; C. Vrinten et al., 2023). Some studies link lower SEC to higher alcohol, smoking, and drug use (Gerra et al., 2020; Andrabi et al., 2017; Green et al., 2016; Simon et al., 2017), while others find greater use among more advantaged adolescents (J. Rodriguez-Ruiz et al., 2023; Kendler et al., 2014; Tolstrup et al., 2023). Vaping research is similarly inconsistent, with evidence for no association (Moore et al., 2015) or increased use among lower SEC adolescents (Simon et al., 2017). These discrepancies may partly reflect differences in how SEC is measured across studies. Regarding SEN, some studies report higher alcohol, cannabis, and smoking among those with emotional or behavioural needs or education plans (Berg & Eisenberg, 2018; Goagoses et al., 2024), while others find no differences or lower use among those with SEN (J. Robertson et al., 2018; Alfaro et al., 2017).

The role of peers, school, wellbeing, and local environment for adolescent substance use

Peer influences are widely recognised as one of the strongest predictors of adolescent substance use (T.C. Woodward et al., 2023), reflecting the increasing role of peers as the primary source of socialisation during this period. For example, adolescents adapt their substance use behaviours to align with percieved peer norms, which can serve as both a risk and protective factor, depending on the peer group (Watts et al., 2023; J. Rodriguez-Ruiz et al., 2023; Skinner et al., 2024). Vulnerability to peer pressure may contribute to increased substance use among adolescents (McDonough, Jose & Stuart, 2016). For instance, resistance to peer pressure has been linked to vaping abstinence (Skinner et al., 2024). Although a common assumption might be that adolescents are most vulnerable to coercive or pressuring behaviours from peers, recent evidence indicates that supportive and validating peers exert greater influence (Allen et al., 2022). Further, while stronger friendships might intuitively seem protective due to increased peer support, they can also elevate risk by providing greater access to substances, such as through attending more parties (V.T. Cole et al., 2024). Negative peer interactions, such as bullying victimisation, also increase vulnerability to increased substance use, experimental use, and poly-substance use– evidenced across multiple substances and bullying types (Tomczyk et al., 2015; Pichel et al., 2022; Nagata et al., 2025). Beyond the peer network, another important relationship for adolescents is with their parents. Positive relationships with parents have been associated with later initiation of or reduced smoking and alcohol consumption (Han et al., 2016; M.B.H. Yap et al., 2017).

School belonging and positive relationships with staff are thought to be protective against adolescent substance use (Rose et al., 2024; K.-A. Allen, Greenwood et al., 2025; Santibanez et al., 2020; S.M. Daily et al., 2020), though evidence is mixed for vaping (Szoko et al., 2021; Wilhelm et al., 2024). In contrast, poorer academic performance is associated with an increased likelihood of using various substances (J. Rodriguez-Ruiz et al., 2023) and reduced academic self-efficacy is a strong predictor of alcohol consumption (Santibanez et al., 2020). Few studies directly investigate the relationship between school pressure and substance use, yet pressure from schoolwork among adolescents has doubled between 2014 and 2022, with parallel increases in emotional difficulties (Armitage et al., 2025; Steare et al., 2023).

Emotional difficulties and stress may increase substance use as a coping mechanism (Leonard et al., 2015). Internalising symptoms increase the risk of alcohol consumption in adolescence (I. Meque et al., 2019), though the relationship may be bi-directional, with increased alcohol consumption worsening mental health (Edwards et al., 2014; Hansen et al., 2025). Internalising symptoms have also been linked to increased vaping (Audrain-McGovern et al., 2021) and smoking (Ranjit et al., 2019). In contrast, self-esteem appears to be protective, with higher self-esteem being associated with reduced illicit substance use (Bitancourt et al., 2016; Khajehdaluee et al., 2013). A less explored mechanism is the use of school based mental health support. Due to high levels of substance use comorbidity among those accessing mental health services (J. Halladay et al., 2024; A.H. Cheung et al., 2019), young people accessing school mental health services may be more likely to use substances.

Along with school and peer influences, the local environment also effects adolescent substance use, such as available places to spend free time. However, evidence is mixed. Some studies show positive associations between greenspaces and binge drinking (Kotlaja et al., 2018; Wiley et al., 2022), whereas others have found no relationship between greenspaces and alcohol use, and reduced odds of smoking (Wiley et al., 2022). A recent scoping review suggests active engagement in greenspaces related to less substance use, whereas more passive time spent in these places, with minimal supervision/ surveillance from adults associated with more substance use (Pearman et al., 2025). An underexplored factor is percieved leisure autonomy, i.e., the extent to which young people feel that they can choose how to spend their free time. This may be reflected in studies examining structured and unstructured leisure time. Structured leisure time is characterised by adult supervision and specific goals (e.g., sports, youth clubs) and is considered a protective factor against substance use (e.g., alcohol, and cannabis (T.C. Woodward et al., 2023). Increased perceived leisure autonomy may be implicitly characteristic of unstructured leisure time, which lacks adult supervision and specific aims/goals (e.g., spending time in shopping centres or socialising with friends). Such unstructured activities are considered risk factors for substance use (e.g., alcohol, smoking and cannabis use (Prieto-Damm et al., 2019; Lee and Vandell, 2015).

Theoretical models of adolescent substance use

Several theories seek to explain the putative determinants of adolescent substance use. Social theories (e.g., social development theory) (Hawkins & Weis, 1996) recognise the importance of familial and peer influences on adolescent substance use (Piko & Kovács, 2010; Van Ryzin et al., 2012). However, these theories rarely differentiate between sources of influence (e.g., family, peers, school) which may shape usage to different degrees (Miller & Cook, 2017). Cox and Klinger's (1988) motivational model of alcohol use proposes that expected affective changes drive alcohol consumption and was later expanded to include broader substance use categories (M.L. Cooper et al., 2016). Cooper's four-factor model outlines that key motives for adolescent substance use

relate to pleasure enhancement, coping, social relatedness/bonding and social conformity.

These theories overlook broader socioeconomic inequalities and structural disadvantage. In contrast, the Adolescent Substance Use Risk Continuum (ASURC) (Miller & Cook, 2017) is a strength-based model which recognises the role of sociodemographic inequalities, as well as the influence of social units. The ASURC incorporates personal characteristics, demographic factors and cultural influences (e.g., ethnicity, socioeconomic status) (Miller & Cook, 2017), and acknowledges the interacting influences of different social units (e.g., peers, parents/caregivers, teachers) that vary in strength over time (Hayre et al., 2023; Marziali et al., 2022; Pichel et al., 2022). Collectively, these theoretical perspectives highlight the broad range of factors that may influence adolescent substance use, including sociodemographic factors, wellbeing and coping mechanisms, and social influences.

An ecological systems framework

According to Bronfenbrenner's ecological systems theory, individuals develop within interconnected systems: the microsystem (immediate settings such as school and peers), mesosystem (connections between these settings), exosystem (indirect environments such as neighbourhood), macrosystem (broader cultural and societal contexts), and chronosystem (changes over time) (Bronfenbrenner, 1979). Individual characteristics sit at the centre of these systems, which interact to shape development. This framework highlights that adolescent behaviours, including substance use, occur within multiple contexts. Given that young people spend substantial time in school and increasingly outside the home, both school and neighbourhood are likely influential microsystem contexts (E.M. Trucco, 2020). The ecological systems model also acknowledges that individuals can simultaneously belong to multiple microsystem contexts, and that these contexts are not strictly hierarchical. This perspective is particularly relevant to the current research as students from the same neighbourhood may attend different schools, and schools draw from multiple neighbourhoods. For example, the average distance that pupils travel to school has increased (Easton & Ferrari, 2015). In the UK, government data for the academic year 2024/25 shows that 37 percent of 11- to 16-year-old school pupils walk to school, compared to 51 percent of 5- to 10-year-old pupils (Department for Transport, 2025), suggesting that secondary school pupils may have further to travel. Supporting this, 8.7% of secondary school children in the UK attended schools outside of their local authority in 2024/25, more than double the figure for primary-age children (Department for Education, 2025). It is therefore crucial to consider the school and neighbourhood environments in tandem.

Cross-classified multilevel models (CCMMs) address this complexity by allowing individuals to belong to two non-nested contexts simultaneously, operationalising the theory in a way that reflects actual social structures. Unlike single-context models, CCMMs avoid overestimating the effect of one context by simultaneously modelling both, providing more accurate estimates of contextual influences (G. Leckie, 2013). For instance, studies have investigated the relative influence of peer, school, and neighbourhood contexts on alcohol consumption (K.M. Barker et al., 2023); school- and neighbourhood-level predictors of cigarette smoking (B. De Clercq et al., 2014; E.C. Dunn et al., 2015); and school- and neighbourhood-level predictors of cocaine use (L.R. Frøyland et al., 2025). Whilst these studies highlighted that examining the neighbourhood context alone overestimates its contribution and school-level variance is more prominent, there are gaps in what we know about factors associated with adolescent substance use, particularly regarding the distinction between substance-general and substance-specific factors.

Whilst there is limited evidence regarding sociodemographic disparities in adolescent substance use (particularly across indicators such as gender diversity, ethnicity, SEC, and SEN), theoretical models such as ASURC posit that different sociodemographic characteristics may function as risk or protective factors. Wider theoretical models and literature also recognise the importance of relational dynamics (e.g., peer influences, friendships, parent/carer relationships), wellbeing (e.g., internalising symptoms, coping), school-based factors (e.g., school pressure, attainment), free time and local environment. Previous studies have examined some of these factors, yet few have correctly accounted for or disentangled the roles of school and neighbourhood contexts. Further, it is not clear whether certain factors are associated with substance use in general, or specific substances only. Since the turn of the 21st century, adolescents' lives have changed considerably, both at a societal and individual level (OECD, 2019). Evidence that considers the influence of contemporary adolescent developmental contexts and the differential influences of risk and protective factors within these contexts is required to effectively address public health concerns.

The current study

In the current study, we conduct secondary analysis of a unique contemporary (2023–2024) dataset from #BeeWell, a youth-centred programme which listens to the voice of young people, acts together for change, and celebrates their wellbeing (#BeeWell, 2025). The analysis aims to provide timely insights into putative determinants of substance use among today's adolescents, capturing factors associated with general substance use and those which are substance-specific (e.g., associated with vaping only). Focusing on a range of substances (vaping, cigarette smoking, alcohol consumption and illicit drugs), we sought to address the following research questions:

1. What is the relative influence of school and neighbourhood contexts on adolescent substance use?
2. Are there sociodemographic disparities (depending on age, gender identity/sexual orientation, ethnicity, SEC, SEN) in adolescent substance use?
3. What are the associations between relational dynamics, wellbeing, school-based factors, free time and local environment, with adolescent substance use?

Method

Data and sample

Our secondary analyses leverage cross-sectional data from the first two waves of the #BeeWell survey in Hampshire, Isle of Wight, Portsmouth, and Southampton (HIPS) in 2023 and 2024. #BeeWell employed a multi-stage, purposive sampling strategy to recruit secondary schools across four regional authorities (Hampshire, Isle of Wight, Portsmouth, and Southampton). Initial recruitment was facilitated through gatekeeper engagement, wherein senior local government officials issued formal invitations to all secondary schools within the target regions (N = 207). Interested schools (N = 109) completed a formal Memorandum of Agreement to trigger their enrolment in the study. This process was repeated annually – hence, schools that were unable to participate in the first wave (2023) were given another opportunity to take part in the second wave (2024).

Data collection followed a sequential cohort design; the first wave (2023) targeted pupils in Year 8 and Year 10, while the second wave (2024) surveyed Year 9 and Year 10. A passive (opt-out) parental consent model was used, allowing parents and carers to withdraw their children prior to data collection (opt-out rate of ~0.3%). Data were collected through the #BeeWell survey, completed by young people on Qualtrics at school. Across both waves, the study achieved an approximate 50% participation rate relative to the total eligible pupil population (i.e., those in the relevant year groups in a given wave) within the four participating regions (#BeeWell Research Team, 2024; K.M. #BeeWell Research Team, 2025).

The analytic sample for this paper comprised N = 30,920 young

people (aged 12–15; mean age = 14 years, 1 month) from 100 schools and 1539 neighbourhoods. See Fig. 1 for inclusion/exclusion criteria and how the final analytical sample was determined. Young people who indicated they used a fictional substance (Semeron) or were missing data on all substance use questions were excluded from analyses. The socio-demographic composition of our sample was comparable to the South of England, and England more broadly, can be found in Supplementary Table 1.

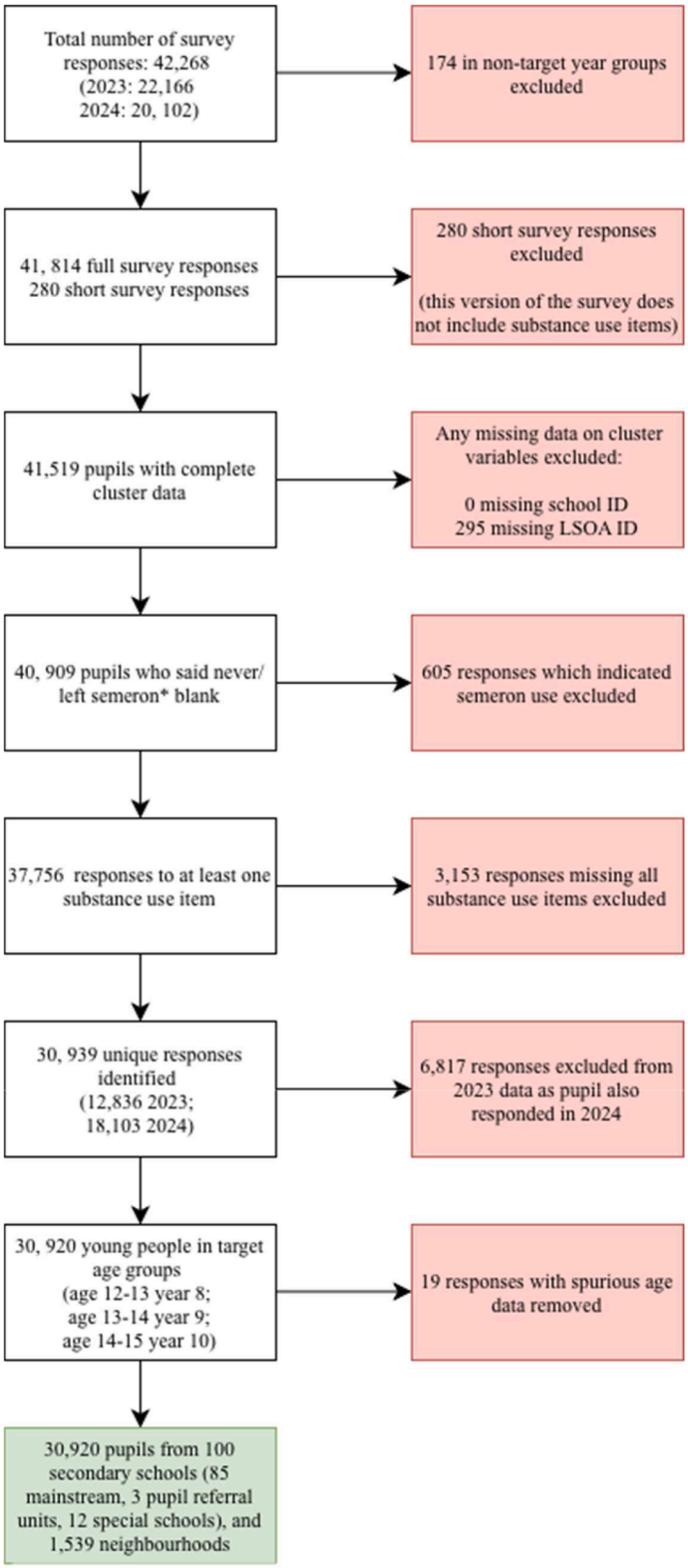

Fig. 1. Sample flow diagram.

Measures

Substance use

Items measuring substance use were adapted from the Health Behaviours in Schools Checklist, the Millennium Cohort Study, and NHS Digital's Smoking, Drinking and Drug Use among Young People in England (Centre for Longitudinal Studies, 2020; C. Currie et al., 2014; Fitzsimons, 2020; NHS Digital, 2023b). Young people reported the number of days they had used the following, in the last 30 days: 1) electronic cigarettes (excluding heat-not-burn products); 2) cigarettes; 3) cannabis; 4) semeron (a fictional substance used to identify false reporting); 5) other illegal drugs (e.g., ecstasy, cocaine, speed); and 6) alcohol (a full drink, not just a sip). Response options were: *Never, 1–2 days, 3–5 days, 6–9 days, 10–19 days, 20–29 days, 30 days, and Previously used but not in the last 30 days.* Young people reporting semeron use were excluded from analysis (S. Pudney, 2010).

We derived four binary substance use outcomes: 1) vaping; 2) smoking; 3) alcohol consumption; and 4) use of illicit drugs (cannabis and/or other illegal drugs). Our main analyses considered current usage (those reporting any use in the last 30 days) versus non-current usage (never and previously used but not in the last 30 days). Current usage was prioritised as the primary outcome due to its greater clinical and behavioural relevance, its alignment with proximal explanatory variables, and its improved measurement reliability. Specifically, recent use provides a more valid indicator of active or sustained consumption, whereas lifetime measures often capture isolated or experimental use (Tibbits, 2014; Gray & Squeglia, 2018). In addition, although our analyses are cross-sectional, modelling current substance use alongside risk factors measured at the same time point strengthens the conceptual alignment between predictors and outcomes, since adolescent substance use is shaped by proximal, contemporaneous social and environmental influences that fluctuate during adolescence (E.M. Trucco, 2020). Finally, shorter recall periods are less susceptible to reporting error, with empirical evidence showing higher agreement between self-reported and biospecimen-confirmed substance use when shorter retrospective periods are used (Folk et al., 2022), thereby increasing the reliability of the outcome measure.

Classification variables: school and neighbourhood

We accounted for the potential cross-classified structure of our data using school attended and residential neighbourhood as classification variables. Neighbourhoods were defined as the Lower-Layer Super Output Area (LSOA) in which participants' home postcodes were located. LSOAs segment England into 32,844 small geographic units each comprising roughly 650 households, or 1500 people. While LSOAs do not necessarily map onto adolescent definitions of neighbourhood, which are often based on social and emotional factors rather than constrained by geographic boundaries (Colburn et al., 2020), administrative units are widely used in research to reflect the structural context of neighbourhoods, providing comparable data for policy and research.

Our analytic sample comprised 100 schools and 1539 neighbourhoods, yielding 4903 school-neighbourhood combinations. Neighbourhoods were linked to a median of 3 schools (range: 1–12), and schools drew pupils from a median of 47 neighbourhoods (range: 1–196). School cluster sizes ranged from 1 to 913 pupils (median: 32; IQR: 27–151), with 3% of schools represented by a single pupil in the analytic dataset. Neighbourhood cluster sizes ranged from 1 to 90 pupils (median: 18; IQR: 8–34), with 12% comprising a single pupil.

Putative determinants of substance use

Table 1 summarises the explanatory variables included in the current study, grouped into relational dynamics, wellbeing, school-related factors, and free time and local environment.

Analytical approach

Missing data strategy

Overall missingness was 3% (with <1% missing data for the substance use items, maximum of 7% missing for explanatory variables). Multiple imputation with chained equations for cross-classified data were used to impute missing data, using the *mice* and *miceadds* R packages (Robitzsch & Grund, 2024; S. van Buuren & Groothuis-Oudshoorn, 2011), following the approach outlined by Grund, Lüdtke and Robitzsch (2023). Following guidance that the number of imputed datasets should exceed the overall proportion of missing data, we created 10 imputed datasets (White et al., 2011). All analyses were conducted on each imputed dataset, and estimates were pooled using Rubin's rules (Rubin, 1987).

Those with complete non-response on all substance use items were excluded, as imputations in such cases would rely solely on auxiliary variables, potentially introducing spurious associations and inflating prevalence estimates. In addition, such missingness was considered unlikely to satisfy the missing at random (MAR) assumption (e.g., due to item non-relevance, non-disclosure, or survey non-completion) underpinning imputation. As such, only those with partial substance use data contributed to imputed estimates.

Data analysis

To address RQ1, three modelling frameworks were applied to each substance use outcome: 1) a traditional two-level logistic multilevel model with a random intercept for neighbourhood (neighbourhood-only random intercept model); 2) a traditional two-level logistic multilevel model with a random intercept for school (school-only random intercept model); and 3) an intercept only cross-classified logistic multilevel model (CCMM). Whereas in a traditional two-level multilevel model it is assumed that young people (level 1) are nested in only one hierarchical level (e.g., school; level 2), CCMMs acknowledge that young people can be simultaneously nested in multiple level 2 units (e.g., schools and neighbourhoods) (G. Leckie, 2013). The resulting intra class correlation (ICC) of the CCMM is the proportion of variance in the outcome due to each level 2 unit, having controlled for the other level 2 units. For each substance use model, we report model fit statistics (Akaike Information Criterion, AIC; Bayesian Information Criterion, BIC) and intra-cluster correlation coefficients (ICCs). Models with the lowest AIC and BIC values yield the best fit to the data (K.P. Burnham & Anderson, 2002). ICCs were calculated using the latent threshold approach (Devine et al., 2024).

To address RQ2, the best fitting model identified in RQ1 was extended to include sociodemographic variables (age, SEN, familial deprivation, neighbourhood deprivation, ethnicity, and gender identity/sexual orientation) for each substance use outcome. To address RQ3, RQ2 models were further extended to include the identified set of putative risk and protective factors. P-values adjusted for false discovery rate and corresponding confidence intervals are reported to account for multiple testing concerns (Y. Benjamini & Hochberg, 1995; Y. Benjamini & Yekutieli, 2005). Nested model comparisons for imputed data (Meng & Rubin, 1992) were used to test the significance of these models: the models built in RQ2 were compared to the best fitting model identified in RQ1 (i.e., the corresponding null model); and those built in RQ3 (with risk and protective factors included) were compared to the models built in RQ2 (which contained only sociodemographic factors). If a given model significantly improved fit compared to the previous model, we concluded that the added variables were associated with unique variance in the outcome.

All analyses were conducted in RStudio (RStudio Team, 2022), using the R package *glmmTMB* (Brooks et al., 2017). Analysis code can be found on GitHub: [blinded for peer review].

Sensitivity analyses

Sensitivity analyses focused on *ever* versus *never* using a given

Table 1
Putative determinants of adolescent substance use.

Variable	Measure/Item	Response format and scoring	% /Mean (±SD)	Source
Socio-demographic factors				
Age	Year group	8, 9, 10	Year 8: 12.26% Year 9: 30.67% Year 10: 57.07%	LA/school data
Special educational needs	Broad SEN categories	No SEN; SEN support; EHC plan	No SEN: 84.69% SEN support: 12.34% EHC plan: 2.97%	LA/school data
Familial deprivation	FSM (eligible for free school meals within the last 6 years)	Yes, No	No FSM: 81.42% FSM: 18.58%	LA/school data
Neighbourhood deprivation	IMD	Quintiles, with quintile 5 denoting the least deprived area and quintile 1 denoting the most deprived area	Quintile 5: 36.73% Quintile 4: 21.06% Quintile 3: 17.72% Quintile 2: 14.33% Quintile 1: 10.16%	LA/school data
Ethnic group	Ethnicity (major) categories	White British, Asian, Black, Mixed, Any other ethnic group (including Chinese), White other	White British: 82.55% Asian: 4.19% Black: 1.65% Mixed: 4.79% AOEG: 0.62% White other: 6.2%	LA/school data
Gender identity and sexual orientation	Gender identity and sexual orientation	Cisgender heterosexual boys, cisgender heterosexual girls, LGBTQ+	Cishet boys: 41.03% Cishet girls: 36.45% LGBTQ+: 22.52%	Survey; LA/school data
Relational dynamics				
Susceptibility to peer pressure	Derived from the Peer Pressure Scale (Santor et al., 2000): My friends could push me into doing just about anything	Scale of 1–7 whereby 1 = completely false and 7 = completely true. Quasi-continuous whereby higher score = more susceptible to peer pressure	3.32 (±1.74)	Survey
Bullying victimisation	Three items adapted from Understanding Society and Health Behaviours in Schools Checklist, asking about frequency of physical, relational, and cyber bullying victimisation (C. Currie et al., 2014; Institute for Social & Economic Research, 2021)	Not bullied at all, not much (1–3 times in the last 6 months); quite a lot (>4 times in last 6 months); a lot (a few times every week). Single binary variable of bullied vs not bullied derived whereby those who were bullied quite a lot or a lot on one of the three bullying items were bullied.	Not bullied: 81.58% Bullied: 18.42%	Survey
Friendships and social support	4-items from the Child Youth and Resilience Measure (Jefferies et al., 2019) (Sample item: "I get along with people around me") The scale has good reliability in our dataset (α = 0.85; ω = 0.85)	Not at all; A little; Somewhat; Quite a bit; A lot 4–20, higher score = better/more secure friendships	14.82 (±3.65)	Survey
Relationships with parents/carers	4-item family connection subscale of the student resilience survey (J. Sun & Stewart, 2007). Sample item: "At home, there is an adult who wants me to do my best". The scale has good reliability in our dataset (α = 0.86; ω = 0.87)	Scale from 1 = Never to 5 = Always 4–20, higher score = better relationships with parents/carers	16.79 (±3.56)	Survey
Internalising symptoms	10-item Me and My Feelings emotional difficulties subscale (sample item: "I cry a lot") (Deighton et al., 2012) The scale has good reliability in our dataset (α = 0.89; ω = 0.88)	Never; Sometimes; Always 0–20, higher score = more frequent emotional difficulties	6.83 (±4.80)	Survey
Self esteem	5 items from the Rosenberg Self-Esteem scale (positively worded items) Sample item: "On the whole, I am satisfied with myself". (C. Bagley & Mallick, 2001; M. Rosenberg, 1965) The scale has excellent reliability in our dataset (α = 0.91; ω = 0.92)	Strongly disagree; disagree; agree; strongly agree 5–20, higher score = better self-esteem.	14.18 (±3.44)	Survey
Coping with stress	2-item perceived coping subscale of the Perceived Stress Scale (Cohen, 1986) (sample item: "In the last month, how often have you felt confident about your ability to handle your personal problems?" The scale has acceptable reliability in our dataset (α =0.76)	Never; almost never; sometimes; fairly often; very often 0–8, higher score = better coping abilities	4.16 (±1.95)	Survey
School related factors				
School belonging	Single item drawn from Child and Youth Resilience Measure (Jefferies et al., 2019) ("I feel like I belong at my school")	Not at all, a little, somewhat, quite a bit, a lot Scores ranging 1–5, with higher score indicating increased feelings of belonging at school	3.26 (±1.15)	Survey
Happiness with attainment	Original item: "How happy are you with the marks you get in school?"	Scale from 0 = Very unhappy to 10 = Very happy. Higher score indicates greater happiness with attainment	5.93 (±2.29)	Survey

(*continued on next page*)

Table 1 (*continued*)

School related factors				
Relationships with staff	4-item school connection subscale of the Student Resilience Survey (J. Sun & Stewart, 2007) (sample item: "At school there is an adult who believes that I will be a success") The scale has good reliability in our dataset (α = 0.89; ω = 0.89)	Scale from 1 = Never to 5 = Always 4–20, higher score = better relationships with staff	13.77 (±4.24)	Survey
School pressure	Single item from Health behaviours in schools checklist (C. Currie et al., 2014) "How pressured do you feel by the schoolwork you have to do?"	Not at all, a little, some, a lot Scores range 1–4 with higher score indicating more pressure 1–4, with higher score indicating more feelings of school pressure	2.80 (±0.95)	Survey
School based mental health support	Single item from NHS digital, Mental health of children and young people in England (T. Newlove-Delgado et al., 2022): "Have you used any mental health and wellbeing support available through your school?	Yes, No, Don't know Binary variable whereby those who responded yes were compared to everyone else.	Yes: 19.22% No/don't know: 80.78%	Survey
	Single item from NHS digital, Mental health of children and young people in England (T. Newlove-Delgado et al., 2022): I know how to get help for worries or mental health concerns at my school	Agree a lot, agree a little, neither agree or disagree; disagree a little; disagree a lot; don't know Binary variable where 0 = disagree a little/ disagree a lot /neither agree/disagree, 1 = agree a little/agree a lot	0 = 47.54% 1 = 52.46%	Survey
	Single item from NHS digital, Mental health of children and young people in England (T. Newlove-Delgado et al., 2022): I feel comfortable talking to adults at my school about my mental health	Agree a lot, agree a little, neither agree or disagree; disagree a little; disagree a lot; don't know Binary variable where 0 = disagree a little/ disagree a lot /neither agree/disagree, 1 = agree a little/agree a lot	0 = 72.3% 1 = 27.7%	Survey
Free time and local environment				
Perceived leisure autonomy	Single original item, developed for the #BeeWell survey. "How often can you do things that you like in your free time?"	Almost never, not often, sometimes, often, almost always. Scores ranging 0 (Never) to 4 (Almost always), with higher score indicating more autonomy	3.02 (±0.94)	Survey
Good places to spend free time	Single item adapted from the Policing and community safety survey and Health behaviours in schools checklist. (C. Currie et al., 2014; M. GMCA, 2024) "There are good places to spend your free time (e.g., leisure centres, parks, shops)	Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree 0–4, with higher score indicating more good places	2.56 (±1.12)	Survey

substance.

As an unplanned, reviewer-requested analysis, we examined the putative determinants of frequent users (defined as ≥3 times in the past month, indicating almost weekly use) compared with non-frequent users, restricting the analysis to participants who had ever used these substances. This additional analysis was limited to vaping and alcohol only. Results can be found in the supplementary materials.

Results

Substance use prevalence rates can be found in Table 2.

What is the relative influence of school and neighbourhood contexts on adolescent substance use?

Table 3 displays the ICC values for the three modelling frameworks for each substance. When neighbourhood membership is included as the only level 2 predictor, it explains between 3.3% to 5.9% of variance depending on the substance. However, when neighbourhood and school membership are modelled in tandem, the variance explained by neighbourhoods reduces to 0%, indicating that variance attributed to neighbourhoods in the neighbourhood-only model is due to school membership (see model fit statistics in Table 3). Across all substances, the school-only model was the best fit to the data, indicating a cross-classified structure was not supported. Therefore, all subsequent analyses employed the standard 2-level approach, modelling pupils nested in schools.

Table 2
Prevalence of substance use.

Substance	Current use	Ever used	Frequent use (in full sample)	Frequent users (among ever users)
Vaping	6.58%	12.05%	4.43%	36.61%
Smoking	1.90%	3.74%	-	-
Alcohol consumption	17.45%	28.97%	9.49%	32.67%
Illicit drugs (cannabis and/or other illegal) drugs	2.40%	4.05%	-	-

Findings from sensitivity analyses (ever vs never) generally aligned with the main current use analyses for vaping, alcohol consumption, and illicit drugs. A more complex pattern emerged for those who had ever smoked cigarettes: the AIC favoured the CCMM, whilst the BIC value favoured the school-only model (see Supplementary Table 3). While adopting CCMM improved fit slightly, improvements were modest and did not offset the BIC's penalty for added complexity (K.P. Burnham & Anderson, 2002; J. Kuha, 2004). The neighbourhood ICC reduced to 2% in the cross-classified model, whereas the school ICC remained at 4.34%, indicating that much of the neighbourhood variance was attributable to school membership. Therefore, to ensure consistency across models, model parsimony was prioritised for RQ2 and RQ3 for smoking.

Are there sociodemographic disparities (depending on age, gender identity/ sexual orientation, ethnicity, SEC, SEN) in adolescent substance use?

Older adolescents were more likely to currently use substances (see Table 4). Those in Year 10 had consistently higher odds of current use than those in Year 8, regardless of substance (e.g., OR = 3.77 for illicit drug use). Those in Year 9 also had greater odds of alcohol consumption, but reduced odds of smoking than those in Year 8.

Table 3
Model fit statistics and intra-class correlations for two-level and cross-classified random-intercept only models associated with current substance use.

	Vaping			Smoking			Alcohol consumption			Illicit drugs (cannabis and/or other illegal drugs)		
Model	AIC	BIC	ICC	AIC	BIC	ICC	AIC	BIC	ICC	AIC	BIC	ICC
Neighbourhood (Model 1)	14,985.83	15,002.51	3.49%	5811.05	5827.73	4.66%	28,535.98	28,552.66	3.25%	6990.66	7007.34	5.87%
School (Model 2)	**14,713.26**	**14,729.94**	7.63%	**5762.85**	**5779.53**	5.89%	**28,072.30**	**28,088.98**	5.82%	**6898.58**	**6915.26**	8.53%
CCMM (Model 3; neighbourhood)	14,715.26	14,740.28	0.03%	5764.85	5789.87	< 0%	28,074.30	28,099.32	< 0%	6900.49	6925.50	0.51%
CCMM (Model 3; school)			7.62%			5.89%			5.82%			8.47%

The smallest AIC/BIC value, denoting the best model fit, is in **bold**.

Table 4
Multi-level logistic regression models for the associations between sociodemographic factors with current substance use.

	OR [95% CIs]			
Variable	Vaping	Smoking	Alcohol	Illicit drugs
Year 8	REFERENCE	REFERENCE	REFERENCE	REFERENCE
Year 9	1.12 [0.89;1.4], p = .399	0.64 [0.43;0.97], p = .031 *	1.27 [1.09;1.48], p = .001 * *	1.4 [0.84;2.34], p = .205
Year 10	2.26 [1.84;2.76], p<.001 * * *	1.82 [1.3;2.55], p<.001 * * *	2.7 [2.36;3.1], p<.001 * * *	3.77 [2.39;5.94], p<.001 * * *
No SEN	REFERENCE	REFERENCE	REFERENCE	REFERENCE
SEN Support	1.3 [1.12;1.51], p<.001 * * *	1.33 [1.02;1.73], p = .031 *	0.8 [0.72;0.89], p<.001 * * *	1.22 [0.93;1.61], p = .165
EHC Plan	0.87 [0.63;1.21], p = .472	1.14 [0.68;1.91], p = .751	0.67 [0.54;0.84], p<.001 * * *	0.65 [0.33;1.3], p = .220
Not FSM eligible	REFERENCE	REFERENCE	REFERENCE	REFERENCE
FSM eligible	1.62 [1.42;1.83], p<.001 * * *	1.64 [1.3;2.07], p<.001 * * *	0.96 [0.88;1.06], p = .413	1.72 [1.36;2.18], p<.001 * * *
IMD quintile 5 (least deprived)	REFERENCE	REFERENCE	REFERENCE	REFERENCE
IMD quintile 4	1.02 [0.88;1.2], p = .832	0.98 [0.75;1.29], p = .890	1.04 [0.95;1.14], p = .359	0.98 [0.74;1.31], p = .870
IMD quintile 3	1.15 [0.97;1.36], p = .093	1.02 [0.75;1.38], p = .890	0.96 [0.86;1.07], p = .413	0.91 [0.66;1.26], p = .532
IMD quintile 2	1.22 [1.01;1.47], p = .037 *	1.15 [0.83;1.58], p = .507	0.93 [0.82;1.05], p = .222	1.14 [0.81;1.62], p = .375
IMD quintile 1 (most deprived)	1.21 [0.97;1.5], p = .089	0.9 [0.6;1.33], p = .745	0.89 [0.77;1.04], p = .139	1.23 [0.83;1.83], p = .256
White British	REFERENCE	REFERENCE	REFERENCE	REFERENCE
Asian	0.4 [0.26;0.61], p<.001 * * *	0.33 [0.13;0.79], p = .015 *	0.23 [0.17;0.31], p<.001 * * *	0.52 [0.25;1.07], p = .077
Black	0.56 [0.33;0.97], p = .037 *	0.33 [0.09;1.22], p = .105	0.29 [0.19;0.44], p<.001 * * *	0.81 [0.33;2.02], p = .586
Mixed	0.98 [0.76;1.26], p = .846	1.03 [0.65;1.62], p = .890	0.75 [0.64;0.89], p<.001 * * *	1.27 [0.83;1.94], p = .250
Any other ethnic group	1.07 [0.56;2.08], p = .846	1.67 [0.64;4.38], p = .381	0.4 [0.22;0.71], p = .001 * *	0.4 [0.06;2.64], p = .293
White (other)	0.92 [0.72;1.16], p = .508	1.05 [0.69;1.58], p = .890	0.54 [0.45;0.64], p<.001 * * *	0.8 [0.49;1.3], p = .300
Cishet boys	REFERENCE	REFERENCE	REFERENCE	REFERENCE
Cishet girls	1.88 [1.66;2.13], p<.001 * * *	1.33 [1.04;1.7], p = .024 *	1.15 [1.07;1.24], p<.001 * * *	0.87 [0.69;1.1], p = .232
LGBTQ+	1.7 [1.47;1.96], p<.001 * * *	2.07 [1.61;2.67], p<.001 * * *	1.1 [1.01;1.2], p = .035 *	1.23 [0.96;1.58], p = .101
ICC of school (after accounting for fixed effects)	5.64%	4.46%	3.47%	6.50%
Overall significance of model[a]	Dm(16,28,009.33)= 28.19p<0.001)	Dm(16, 24,183.11) = 11.49 p<.001	Dm(16, 25,936.5)=52.11, p<.001	Dm(16,28,281.84) = 13.33, p<.001

[a] The overall significance of the model was established by comparing the full model to the null model (i.e., model with sociodemographic variables to the school only model), using the multivariate Wald test, following the method outlined for imputed datasets by Meng and Rubin (1992). Dm is the Wald test statistic for this method, with p<.05 indicating an improved model fit compared to the null model.

Findings for young people with SEN were mixed. Those receiving SEN support had increased odds of vaping and smoking, but reduced odds of alcohol consumption, compared to those without SEN. Young people with an EHC plan also had lower odds of alcohol consumption than those without SEN.

The influence of socioeconomic deprivation was complex, varying by type of deprivation and substance. Young people eligible for FSM (familial deprivation) were more likely to vape, smoke and use illicit drugs, compared to those not eligible. No differences were observed for alcohol consumption. Contrastingly, neighbourhood deprivation was not associated with substance use, except for those in the second most deprived quintile, who had greater odds of vaping, compared to the least deprived (most affluent) quintile.

Young people from all minoritised ethnic backgrounds had lower odds of alcohol consumption compared to those from White British backgrounds. Asian young people had lower odds of using all substances except for illicit drugs, while Black young people had decreased odds of vaping.

Finally, cisgender heterosexual girls were more likely to vape, consume alcohol and smoke than cisgender heterosexual boys. LGBTQ+ young people had consistently higher odds of using all substances compared to cisgender heterosexual boys (e.g., OR = 2.07 for smoking).

Findings were generally consistent with the above in sensitivity analyses (ever vs never; see Supplementary Table 4), although some different patterns pertaining to year group, SEN, neighbourhood deprivation, and ethnic background emerged (e.g. being in Year 9 was no longer associated with smoking, but was associated with previous use of vapes; receiving SEN support was no longer associated with previous use of vapes).

What are the associations between relational dynamics, wellbeing, school-based factors, free time and local environment, with adolescent substance use?

Extension of the models reported for RQ2 to include potential explanatory factors influenced the strength and statistical significance of some previously observed differences between sociodemographic subgroups. Odds ratios and 95% confidence intervals are plotted in Fig. 2. Results are also reported in full in Supplementary Table 2. Generally, effect sizes were small-moderate in magnitude.

Relational dynamics

Increased susceptibility to peer pressure was associated with 33–58% higher odds of using all substances (ORs 1.33 to 1.58), while having close/supportive friendships was associated with 8–20% higher odds (ORs 1.08 to 1.20), indicating risks for general substance use. Stronger relationships with parents/carers was associated with reduced odds (16–27% lower odds; ORs 0.73 0.84 across substances). Being bullied was associated with increased odds of vaping (OR = 1.31), smoking (OR = 1.54) and drinking alcohol (OR = 1.2), but not illicit drug use.

School-related factors

Young people who reported accessing school-based support were more likely to use all substances (OR range 1.31 to 1.51); in contrast, increased happiness with attainment (OR range 0.77 to 0.91) and better relationships with staff (OR range 0.80 to 0.91) were associated with reduced odds of using any substance (protective factor for general substance use). Knowing how to access mental health support at school and feeling comfortable discussing mental health with trusted adults in school were associated with reduced odds of alcohol consumption only (OR = 0.9), while a strong sense of school belonging was associated with a 7–15% reduction in the odds of vaping (OR = 0.93), smoking (OR = 0.86), and illicit drug use (OR = 0.85), but not alcohol consumption (substance-specific factors). Adolescents reporting higher levels of school pressure had increased odds of alcohol consumption only, although the effect size was small (OR = 1.04).

Wellbeing

Greater internalising symptoms increased the odds of vaping (OR = 1.11), smoking (OR = 1.17) and alcohol consumption (OR = 1.11), and higher self-esteem scores reduced the odds of vaping (OR = 0.86) and alcohol consumption (OR = 0.93). However, these factors were not associated with illicit drug use. Adolescents with better perceived coping skills had reduced odds of vaping (OR = 0.93).

Free time use and the local environment

Increased leisure autonomy was related to higher odds of vaping (OR = 1.06) and illicit drug use (OR = 1.13); in contrast, increased perceptions of having good things to do in the local environment reduced the odds of these substances, plus alcohol consumption (OR range 0.84 to 0.9).

Sensitivity analyses

While some differential results emerged (e.g., perceived leisure autonomy was no longer associated with vaping or illicit drugs; bullying victimisation was associated with increased odds of any previous illicit drug use; see Supplementary Table 5), the pattern of findings across main and sensitivity analyses indicate that putative risk and protective factors for current substance use and ever having used a substance are largely consistent. Among the subset of young people who had ever vaped or drank alcohol, susceptibility to peer pressure remained a predictor of frequent use, with close/supportive friendships also linked to more frequent alcohol consumption. Conversely, stronger parent relationships and greater happiness with attainment reduced the odds of frequent use, with school belonging also reducing the odds of frequent vaping. Comfort speaking to adults at school and greater perceived leisure autonomy were each associated with higher odds of frequent vaping, while having good places to go in the local area was associated with lower odds of frequent alcohol use (see Supplementary Table 6). Given the exploratory and unplanned nature of this analysis, and the much

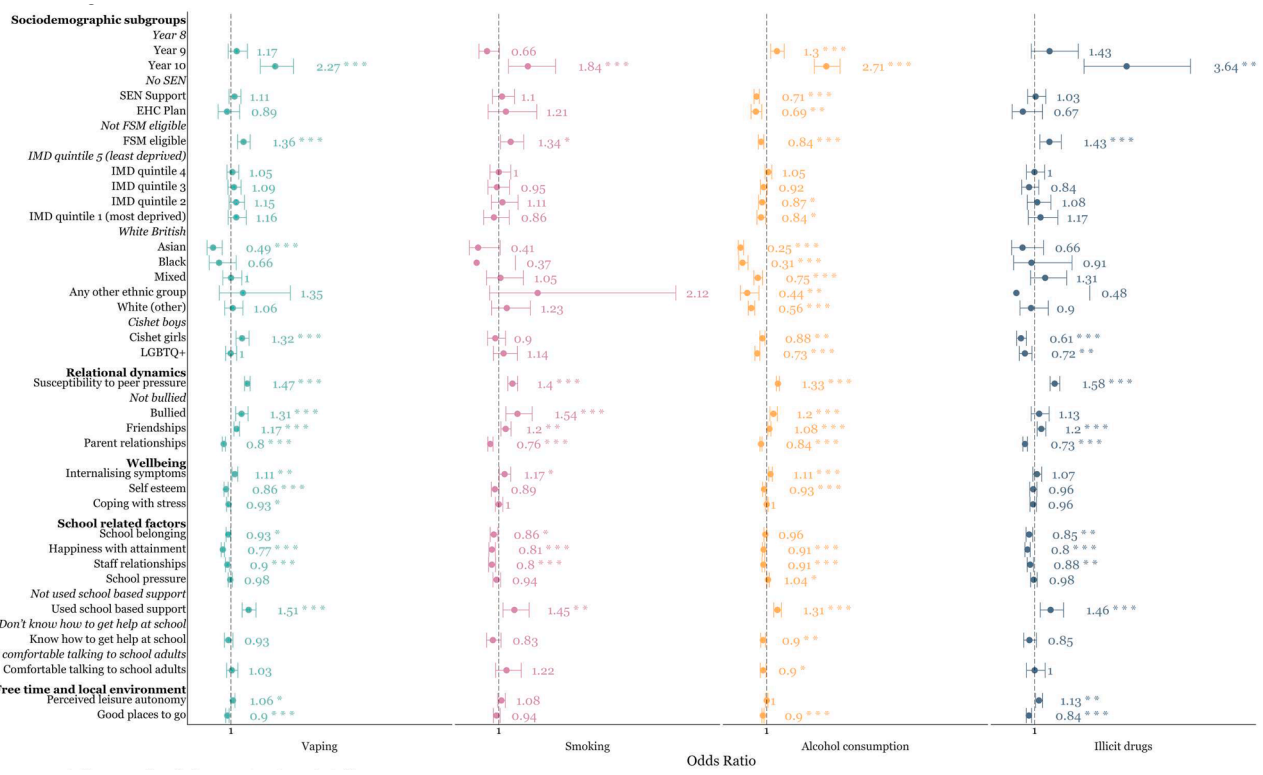

Fig. 2. Associations with current substance use.

smaller subsample involved, these results should be interpreted cautiously.

Discussion

The results of the current study highlight the importance of the school context in shaping adolescent substance use. When considered in isolation, neighbourhoods accounted for approximately 3–6% of the variance in adolescent substance use. However, when both school and neighbourhood contexts were modelled simultaneously, the influence of neighbourhood disappeared, while the ICC of schools remained unchanged (between 6–8.5%). Our findings align with previous research employing CCMM to examine alcohol use (K.M. Barker et al., 2023; Takakura et al., 2019), smoking (B. De Clercq et al., 2014; E.C. Dunn et al., 2015), and illicit drug use (L.R. Frøyland et al., 2025), adding important new insights relating to the influence of differences between schools on adolescent vaping. Peer influences are strongly associated with substance use (T.C. Woodward et al., 2023), and schools are a primary context for the formation and maintenance of peer relationships. As a setting for peer socialisation, selection, norms and perceived peer approval processes (E.M. Trucco, 2020), school-level variation in substance use is highly plausible. Additionally, levels of access and opportunities for substance use may vary between schools due to differences in monitoring and the enforcement of disciplinary policies. In contrast, neighbourhoods generally encompass a broader range of demographics, cultural norms, and parental supervision practices, making them a less consistent context for shaping adolescent substance use.

Our findings contribute to a growing body of literature employing CCMMs in public health research (K.M. Barker et al., 2020). Nonetheless, differences between schools only explained up to 8.5% of the variance in substance use, highlighting the substantial role of differences between individuals. We observed numerous sociodemographic disparities, some of which varied by substance. Consistent with previous literature, older adolescents were more likely to report current substance use for all substances (J. Rodriguez-Ruiz et al., 2023); cisgender heterosexual girls and LGBTQ+ young people had greater odds of substance use than cisgender heterosexual boys (R. Amos et al., 2020; M. Cotaina et al., 2022; R.K. McHugh et al., 2018); and White British adolescents were more likely to consume alcohol than their peers from minoritised ethnic groups, though differences were less clear for other substances (NHS Digital, 2022; C. Vrinten et al., 2023). Findings were more varied for deprivation. FSM-eligible young people were more likely to vape, smoke and use illicit drugs, whereas few differences were observed across indices of deprivation. These findings are consistent with evidence that outcomes differ depending on whether familial or neighbourhood deprivation is measured (J. Rodriguez-Ruiz et al., 2023). The general lack of associations between neighbourhood deprivation and substance use is consistent with our broader finding that the school context is more influential than the neighbourhood context. Finally, those receiving SEN support had increased odds of vaping and smoking, but reduced odds of alcohol consumption, which contrasts an earlier study which identified a lower prevalence of substance use among young people with intellectual needs (J. Robertson et al., 2018). However, there is substantial heterogeneity within those with SEN and there may be variations in substance use depending on type or severity of needs (C. Public Health England, 2016); some research suggests emotional or behavioural needs predict higher use than learning needs (A. Kepper et al., 2014), and evidence from young adults suggests higher vaping and smoking among those with physical disabilities (J. Hanafin et al., 2025).

Coping motives, which may be a response to greater internalising symptoms (I. Meque et al., 2019), may be a key risk factor for vaping, smoking, and alcohol use (M.L. Cooper et al., 2016): bullying victimisation, internalising symptoms, low self-esteem, poor coping skills, and school pressure were associated with increased odds across these substances. However, this does not appear to be the case for illicit drug use, which was not associated with any of these factors. Peer influences were consistently linked to higher odds of substance use, indicating that these effects are not substance specific and aligning with previous research showing that greater peer connectedness is associated with increased substance use (V.T. Cole et al., 2024). Although our analyses did not include a direct measure of peer substance use, a likely mechanism, previous research indicates that associations with peer connectedness persist even when peer substance use is accounted for (V.T. Cole et al., 2024). Our findings suggest that young people who are more susceptible to peer pressure are at greater risk of engaging in substance use. Given evidence that supportive friendships can sometimes facilitate substance use (J.P. Allen et al., 2022), it is possible that susceptibility to peer pressure coincides with stronger friendships, perhaps reflecting a heightened concern about relational consequences.

Compared to vaping, smoking, and alcohol use, fewer factors were associated with illicit drug use. Aside from peer influences, our findings suggest that illicit drug use in early adolescence is primarily related to relationships with parents/carers and teaching staff (S.M. Daily et al., 2020; Y. Han et al., 2016; M.B.H. Yap et al., 2017) and school-based factors (e.g., happiness with attainment, school belonging; K.-A. Allen, Greenwood et al., 2025; Rose et al., 2024), with these factors being generally associated with reduced odds of substance use. Further, how much unstructured free time a young person has (i.e., perceived leisure autonomy), and the availability of local free-time assets was also associated with illicit drug use. Thus, young people with lots of perceived leisure autonomy may engage in more unstructured activities, which is a known risk factor for increased substance use, but having good places to spend their free time (e.g. leisure centres or parks) may offset this risk, perhaps by reducing boredom which may otherwise result in substance use (Y. Children's Comissioner, 2025).

Utilisation of mental health and wellbeing services at school, a previously underexplored factor, was associated with substance use, emerging as a general risk factor. Use of school mental health services often precedes use of external mental health support (J.G. Green et al., 2013; Newlove-Delgado et al., 2015). This aligns with research from Canada and the US indicating comorbidity between mental health difficulties and substance use problems (A.H. Cheung et al., 2019; J. Halladay et al., 2024). A particularly interesting finding is the relationship between utilisation of school mental health services and illicit drug use, despite a lack of assocation with coping. It is possible that illicit drug use is influenced by unmeasured factors that may cause young people to engage with mental health services, such as behavioural difficulties (Trucco & Hartmann, 2021) or adverse childhood experiences (L. Leza et al., 2021). It is also possible that utilisation of school mental health and wellbeing services are a result of, rather than a driver of, illicit drug use. Interestingly, school-based help-seeking knowledge and comfort discussing mental health with school adults mitigated the likelihood of endorsing alcohol use, indicating that increased confidence in school mental health services may act as a protective buffer.

Implications

The current study contributes to adolescent substance use theory by demonstrating that the ecological clustering of young people within schools explains substantially more variation in substance use than the neighbourhood boundaries used in our analyses. Schools, which represent a salient social and environmental context for adolescents, capture meaningful differences in substance use patterns, beyond those observed across neighbourhoods. The observed variation appears more closely aligned with school-based ecological contexts (e.g., peer networks, social norms, routines) than with broader neighbourhood environments, although this should not be interpretated as evidence that schools as institutions are themselves the sole causal drivers. Although most observed effect sizes were small to moderate in magnitude, the consistency of associations across multiple substances suggests that relational and school-based factors exert a meaningful influence on adolescent

substance use. Given that school-based factors were generally protective, future studies should examine how school experiences and contextual factors (e.g., school climate), directly impact substance use behaviours. These findings reinforce the central role of schools in prevention efforts, not only as ideal settings for universal interventions (e.g., R Ponsford et al., 2024) but also as contexts for targeted strategies addressing relational and environmental putative determinants.

Our nuanced findings relating to SEN and familial deprivation highlight the need for more granular research into these sociodemographic groups. For example, the mixed findings for young people with SEN, who were more likely to vape but less likely to drink alcohol than their peers without SEN, warrants more focused, qualitative, and/or longitudinal studies to understand why these differences are evident. Additionally, the finding that close friendships increase the odds of substance use while strong relationships with adults reduce it, presents a complex dynamic for further exploration, especially given the developmental phase in question (i.e., adolescence is characterised by increased independence from adults and growing salience of peer influence; E.M. Trucco, 2020). This highlights the need for research that differentiates between different types of relationships and their potentially competing influences on adolescent decision-making.

Our findings suggest that some putative determinants of adolescent substance use show broadly similar patterns across substances (e.g., peer influences, relationships with staff), whereas others appear more substance-specific in their associations (e.g., school pressure for alcohol use; leisure autonomy for vaping and illicit drugs; coping-related measures for vaping, smoking, and alcohol but less so for illicit drugs). These patterns should be interpreted descriptively, as we did not formally test whether effects differed statistically between substances. Nonetheless, recognising such variation is important because most existing prevention programmes adopt broad, multi-substance approaches, despite systematic reviews reporting mixed evidence for their effectiveness and highlighting a need for more tailored, substance-specific strategies (Hodder et al., 2017; Liu et al., 2023; L. Tinner et al., 2022), particularly for emerging products such as e-cigarettes (Gardner et al., 2024). Prevention strategies should also be both targeted and equitable, with particular value for groups identified as more vulnerable in our analysis. Future work should investigate how determinants interact with sociodemographic characteristics to determine whether they operate similarly across different groups of young people.

Strengths & limitations

This study has a number of important strengths. First, the very large sample (>30,000) facilitated statistical power to test a wide range of sociodemographic factors and explanatory variables. We also investigated use of multiple substances (vaping, smoking, alcohol consumption, and illicit drug use), using contemporary (2023–2024) data, a crucial consideration given the unprecedented challenges adolescents currently face regarding mental health, availability of mental health services, and the ease with which vapes, for example, can be accessed. The study therefore provides important new insights into the factors associated with current adolescent use of different substances, updating and extending prior research investigating, for example, its cross-classified nature. We also considered the sensitivity of our findings to the timeframe of substance use (e.g. current versus ever).

However, data on substance use and risk/protective factors were self-reported, and may have been under- or over-reported, because of hesitancy to disclose use or exaggeration due to image management or peer conformity (though to mitigate over-reporting, a fictional substance, semeron, was included to identify reports which were likely unreliable; S. Pudney, 2010). Also, our measures were broad, identifying substance use within a given timeframe but not frequency, so we could not distinguish extensive from occasional use, and different risk and/or protective factors may apply to heavier users. Although our analyses benefit from examining multiple substances within a harmonised modelling framework, we did not conduct formal tests of whether associations differed statistically across substances. As such, any references to substance-general or substance-specific determinants are based on descriptive cross-substance comparisons rather than formal tests of heterogeneity. Future research should investigate whether key determinants operate similarly across different groups of young people and undertake formal heterogeneity analyses to assess cross-substance differences. Furthermore, analyses were cross-sectional, preventing firm conclusions about causal inference and direction (and indeed, some associations may be bi-directional). Since the #BeeWell survey was completed at school, those who were absent (who may be more likely to use substances; Knowles et al., 2025) were less likely complete the survey, potentially resulting in underestimation compared with recent cross-national data (L. Charrier et al., 2024). Finally, data were drawn from a single geographical region of England, with compositional deviations from national trends (e.g., lower proportion of minoritised ethnic groups) meaning that caution should be applied when considering national generalisability.

Conclusion

The current study demonstrates that the school context is a more influential determinant of adolescent substance use than the neighbourhood in which young people live, with school-based factors generally acting as protective influences. These findings underscore the importance of developing prevention strategies that incorporate elements of school climate and address key risk and protective factors, including peer pressure, relationships with staff, coping skills, and mental health concerns. Our results reveal both substance-general and substance-specific putative determinants, highlighting the need for tailored approaches that target shared and unique drivers of use. Such strategies should also account for sociodemographic differences, as some groups (e.g., older adolescents, LGBTQ+ youth) appear at elevated risk across substances, while others exhibit substance-specific vulnerabilities (e.g., SEN, familial deprivation).

Declaration of generative AI and AI-assisted technologies in the writing process

Generative AI (specifically, Gemini and Copilot) was used to help organise and structure the *Implications* subsection of the discussion such that it delineated the theoretical, research, and practical implications of the study more clearly and concisely. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

Ethics

Ethical approval from the University of Manchester Research Ethics Committee (UREC) was sought and granted prior to the commencement of data collection on 12 May 2021 (Ref: 2021–11133-18179). Informed consent was obtained from the parents/legal guardians of all the study participants. Consistent with the conditions of ethical approval and related documentation (e.g., parent information and informed consent forms), the data were in pseudonymised form during the analysis.

CRediT authorship contribution statement

Emma Thornton: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation. **Kathryn Mills-Webb:** Writing – review & editing, Writing – original draft, Conceptualization. **Patricia Irizar:** Writing – review & editing, Writing – original draft, Conceptualization. **Christopher Knowles:** Writing – review & editing, Writing – original draft, Conceptualization. **Jose Marquez:** Writing – review & editing, Conceptualization. **Neil Humphrey:** Writing – review & editing, Funding acquisition, Conceptualization.

Declaration of competing interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2026.105272.

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