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Title:

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Date:

2024-12-01

Citation:

Graham, P. L., Schofield, D. J., Tait, R. J., Bista, S., Ivers, R. Q., Liu, B., Lymer, S., Marino, J. L., Sanci, L. A., Shrestha, R. N., Steinbeck, K., Straker, L. M. & Skinner, S. R. (2024). Adolescent risk behaviours are associated with educational attainment in early adulthood: results from the Raine Study cohort. *BMC Public Health*, 24 (1), <https://doi.org/10.1186/s12889-024-20208-2>.

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RESEARCH

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# Adolescent risk behaviours are associated with educational attainment in early adulthood: results from the Raine Study cohort

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## Abstract

**Background** Higher educational attainment is important for economic wellbeing and associated with better health and longevity. Previous research focused on intelligence, socioeconomic status and mental health or individual risk behaviours as predictors of educational attainment, but the role of multiple domains of adolescent risk behaviours is less clear. This study examined the association between multiple domains of risk behaviour in adolescence and educational attainment by 22 years-of-age.

**Methods** Young people (Generation 2, Gen2) and their parents (Generation 1, Gen1) participating in the Raine Study completed questionnaires at years 1, 5, 8, 10 (Gen1 only), 14, 17 (both) and 22 (Gen2 only). The Raine Study is an ongoing longitudinal study initiated in Perth, Western Australia, between 1989 and 1991. The 1,102 Gen2 participants who responded to questions about highest educational attainment were included in this study. The association between Gen2 self-reported risk behaviours (including age at commencement of drinking alcohol, smoking, sexual intercourse and drug use) and educational attainment (defined as self-reported years of completed high school:  $\leq 10$ , 11, 12 or tertiary education ( $> 12$ )) at year 22, after adjusting for mother's age and combined parental education level, participant sex, and family income, educational performance and adolescent mental health, was explored using ordinal regression models and presented as odds ratios (OR) with 95% confidence intervals (CI).

**Results** Ordinal models suggested that never smoking or starting older than 18 compared with smoking before age 15 (OR 2.02, 95%CI: 1.28–2.14); first drinking alcohol between 15 and 17 years compared with younger than 15 (OR 1.52, 95%CI: 1.08–2.14); and, first sexual intercourse aged  $\geq 18$  years compared with under 15 (OR 1.67, 95%CI: 1.08–2.57) were associated with higher levels of educational attainment at 22-year follow-up. Additionally, lower ("better") behavioural scores increased the odds of higher levels of attainment.

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**Conclusions** Absence of health risk behaviours at a younger age or later commencement was associated with higher educational attainment. Evidence-based interventions that address the societal influences underpinning risk behaviours in adolescents may support longer school retention.

**Keywords** Educational attainment, Risk behaviour, Substance use, Sexual health, Schooling

## Introduction

By twenty-two years of age, a young person is generally considered to have entered adulthood [1] and many young adults will be establishing themselves in career paths. Often these career paths depend on skills gained from education beyond high school [2]. Together with greater economic wellbeing, higher educational attainment has additional benefits, with research showing that it is associated with better mental and physical health [3, 4] and longevity [2].

In Australia in 2023, the retention rate to the end of high school was 79%, a value that varies considerably by State (89% in the Australian Capital Territory to 52% in the Northern Territory), sex (83% of females and 75% of males) and whether a student was an Aboriginal or Torres Strait Islander person (56% for Aboriginal or Torres Strait Islander students compared with 84% for non-Indigenous) [5]. To address the disparity in educational and hence economic and health outcomes, interventions aimed at increasing educational attainment are vital, but first a broad understanding of the factors contributing to increased educational attainment is needed.

Past research on predictors and associated factors for educational attainment has focused on childhood measures of intelligence and early academic achievement [6] or parental and sociodemographic factors [7, 8] with results suggesting that higher intelligence, good early achievement and higher socioeconomic status (better parental education, higher family income) are positively associated with better educational attainment. The precise definition of educational attainment varies and reflects local educational structures and key assessment ages. Other studies have explored the role of childhood behavioural indicators such as externalising behaviour, mental health and inattentiveness, with each showing a negative association with educational attainment [9–11].

Behaviours typically beginning in adolescence [12] that could be associated with educational attainment include risk behaviours such as smoking, alcohol and other drug use and earlier sexual activity. These behaviours may have direct effects on educational attainment (e.g., through early pregnancy), or indirect effects, for example through exposure to peers with low school engagement [13, 14]. The few studies that have explored these associations include two studies which showed that a higher number of risk behaviours [15] or cannabis and tobacco use at age 15 [16] was associated with poorer educational attainment at age 16 and a study of Finnish twins

found that smoking and alcohol use at 12 and 14 were associated with lower educational attainment at 17 and approximately 24 years of age [14]. Additionally, a study on young adults in Australia and New Zealand found that cannabis use was associated with failure to complete high school and failure to enrol in or complete university, but the association with alcohol use was less clear [17]. Identifying modifiable risk factors could provide opportunities for intervention to increase educational attainment levels.

This study adds to the literature by exploring the association between the age at onset of multiple risk behaviours and educational attainment by 22 years of age, an age at which secondary school will have been completed, after adjusting for established predictors of educational attainment such as parental education, socioeconomic, demographic and childhood behavioural factors in a prospective longitudinal study of young adults followed since birth.

## Methods

### Study design, setting and participants

Of the 1235 Generation 2 (Gen2) participants in the 22-year follow-up of the Raine Study ([rainestudy.org.au](http://rainestudy.org.au)), 1,102 responded to questions about highest educational attainment and were included in this study. Gen2 young people and their parents (Generation 1, Gen1) participating in the Raine Study completed questionnaires at years 1, 5, 8, 10 (Gen1 only), 14, 17 (both) and 22 (Gen2 only). The Raine Study is an ongoing longitudinal study of women (Gen1) recruited when pregnant from the only (at that time) tertiary obstetric referral hospital and nearby private clinics in Western Australia between 1989 and 1991. The children (Gen2) arising from the recruited participants (Gen1) form the Raine Study Gen2 cohort; the Gen2 profile is well-described by Straker and colleagues, including confirmation of population representativeness [18].

### Data source

Gen2 participants had their demographic, health, behaviour and socioeconomic survey data collected at regular intervals from birth as reported elsewhere [18]. The outcome of interest in this study was educational attainment at the 22-year follow-up (defined here as a categorical variable for number of years of school completed after kindergarten:  $\leq 10$ , 11, 12,  $> 12$  whereby year 12 is the final year of high school (secondary school)

and >12 comprised those who had completed or were still completing university degrees). Variables of interest in this study were collected at the 1-, 5-, 8-, 10-, 14-, 17- and 22-year follow-ups relating to child and adolescent behavioural, educational and health risk behaviour factors, parental educational attainment (neither completed high school, at least one completed high school or alternate, at least one completed a university degree or higher or neither stated) and family income at various follow-ups. The mean (standard deviation; SD) ages of included Gen2 participants at these follow-ups were 1.2 (0.1), 5.9 (0.2), 8.1 (0.4), 10.6 (0.2), 14.1 (0.2), 17.0 (0.2) and 22.1 (0.6) years respectively. In addition to parental/adult reports, adolescent self-report surveys commenced at the 14-year follow-up. Health risk behaviours (smoking cigarettes, drinking alcohol, use of drugs [including marijuana, amphetamines, inhalants and other drugs for non-medicinal purposes] and sexual intercourse) were coded based on the age at which the participant self-reported starting to engage in those behaviours.

Parental reports of child behavioural and emotional problems (“mental health”) were assessed using the Achenbach Child Behaviour Checklist (CBCL), now termed the Achenbach System of Empirically Based Assessment [19]. The tool consists of around 113 questions (depending on child age), scored on a three-point Likert scale (0=not true (as far as you know), 1=some-what or sometimes true, 2=very true or often true) which are combined to form multiple subscales. The subscales are used to identify behavioural and emotional problems including externalising and internalising behaviours. Internalising behaviour includes problems such as anxiety, depression and social withdrawal while externalising behaviours include fighting, outbursts of temper, lying and truancy. In this study we use the parent reported normalised CBCL internalising, externalising and total T-scores in their continuous form whereby higher scores indicate greater levels of internalising and externalising. The CBCL internalising and externalising measures have been shown to have good internal validity and reliability [20] and the CBCL has been widely used in child development studies including in more than 150 Australian studies (<https://aseba.org/research-updates-from-around-the-world/>).

Parental income was collected as an ordinal categorical variable at all survey time points. To analyse the data, the midpoint of each level was used as a proxy for the actual family income at those ages and these midpoints were used to create numerical estimated family income variables. Educational performance at the 8-, 10-, 14- and 17-year follow-ups was categorised according to their pattern over all time points: average or lower at all time points, above average or excellent at all time points or mixed over time (so sometimes average or lower and

other times above average or better). The ratings were provided by parents. Parent ordinal rating of their child’s overall health was collected at the 14- and 17-year follow-ups and coded from 0 to 3 where 0 indicated that the child was seldom well and 3 indicated that the child was nearly always well (excellent health). Since the majority of participants were not in lower categories this variable was coded to indicate excellent health at both the 14- and 17-year follow-ups, other than excellent health at both the 14- and 17-year follow-ups, mixed (i.e. their health status changed between the 14- and 17-year follow-ups) or health never stated.

### Statistical analyses

Variables were summarised using count and percentage, mean and standard deviation (SD) or median and interquartile range (IQR). Several numerical predictors (parental income and the CBCL measures) comprise of repeated measures over time. To capture the longitudinal change in income and CBCL we used the two step growth model approach of Welten et al. [21]. In the first step the predictor is regressed against age at measurement for each participant and the estimated linear slope coefficients were obtained. Then, in the second step, the slope coefficients were used together with the mean of all available repeated measure predictor data for each person as predictors in the model for predicting educational attainment. Quadratic slope terms were also considered but were never significant and are not considered further.

Ordinal logistic regression was used to determine whether child and adolescent demographic (sex, mother’s age at childbirth, parental education, mean family income, change in annual family income), overall health, educational performance over time, behaviour (mean CBCL total score and change in CBCL total score), or health risk behaviour (age that the participant started smoking, alcohol, any drug use and sexual intercourse) were associated with year leaving school. Among these 13 variables, 7 (54%) had no missing data, and the other six variables had between 1 (1 variable, 0.1%) and 27 (1 variable, 2.5%) missing values. Missing values were imputed using Multivariate Imputation by Chained Equations using the *mice* package in R. All variables included in the logistic model were used to predict the outcome for a particular missing data point with linear regression used for continuous variables and logistic or ordinal regression for categorical variables. The missing value generation was repeated resulting in 5 imputed data sets. Analysis of the 5 imputed data sets was pooled to provide a single set of estimates and standard errors. Complete case analysis was also undertaken to determine whether results were consistent with the imputed data analysis.

Results are reported as odds ratio (OR) with 95% confidence interval (CI) and p-values. P-values less than 0.05

(i.e., 95% confidence intervals excluding 1) are considered statistically significant. The statistical software package R version 4.3.2 was used for all analyses.

## Results

Table 1 shows summary statistics for each demographic, health, behaviour and socioeconomic variable of interest by educational attainment category. Results show that overall, about half of the participants reported university educational attainment (>12:  $n=578$ ) and almost two-thirds of participants were female ( $n=329$ , 57%). Among those with university attainment, half had one or both parents who reported completing university degrees ( $n=295$ ; 51%). Participants with higher levels of attainment had older mothers and came from families with higher median incomes.

Among the CBCL scores, at every survey time point, those with lower educational attainment had higher (“worse”) mean internalising, externalising and total scores. A higher proportion of participants who were rated average or lower in their academic performance consistently over time left school earlier compared to those with higher ratings (33% of those who completed year 10 or less compared to 5% of those reporting university attainment). The CBCL scores were highly correlated and so only the total score variable was used in ordinal modelling but the externalising and internalising scores gave very similar results.

A large proportion of participants were never-smokers or older than 18 when starting (64%). Among those with year 10 or less education, 54% had tried smoking before the age of 18 compared to 29% of those with university attainment (Table 1). Most participants had tried alcohol by 17 years of age (70%) regardless of age of leaving school, but the proportion of those who tried alcohol younger than 15 among those who left in year 10 or earlier (36%) was much larger than those who continued beyond year 12 (17%). A large proportion of all participants had used drugs at least once (78%) with a higher proportion of those with university education (27%) never or not knowing if they had used drugs compared to those with lower educational attainment (15%, year 10 or lower completion). Almost one quarter of participants with up to year 10 attainment had experienced sexual intercourse before age 16 compared to only 8% of those with university attainment (Table 1).

Ordinal logistic regression modelling results are shown in Table 2 (column 2). Results indicated that after adjusting for other predictors in the model, male participants were significantly less likely to have higher educational attainment (OR 0.55, 95%CI 0.42, 0.71), as were those with higher mean total CBCL scores (OR 0.98, 95%CI 0.97, 1.00) and smaller decrease (or an increase) over time (OR 0.74, 95%CI 0.65, 0.85). Participants with older

mothers (OR 1.07, 95%CI 1.05, 1.10) and participants with at least one parent with university education (OR 3.50, 95%CI 2.29, 5.34) were more likely to have higher educational attainment as were participants with higher mean family incomes (OR 1.03, 95%CI 1.01, 1.04). The rate of change in income over time was not associated with educational attainment (OR 1.01, 95%CI 0.92, 1.10).

Results also indicated that when participants abstained from some risk behaviours or waited until they were older, the odds of higher educational attainment were significantly higher compared to participants who initiated the risk behaviour at a younger age. For example, the odds of higher educational attainment for never smokers or those who started at >18 years was double that of those who began smoking under 15 years (OR: 2.02, 95%CI: 1.28, 2.14). Similarly, those who started drinking alcohol at 15–17 years-of-age were significantly more likely to have higher educational attainment than someone who started drinking younger than 15 (OR: 1.52 95%CI: 1.08 to 2.14). Lower educational attainment was associated with earlier age of first sexual intercourse (OR 0.60, 95%CI: 0.39 to 0.93, for <16 vs. ≥18 years). Complete case analysis (Table 2, column 3) results were consistent with those of the imputed data.

## Discussion

Our findings extend understanding of the association between health risk behaviours undertaken in adolescence and subsequent educational attainment, showing the effects of multiple risk behaviours and elevated mental ill-health measures, even after adjusting for a range of economic and family factors. In a cohort study conducted in the United Kingdom, Wright and colleagues [15] analysed the total number of risk behaviours finding higher numbers of risk behaviours to be associated with lower educational attainment although they did not examine individual risk behaviours. In addition, educational attainment was reported only to mid-adolescence (16 years) while the current study extends that to young adulthood. The analysis of data from twins in Finland [14] was based on a cohort recruited at age 11–12 years, and so lacks data on early child behaviours. Although that study controlled for family factors including parental education, smoking and alcohol use, income was not addressed. The cohort examined here adds to that knowledge by providing rich data on child and family factors, allowing control of other potential influences on educational attainment, enabling the odds of multiple specific behaviours to be evaluated.

Our data also support findings in the literature [7, 8] that suggest that participants from lower socioeconomic groups, whose families had a lower income over time and whose parents had lower educational attainment, were less likely to achieve higher educational attainment.

**Table 1** Raw data summaries for participants and parental factors

Parental/ demographic factors	Educational attainment (Year leaving school)				Overall (n = 1102)
	≤ 10 (n = 118)	11 (n = 81)	12 (n = 325)	> 12 (n = 578)	
Number (%) female	47 (39.8)	39 (48.1)	179 (55.1)	329 (56.9)	594 (53.9)
Mothers age at childbirth; mean (SD)	27.2 (6.2)	27.1 (5.6)	28.4 (5.6)	31.1 (5.0)	29.6 (5.6)
Parental education					
High school (neither completed)	19 (16.1)	16 (19.8)	71 (21.8)	48 (8.3)	154 (14.0)
High school or alternate <sup>a</sup> (≥ 1 completed)	52 (44.1)	37 (45.7)	148 (45.5)	184 (31.8)	421 (38.2)
UG/PG degree (≥ 1 completed)	16 (13.6)	8 (9.9)	51 (15.7)	295 (51.0)	370 (33.6)
Neither stated	31 (26.3)	20 (24.7)	55 (16.90)	51 (8.8)	157 (14.2)
Annual family income in thousands of AUD; mean (SD) <sup>b</sup>					
Y1	24 (11)	25 (11)	26 (10)	32 (9)	29 (10)
Y5	31 (14)	31 (13)	35 (14)	42 (12)	38 (13)
Y8	39 (20)	39 (20)	43 (20)	57 (22)	50 (23)
Y10	41 (22)	44 (24)	46 (23)	59 (22)	52 (24)
Y14	49 (28)	57 (30)	59 (30)	76 (30)	67 (31)
Y17	59 (35)	69 (33)	72 (31)	86 (28)	78 (31)
<b>Health factors</b>					
CBCL total; mean (SD)					
Y5	54 (10)	56 (10)	53 (10)	49 (10)	51 (10)
Y8	53 (10)	55 (11)	51 (11)	47 (10)	49 (11)
Y10	52 (11)	53 (12)	48 (12)	44 (10)	47 (11)
Y14	52 (12)	54 (12)	47 (11)	42 (11)	45 (12)
Y17	48 (13)	51 (13)	43 (12)	40 (10)	42 (12)
CBCL internalising; mean (SD)					
Y5	51 (11)	52 (10)	51 (10)	49 (10)	50 (10)
Y8	52 (10)	54 (11)	52 (11)	49 (9)	50 (10)
Y10	51 (11)	53 (12)	50 (11)	48 (10)	49 (10)
Y14	49 (11)	52 (13)	48 (11)	44 (10)	46 (11)
Y17	48 (21)	50 (12)	45 (11)	43 (9)	44 (10)
CBCL externalising; mean (SD)					
Y5	55 (10)	56 (10)	53 (10)	49 (9)	51 (10)
Y8	54 (11)	54 (11)	50 (11)	46 (9)	49 (10)
Y10	52 (11)	52 (12)	47 (10)	44 (9)	46 (11)
Y14	54 (12)	54 (12)	48 (10)	44 (9)	47 (11)
Y17	50 (12)	51 (12)	44 (10)	42 (9)	44 (10)
Overall health; Y14 F-U					
Seldom to mostly well	32 (33.0)	26 (41.3)	87 (30.4)	99 (19.0)	244 (25.2)
Almost always well	65 (67.0)	37 (58.7)	199 (69.6)	423 (81.0)	724 (74.8)
Overall health; Y17 F-U					
Seldom to mostly well	32 (40.0)	28 (49.1)	83 (32.7)	121 (25.9)	264 (30.7)
Almost always well	48 (60.0)	29 (50.9)	171 (67.3)	347 (74.1)	595 (69.3)
<b>Risk behaviour factors</b>					
Age initiated smoking; n (%)					
<15 years	32 (27.1)	12 (14.8)	35 (10.8)	40 (6.9)	119 (10.8)
15–17 years	32 (27.1)	27 (33.3)	92 (28.3)	126 (21.8)	277 (25.2)
≥18 years or never	53 (45.3)	42 (51.9)	198 (60.9)	411 (71.2)	704 (64.0)
Age started alcohol; n (%)					
<15 years	43 (36.4)	21 (25.9)	72 (22.2)	98 (17.0)	234 (21.3)
15–17 years	29 (24.6)	36 (44.4)	163 (50.2)	306 (53.0)	534 (48.5)
≥18 years or never	46 (39.0)	24 (29.6)	90 (27.7)	173 (30.0)	333 (30.2)
Any drug; n (%)					
<15 years	15 (12.7)	9 (11.1)	27 (8.3)	27 (4.7)	78 (7.1%)
15–17 years	39 (33.1)	26 (32.1)	110 (33.8)	162 (28.0)	337 (30.6)
≥18 years	46 (39.0)	36 (44.4)	128 (39.4)	236 (40.8)	446 (40.5)
Never / Don't know	18 (15.3)	10 (12.3)	60 (18.5)	153 (26.5)	241 (21.9)
Age first intercourse; n (%)					

**Table 1** (continued)

Parental/ demographic factors	Educational attainment (Year leaving school)				Overall (n = 1102)
	≤ 10 (n = 118)	11 (n = 81)	12 (n = 325)	> 12 (n = 578)	
<16 years	27 (22.9)	14 (17.3)	45 (13.8)	45 (7.8)	131 (11.9)
16–17 years	53 (44.9)	39 (48.1)	147 (45.2)	210 (36.3)	449 (40.7)
≥18 years / have not yet	38 (32.2)	28 (34.6)	133 (40.9)	323 (55.9)	522 (47.4)
<b>Educational Performance over time</b>					
Education performance; n (%)					
Consistently average or lower	39 (33.1)	25 (30.9)	66 (20.3)	31 (5.4)	161 (14.9)
Mixed <sup>c</sup>	49 (41.5)	39 (48.1)	173 (53.2)	242 (41.9)	503 (45.6)
Consistently above average or excellent	26 (22.0)	14 (17.3)	78 (24.0)	298 (51.6)	416 (37.7)
Not stated	4 (3.4)	3 (3.7)	8 (2.5)	7 (1.2)	22 (2.0)

AUD=Australian dollars, CBCL=Child Behaviour Check List, F-U=follow-up, IQR=interquartile range, SD=standard deviation, UG=undergraduate degree, PG=postgraduate degree, Y1 – Y17=Raine follow-up year

<sup>a</sup> Alternate includes trade or apprenticeship or postsecondary diploma. ≥ completed implies at least one parent completed this level of education

<sup>b</sup> For comparative purposes, \$40,000 in (Y1) 1990, 1992, 1995, 2000, 2004 and (Y22) 2012 adjusted for inflation would be in 2021: \$83,150, \$79,783, \$73,492, \$66,835, \$59,121 and \$47,285 [40]

<sup>c</sup> At some time points educational performance was categorised by parents as average or lower and other time points was categorised as above average or excellent

Those with higher levels of education have a lower probability of unemployment [22] and studies have shown that unemployed young adults are at increased risk of negative outcomes that persist into older adulthood [23] including crime [24] and social exclusion [25]. Parental demographics are not easily modifiable however research has shown that parental engagement and involvement in learning can influence attainment [26] including among parents in high poverty areas [27].

Not all risk taking in adolescence is associated with negative consequences; normal and healthy risk taking can develop independence and decision making skills [28]. The type and level of risk taking is predicted by societal influences including peer relationships, parental attitudes, school climate, and school connectedness [28, 29] and economic inequity [30]. These societal factors are also associated with educational outcomes [28, 29]. Educational outcomes appear to be influenced by factors that occur over the life course, the order of which has been investigated by some studies. For example Schmengler and colleagues [31] investigated whether educational outcomes predicted alcohol use or vice versa, finding evidence that lower education predicted later alcohol use but not the reverse relationship, while our study found that both poorer early educational outcomes and early risky behaviours were associated with early school leaving. Similarly, Latvala et al. [14] found lower achievement predicted engagement with smoking while higher educational attainment predicted more frequent drinking in young adulthood. Despite the complexity of the relationships, there is no doubt that higher education predicts better economic outcomes and so it is imperative that strategies to support “at-risk” adolescents to attain higher levels of education are adopted.

A strength of this study was its use of methods to incorporate longitudinal predictor information enabling exploration of the mean behavioural scores and their change over time. In this cohort, lower (better) mean total CBCL scores and scores with a faster (more negative) rate of decrease over time were associated with remaining in education for longer. Other studies have also shown that early childhood behavioural problems negatively impact on educational attainment and later achievement [32]. Identification of emotional and problem behaviours in childhood and adolescents can facilitate targeted strategies to support educational retention, potentially altering adverse trajectories that are carried through adulthood.

Our results also showed that younger age of reporting engagement in risk behaviours was associated with lower educational attainment by about 22 years of age, similar to the findings of other studies [15, 17, 33]. Modifiable behaviours including smoking, alcohol use and earlier age of first sexual intercourse were all associated with lower educational attainment after adjusting for other factors. These results provide further rationale for the important role of evidence-based interventions such as comprehensive sex education and interventions to prevent drug and alcohol use in adolescence.

As for any self-reported study data, the data are limited by the accuracy of reporting with concordance between self-reported and actual risk behaviour (such as substance use confirmed with biospecimen data) often moderate or low [34]. We do not have biospecimen data that can be used to confirm substance use. Similarly, a USA Centers for Disease Control study found that school samples of 15–19 year olds underestimated risky sexual behaviours relative to the whole age cohort [35]. We anticipate a similar bias in participants retained over time in the Raine Study, who have been shown to be of

**Table 2** Odds of higher educational attainment (leaving school later) with 95% confidence interval (CI)

Predictor	Odds ratio (95%CI) Imputed data	Odds ratio (95%CI) Complete case
Male (ref = Female)	<b>0.55 (0.42, 0.71)*</b>	<b>0.57 (0.44, 0.75)*</b>
Mothers age at childbirth (years)	<b>1.07 (1.05, 1.10)*</b>	<b>1.07 (1.05, 1.10)*</b>
Parental education		
High school (neither completed)	Ref	Ref
High school or alternate <sup>a</sup> (at least one completed)	1.14 (0.80, 1.62)	1.15 (0.81, 1.65)
UG/PG University (at least one completed)	<b>3.50 (2.29, 5.34)*</b>	<b>3.61 (2.36, 5.52)*</b>
Not stated	1.37 (0.87, 2.16)	1.35 (0.86, 2.14)
Annual family income (mean per AUD\$10K)	<b>1.03 (1.01, 1.04)*</b>	<b>1.03 (1.01, 1.04)*</b>
Change in annual family income (slope, per AUD\$10K)	1.01 (0.92, 1.10)	0.99 (0.91, 1.08)
CBCL Total (mean)	<b>0.98 (0.97, 1.00)*</b>	<b>0.98 (0.96, 0.99)*</b>
CBCL Total (slope)	<b>0.74 (0.65, 0.85)*</b>	<b>0.75 (0.65, 0.85)*</b>
Overall health		
Consistently less than excellent	Ref	Ref
Mixed	1.13 (0.76, 1.69)	1.08 (0.72, 1.61)
Consistently excellent	1.07 (0.72, 1.61)	1.05 (0.70, 1.57)
Not stated	1.21 (0.64, 2.29)	1.09 (0.58, 2.07)
Education performance		
Consistently average or lower	Ref	Ref
Mixed	<b>2.18 (1.52, 3.13)*</b>	<b>2.33 (1.62, 3.36)*</b>
Consistently above average or excellent	<b>4.77 (3.19, 7.13)*</b>	<b>5.12 (3.41, 7.69)*</b>
Not stated	2.73 (0.87, 8.57)	<sup>b</sup>
Age started smoking		
<15 years	Ref	Ref
15–17 years	1.22 (0.78, 1.91)	1.22 (0.78, 1.92)
≥18 years or never	<b>1.84 (1.16, 2.92)*</b>	<b>1.86 (1.17, 2.95)*</b>
Age started alcohol		
<15 years	Ref	Ref
15–17 years	<b>1.53 (1.09, 2.15)*</b>	<b>1.53 (1.09, 2.16)*</b>
≥18 years or never	0.93 (0.61, 1.43)	0.96 (0.62, 1.48)
Any drug use		
<18 years	Ref	Ref
≥18 years	1.05 (0.76, 1.45)	1.04 (0.75, 1.44)
Never used/ Don't know	1.27 (0.85, 1.90)	1.33 (0.89, 1.99)
Age of first intercourse		
<16 years	Ref	Ref
16–17 years	1.00 (0.67, 1.50)	1.02 (0.67, 1.51)
≥18 years / have not yet	<b>1.66 (1.07, 2.57)*</b>	<b>1.64 (1.06, 2.54)*</b>

Bolded odds ratios and confidence intervals with asterisks are significant at the 5% level

AUD=Australian dollars; CBCL=Child Behaviour Check List; F-U= follow-up; Ref=reference category;

<sup>a</sup> alternate implies apprenticeships, trades, and diplomas; UG/PG=undergraduate / postgraduate. <sup>b</sup> category not present due to exclusion of cases with missing values

higher socioeconomic status than the average age-peer in Western Australia [18].

An additional challenge was determining the most appropriate categorisation for educational attainment for 77 participants who identified Technical and Further Education (TAFE) or college as their highest educational attainment but left school prior to year 12. TAFE and college courses comprise various levels including skills based (not nationally accredited) courses, and courses considered below year 12 level or alternatives to year 12 (but not equivalent [36]). Research on transitions from school indicated that those who completed certificate level courses had poorer outcomes than those who

completed year 12 [37]. As such, we retained the participants' attainment at the year of leaving school.

Although the level of missing data was small (no variable had more than 2.5% of cases missing, 7 variables had no missing data), imputation of missing values can bias results if missing data assumptions are incorrect [38]. In this study the imputed analysis and complete case analysis results were consistent, suggesting no evidence of bias.

As for any observational study, caution should be applied in generalising the findings beyond the setting in which the data were collected.

## Conclusion

In this cohort, after adjusting for socioeconomic, parental and mental health factors, risk behaviours at a younger age were associated with lower educational attainment. In addition, higher scores for problem behaviours on the CBCL and less decline over time were associated with lower levels of educational attainment. Our findings emphasise the need for early identification of risk behaviours and intervention for those at risk of leaving school early, or not entering higher education, to maximise later opportunity. Interventions are likely to need to be holistic in addressing multiple risk factors taking developmental stage into account.

## Abbreviations

CBCL	Child behaviour checklist
CI	Confidence interval
Gen1	Generation 1
Gen2	Generation 2
OR	Odds ratio
SD	Standard deviation

## Acknowledgements

This paper is dedicated to the memory of our esteemed and sorely missed colleague Professor Fiona M. Brooks, whose thinking on how best to challenge deficit framing was important to the development of the parent study and this manuscript. We would like to acknowledge The Raine Study participants and their families for their ongoing participation in the study and The Raine Study team for study co-ordination and data collection.

## Author contributions

DS, SRS, JLM and RNS conceived this work. All authors (PLG, DJS, RJT, SB, RQI, BL, SL, JLM, LAS, RNS, KS, LMS, SRS) have made substantial contributions to the design of the work. JLM and LMS liaised with The Raine Study to obtain study data. PLG conducted the analysis, interpreted the data and wrote the initial draft together with RJT. All authors (PLG, DJS, RJT, SB, RQI, BL, SL, JLM, LAS, RNS, KS, LMS, SRS) contributed to review and editing of the manuscript. Funding acquisition by SRS, KS, BL, LAS and RQI. Full access to data PLG, JLM, RJT, and SB. All authors (PLG, DJS, RJT, SB, RQI, BL, SL, JLM, LAS, RNS, KS, LMS, SRS) read, contributed to drafting the manuscript, revised and approved the final version of the manuscript.

## Funding

The core management of The Raine Study is funded by The University of Western Australia, Curtin University, Telethon Kids Institute, Women and Infants Research Foundation, Edith Cowan University, Murdoch University, The University of Notre Dame Australia and the Raine Medical Research Foundation. We also thank the National Health and Medical Research Council of Australia (NHMRC) for their long-term contribution to funding the study over the last 30 years. The Raine Medical Research Foundation funded the antenatal and perinatal data collection. NHMRC and the Raine Medical Research Foundation funded the 1-, 5- and 10-year Gen2 follow-ups. The 14-year follow-up data collection was funded by NHMRC (#211912 & Program ID #003209) plus the Raine Medical Research Foundation. The 17-year data collection was funded by NHMRC Program ID #353514. The Raine Study Gen2 22-year follow-up was funded by NHMRC (#1027449, #1044840 and #1021858). The current study was supported by a grant from the NHMRC (#1161445) and NHMRC Centre for Research Excellence APP1134894. RJT is supported by NHMRC (#1161445) and through employment at The National Drug Research Institute at Curtin University. JLM is supported by NHMRC grants #1161445 and #1134894. The funder had no role in the design, data collection, analysis, interpretation or writing of this work.

## Data availability

The Raine Study data may be obtained from a third party but are not publicly available and access is strictly controlled to protect the privacy of participants.

Details of application procedures can be found at the study website <https://rainestudy.org.au/>.

## Declarations

### Ethics approval and consent to participate

The Raine Study and each follow-up has informed consent from all participants and institutional human research ethics approval, most recently from the Human Research Ethics Committee at the University of Western Australia (RA/4/20/5722). This specific project was approved by the Human Research Ethics Committee at Curtin University (HRE2019-0774) and the protocol published [39]. The study was conducted in accordance with the Declaration of Helsinki.

### Consent for publication

Not applicable.

### Competing interests

LMS was Scientific Director of The Raine Study from 2013 to 2019. All other authors declare that they have no competing interests.

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Received: 12 March 2024 / Accepted: 26 September 2024

Published online: 08 October 2024

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