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Looking beyond the individual: The relative importance of neighbourhood socioeconomic status and the development of internalising symptoms across adolescence

Ainsley Furneaux-Bate [a,1], Louise Birrell [a,1,*], David Berle [b], Nicola C. Newton [a], Cath Chapman [a], Tim Slade [a], Louise Mewton [a], Scarlett Smout [a], Maree Teesson [a]

[a] The Matilda Centre for Research in Mental Health and Substance Use, The University of Sydney, Australia
[b] School of Medicine and Psychology, Australian National University, Australia

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ABSTRACT

Background: Mental disorders have considerable impact on individual and societal well-being, with peak onset during adolescence. This study explored the relationship between neighbourhood socioeconomic status and internalising symptom progression during adolescence.
Design: Longitudinal data from 1556 adolescents was taken from the control group of a cluster-randomised controlled trial of school-based prevention program for mental health and substance use. Measures assessed internalising symptoms (SDQ) across six time points from 13 to 16 years and the Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) was used to measure participants' neighbourhood socioeconomic status (SES) at baseline. Latent class growth analysis was used to estimate different internalising symptom trajectories among adolescents. Multinomial logistic regression explored the relationship between SES and internalising trajectory class, controlling for covariates.
Results: Four distinct trajectories of internalising symptoms were identified: Low stable (49 % of adolescents), Increasing (30.6 %), Decreasing (10 %), and High Increasing (10.2 %). Lower neighbourhood SES was associated with an increased likelihood of belonging to the High Increasing class relative to the Low Stable group. Additionally, female gender and baseline externalising symptoms were associated with an increased likelihood of belonging to all three elevated symptom trajectories compared to the low stable class, controlling for SES and other covariates.
Conclusion: The findings provide novel insight into the negative relationship between neighbourhood disadvantage on individual mental health trajectories, above and beyond individual factors, during adolescence. The findings have significant implications for social and economic policies.

1. Introduction

Mental disorders are a substantial contributor to the global disease burden in children and young people, with one-fifth of the disability related to all diseases attributable to mental disorders in those aged 5 to 24 years of age (Kieling et al., 2024), indicating a critical need for early intervention. Symptoms of mental ill-health, such as internalising symptoms, frequently begin in childhood, with early life factors such as parenting, temperament, and stressful life events contributing to their development (Arango et al., 2021; Lynch et al., 2021). Internalising symptoms are those reflecting inward psychological distress such as anxiety and depression. Symptoms often continue into adolescence and progress to disorder-level thresholds at a critical time of physical, social, and psychological change (Solmi et al., 2022). Anxiety and mood disorders commonly onset by 14 years of age, with almost half of all lifetime disorders commencing by 18 years, indicating middle to late adolescence as a significant period of mental disorder onset (McGrath et al., 2023).

The ways young people develop internalising difficulties are not homogenous. It is estimated that between 11 % to 30 % of children aged

* Corresponding author.
E-mail address: louise.birrell@sydney.edu.au (L. Birrell).
[1] Joint fist authors.

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3 to 11 years old follow trajectories characterised by highly persistent or increasing internalising problems (Flouri et al., 2018; Patalay et al., 2016). Such trajectories are associated with worse outcomes than patterns of stable and low symptoms, including increased risk of depression and self-harm (Papachristou & Flouri, 2020). Concerningly, longitudinal studies have demonstrated that depressive symptoms rose in adolescents between 1991 and 2018, particularly among girls (Keyes et al., 2019). Moreover, evidence suggests differential trajectories of mental health by internalising, externalising symptoms and gender-specific trajectories (Gutman & Codiroli McMaster, 2020; Papachristou & Flouri, 2020), with marked differences emerging around the onset of puberty, indicating a need to consider different trajectories during adolescence.

Latent Class Growth Analysis (LCGA) has gained popularity as researchers increasingly move away from a 'one-size-fits-all' model to better capture the diverse developmental trajectories within populations (Nagin & Odgers, 2010). It strikes a good balance between representing the inherent complexity of developmental processes and summarising data in an easily comprehensive form by splitting data into distinct groups and examining their predictors and outcome (Nagin & Odgers, 2010). Research using group-based trajectory modelling in longitudinal data to uncover adolescent internalising symptom trajectories have typically uncovered between three to six distinct trajectories (Kent & Bradshaw, 2021; McLaughlin & King, 2015; Olino et al., 2010). Several Australian studies have explored the progression of internalising symptoms during adolescence. In a sample of 431 Australian adolescents (13 – 16 years), Birrell et al. (2017) found four distinct internalising symptom patterns, ranging from Low Stable to High Stable symptoms. Using a parent-report scale of total psychological difficulties (measuring both internalising and externalising), Vella et al. (2019) identified six classes of symptom development in 3717 Australian youth (4 – 12 years), while Letcher et al. (2012) observed three distinct patterns (Low, Middle, High) of self-reported anxiety for Australian adolescents (11 – 17 years), using four time points. However, there remains a research gap on heterogeneous internalising symptom trajectories in a contemporary representative Australian sample that spans middle adolescence. Identifying such symptom courses would further allow the identification of the risk factors associated with adverse trajectories for young people's mental health.

1.1. Neighbourhood socioeconomic status and mental health

Social determinants - the environmental conditions in which people exist - have been identified as important sources of risk or resilience for mental ill-health in children and adolescents (Viner et al., 2012). Social determinants influence an individual's mental health through varied factors, including relatively fixed (e.g. gender, ethnicity) and malleable (e.g. parenting style, education, social connectedness) factors, as well as broader environmental factors, for example neighbourhood safety (Alegria et al., 2018; Bronfenbrenner, 2005). Social determinants have been shown to predict mental health symptom trajectories in children and adolescents (Shore et al., 2018). One crucial social determinant is socioeconomic status (SES). The relationship between SES and mental health in children and adolescents has largely been measured by assessment of family or household measures of SES (Peverill et al., 2021; Reiss et al., 2019; Vella et al., 2019). Studies including measures of SES at the household or family level typically find that lower household/family SES is associated with poorer mental health across a range of measures however, associations appear stronger for externalising or problem behaviours compared to internalising problems such as, anxiety or depression (Peverill et al., 2021). Distinct from household/family is neighbourhood-level SES, which goes beyond measuring the individual resources of a family unit to capture broader environmental factors within a specific geographic area. Neighbourhood SES represents the broader economic and social context in which children and adolescents grow up. Neighbourhood SES with higher disadvantage has been linked to worse overall mental health and wellbeing outcomes for children and adolescents (Visser et al., 2021).. Socio-economically disadvantaged neighbourhoods may directly influence adolescent mental health through reduced access to resources and increased stressors such as crime and violence (Aisenberg & Herrenkohl, 2008; Visser et al., 2021) . They may also act indirectly via impacts on parents such as substance misuse, unemployment, and harsh parenting style, which have demonstrated flow- through effects on the child and adolescent health (Eamon, 2008; Wang et al., 2020). A systematic review of 30 studies found that neighbourhood SES is significantly associated with adolescents' overall mental health, with associations more commonly found for externalising symptoms and overall wellbeing (Visser et al., 2021). Within the review, 18 studies focused on internalising symptoms (operationalised through different measures across studies), findings inconsistent associations between internalising symptoms and neighbourhood SES (Visser et al., 2021).

However, the relationship between neighbourhood SES and different adolescent internalising trajectories remains unclear. Research thus far has primarily explored its association with mean levels of mental health symptoms, with few studies examining its relationship to heterogeneous trajectories in adolescent symptom profiles. For example, research found that Australian adolescents from more socioeconomically disadvantaged areas experience significantly more mental health problems, such as self-harm and suicidality (Islam et al., 2021), and higher internalising symptoms (Christensen et al., 2017) than those from more advantaged areas.

Further research is needed to explore how neighbourhood SES is associated with different trajectories of internalising symptoms in a general population sample across middle adolescence. In addition to neighbourhood-level indicators, individual-level variables are associated with adolescent internalising symptoms, including gender (Campbell et al., 2021), externalising symptoms (Patalay & Fitzsimons, 2018), absenteeism (Fornander & Kearney, 2019), and school grades, the latter which may have a bidirectional impacts on mental health (Weidman et al., 2015). Understanding the specific risk factors for mental health progression during this vital period in young people's lives holds significant potential to inform appropriate targeted prevention and early intervention programs.

Therefore, this study aimed to explore heterogeneity in internalising symptom trajectories in a large sample of Australian adolescents between ages 13 and 16 and examine whether neighbourhood SES was related to symptom trajectories, adjusting for individual characteristics. Specifically, the study will address two aims:

1. To identify the number and nature of internalising symptom trajectories for Australian adolescents during a critical time of mental health risk using a contemporary community sample.
2. To examine the relationship between neighbourhood SES and specific internalising trajectories, controlling for covariates.

Based on current literature (Birrell et al., 2017; Letcher et al., 2012; Papachristou & Flouri, 2020; Vella et al., 2019), it was hypothesised that between three and six developmental trajectories would be identified, containing a minimum of one low, stable symptom pattern and one high-risk symptom pattern. Drawing on studies of social determinants and at-risk trajectories in childhood populations (Rowe et al., 2016), it was hypothesised that lower neighbourhood SES, indicating greater disadvantage, would predict membership in the persistently high class, while controlling for gender, externalising symptoms, grades, and truancy.

2. Methods

This study reports a secondary data analysis from the control group of the Climate Schools Combined (CSC) Study, a cluster randomised controlled trial (RCT) evaluating a combined online universal school-based prevention program that targeted substance use, depression,

and anxiety symptoms in adolescents (Teesson et al., 2014). The University of Technology Sydney Human Research Ethics Committee approved the secondary analysis (ETH22–7768).

2.1. Procedure

Between 2014 and 2016, 71 public, independent, and Catholic secondary schools across New South Wales (NSW), Western Australia (WA) and Queensland (QLD) took part in the CSC study. All students from participating schools in Year 8 (NSW and WA) or Year 9 (QLD) who provided parental and self-consent were eligible. Students in the control condition completed six self-report questionnaires in classroom settings via an online questionnaire or paper survey over three years, including baseline (Term 1, 2014; wave 0), then 6- (wave 1), 12- (wave 2), 18- (wave 3), 24-(wave 4), and 30-months (Term 3, 2016; wave 5) post-baseline. Further information on the study design and sampling methodology is reported in the published protocol (Teesson et al., 2014). The main results from the intervention trial may be found in Teesson et al. (2020), noting that students in the control group only are included in the current study.

2.2. Participants

The current study restricted its sample to control group participants ($n = 1556$) from 19 schools to reduce intervention effects confounding natural symptom trajectories. Schools allocated to the control condition delivered usual health education classes, including lessons on alcohol, drugs, and mental health, as part of the mandatory health curriculum in Australia. The inclusion criteria for the current study required participants to have provided data on the outcomes of interest for at least one assessment occasion. Table 1 outlines the demographics of participants. The follow-up rate for each assessment point was 83 % at 6-months, 85 % at 12- months, 83 % at 18-months, 77 % at 24-months, and 69 % at 30-months follow-up.

2.3. Measures

Internalising symptoms were assessed at each wave of the CSC study using the youth self- report Strengths and Difficulties Questionnaire (SDQ; Goodman (2001)). The SDQ internalising subscale was selected as the primary outcome measure comprising the five-item emotional symptoms and peer problem subscales (Goodman, 2001). The SDQ shows good internal consistency (Cronbach's alpha range 0.41 – 0.88 for subscales) and retest reliability (0.62; Goodman, 2001). In the current study, Cronbach's alpha values for the internalising subscale ranged from 0.76 – 0.80 for Wave 1 to 6, consistent with internal reliability estimates in Australian samples regarding in-person (Hawes & Dadds, 2004) and web-based administration (Seward et al., 2020). The internalising subscale is recommended for use in low-risk or general-population adolescent samples (Goodman et al., 2010). Participants were asked to rate items on a Likert scale ranging from 0 (not true) to 2 (certainly true) about the previous six months, with higher total scores reflecting more significant symptoms (range: 0 – 20).

Table 1
Baseline Characteristics of Participants.

Variable	*n*	%
Gender		
Female	1032	66.8
Male	513	33.2
Truancy		
0 days	1431	92.6
1–2 days	45	2.9
3–5 days	26	1.7
6–10 days	18	1.2
10+ days	24	1.6
Grades		
<49 %	45	2.9
50–59 %	88	5.7
60–69 %	226	14.6
70–79 %	457	29.6
80–89 %	508	32.9
90–100 %	209	13.5
	M	*SD*
Age (years)	13.5	0.46
Internalising	4.3	3.57
Externalising	4.8	3.36
IRSAD	1034.4	77.94

Note. $N = 1545$. M = Mean. SD = Standard Deviation. IRSAD = Index of Relative Socioeconomic Advantage / Disadvantage.

The 2016 Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) was used to measure participants' neighbourhood SES at baseline. IRSAD scores represent the average social and economic conditions of people and households within an area along a continuum of advantage (high values) to disadvantage (low values). It was calculated based on five-yearly national Census data (Australian Bureau of Statistics, 2011), incorporating 25 variables that align with SES, such as education, employment, disability, financial position, and household overcrowding. Lower IRSAD scores have been consistently associated with poorer health outcomes such as increased cancer risk (Gregory et al., 2022), adverse childhood outcomes (Watkeys et al., 2022), and general psychological distress (Isaac et al., 2018). The 2016 IRSAD scores were mapped to postcodes of residence that participants provided at baseline in 2014. While it is recognised that students may move during schooling and that the SES of areas may shift over time, IRSAD was treated as time-invariant for the study as a baseline predictor of internalising symptom trajectories. IRSAD scores are standardised across all geographical locations in Australia to a distribution with an average of 1000 and a standard deviation of 100. In the 2016 data collection, scores ranged from 400 to 1239 (Australian Bureau of Statistics, 2011). Within the current study, 843 participants provided postcode data mapped to IRSAD scores. The mean IRSAD score at baseline was 1034 (SD = 78, Range 800 – 1181).

2.3.1. Covariates

2.3.1.1. Demographics as reported at baseline. Participant self-report demographics, including gender (female/male), age (reported as years and months old, converted to an integer value), truancy rates (number of days off school in the previous year without parents' permission) and academic performance (self-reported grades achieved selected from the following options; 49 % and below, 50–59 %, 60–69 %, 70–79 %, 80–89 %, 90–100 %, and converted to a continuous scale ranging from 0–5, in response to the question 'what grades do you usually get in school?, with higher percentages reflecting higher overall grades) were obtained at baseline.

2.3.1.2. Externalising symptoms. Externalising symptoms at baseline were measured using the youth self-report SDQ externalising subscale, computed by adding the five hyperactivity and conduct problems items. Items were rated from 0 (not true) to 2 (certainly true) about the previous six months, with higher scores reflecting more significant symptoms (range: 0 – 20). The externalising symptom subscale demonstrates sound psychometric properties (Goodman et al., 2010). In the current study, Cronbach's alpha values ranged from 0.75 to 0.79 from Wave 1 to Wave 6, in line with internal consistency estimates in Australian samples (Hawes & Dadds, 2004; Seward et al., 2020).

2.4. Statistical analysis

Analyses were conducted using Mplus version 8.9 (Muthen, 2017), using a 3-step approach to latent class modelling and regression, whereby the regression adjusts for misclassification in class assignment,

in line with latent trajectory recommendations (Asparouhov & Muthén, 2014). Latent trajectory approaches aim to identify subgroups of individuals with similar patterns of change on an outcome within a larger cohort (Berlin et al., 2014). For the present study, the three-step approach involved: (1) running a standard LCGA of internalising symptoms across time, (2) assigning participants to latent trajectory classes based on the posterior distribution of latent trajectory classes, and (3) conducting a multinomial regression analysis to examine the associations between assigned latent trajectory class membership and other variables, while adjusting for misclassification in class assignment (step 2) (Asparouhov & Muthén, 2014)

Initially, eleven participants were excluded before analysis due to missing data on the outcome measure at all assessment occasions, leaving a final $n = 1545$ participants. Given that Mplus relies on listwise deletion when conducting regression analyses as part of the 3-step approach, we conducted chi-square tests (for categorial variables) and independent samples *t*-tests (for continuous variables) to determine which socio-demographic variables were associated with incomplete data (i.e., internalising symptoms missing at any timepoint) for the regression analyses. The results of these analyses are reported in Appendix A.1. Variables which predicted missing data on the outcome variable (internalising symptoms) at any of the timepoints were then included in the regression analyses to statistically control for the possibility that these variables may otherwise bias the parameters of the regression model.

2.4.1. LCGA

Latent growth mixture modelling (LGMM) was conducted initially with random intercepts, slopes and covariance of intercept and slope and time specified as wave number to identify different longitudinal linear trajectories of internalising symptoms. However, the LGMM demonstrated convergence problems. Therefore, a Latent Class Growth Analysis (LCGA) was conducted in which growth factor variance and covariance estimates within each latent class were constrained to zero, assuming homogenous individual trajectories. Residual variances were fixed across classes and were constrained to be zero across time. The classes identified by LCGA reflect prototypic trajectories derived from the data. They reflect the most likely course of a given participants' symptoms for each trajectory. Since data was drawn from a cluster-randomised school-based trial, the effects of clustering within schools were calculated via an intraclass correlation coefficient (ICC) for internalising symptoms at each time point. All ICC values were <0.1 (Range: 0.028 – 0.037); therefore, a more parsimonious model was adopted that did not include a term for clustering, which aligns with previous research (McNeish & Kelley, 2019).

Models ranging from one to seven classes were estimated to determine the optimal number of internalising symptom trajectories, following recommendations from Jung and Wickrama (2007). The number of random starts was set to 1000, with the initialisation of random starting values repeated 10 times to increase the likelihood of finding the optimal global best fit for the model. Models were re-run with increasing random sets of starting values, with the upper-level set at 4000 to help ensure that results were not an artefact of local maxima due to the particular parameter estimates chosen. Time was equally spaced at 6-month intervals, in line with data collection and linear trajectories were specified. Observed variables were approximately normally distributed.

The final number of trajectory classes was determined using statistical information criteria (IC) and parsimony, interpretability, and theory (Jung & Wickrama, 2007). The IC considered were Akaike's Information Criterion (AIC;Akaike, 2025), Bayesian Information Criterion (BIC; Schwarz, 1978) and sample-size adjusted BIC (SABIC; Sclove, 2025), with lower values indicating better model fit (Geiser, 2012). The Lo-Mendell-Rubin adjusted Likelihood Ratio Test (LMR-LRT; Lo et al., 2001) was used to compare the improvement in model fit between each adjacent pair of class solutions (e.g., from 2-class to 3-class model). The LMR-LRT provides a p-value indicating a statistically significant improvement (below 0.05 threshold) in class model fit compared to the preceding class model. While not recommended for use with model selection, Entropy was considered a measure of the degree of discrimination between classes, with higher values (closer to 1) indicating improved accuracy in classification (Nylund et al., 2007). The analysis has been reported in line with best practice guidelines (The GRoLTS-Checklist: Guidelines for Reporting on Latent Trajectory Studies (van de Schoot et al., 2016)).

2.4.2. Multinomial regression

Multinomial logistic regression was conducted as the final phase of the 3-step process to identify significant predictors of latent trajectories. These analyses used listwise deletion in which participants without complete data on all variables of interest were excluded, leaving 773 (50 %) participants. Analyses were conducted comparing LCGA and regression samples on variables of interest (see Appendix A). The Mplus 3-step approach enters all predictor variables simultaneously into a single model. All predictor variables were considered time-invariant as they were only taken from the Wave 1 assessment. The primary predictor variable of interest was neighbourhood SES (IRSAD). Demographic covariates related to missingness (gender, age, baseline externalising symptoms) and with known relationships to internalising symptoms were entered into the regression model, including gender (Campbell et al., 2021), grades (Weidman et al., 2015), truancy (Egger et al., 2003; Fornander & Kearney, 2019), age at baseline (Keyes et al., 2019) and externalising symptoms (Essau & de la Torre-Luque, 2023). Truancy was re-coded into a binary variable, collapsing any days off school the previous year without the parent's permission into 'some truancy' (1) versus 'no truancy' (0). Finally, baseline externalising scores were included as a time-invariant covariate to account for the association with internalising symptoms (Essau & de la Torre-Luque, 2023) and due to their association with missing data at follow-up.

3. Results

3.1. Sample characteristics

Table 1 outlines the baseline demographic characteristics of the 1545 participants included in the analyses. Participants were predominantly female (66.8 %), had not truanted in the previous year (92.6 %), and 76 % achieved grades equal to or greater than 70 %. They were, on average, 13.5 years (SD = 0.46), with area-level socioeconomic scores at 1034 (SD = 77.94). Average internalising and externalising symptom scores were 4.3 (SD = 3.57) and 4.8 (SD = 3.36), respectively. Post hoc analyses explored differences between the total study sample ($n = 1545$) and the sample included in regression analyses ($n = 773$). Students included in the regression were more likely to be male, slightly younger, and have somewhat higher baseline externalising symptoms. For full details and comparisons between the samples, refer to Appendix A. These variables were included in the Mplus regression as covariates due to their established relationship to internalising symptoms.

3.2. Latent class growth analysis

3.2.1. LCGA model fit indices

The LCGA fit indices for one to seven classes are reported in Table 2. The IC values decreased with each additional class solution. The LMR LRT indicated that additional class solutions showed significantly improved fit compared to the previous model ($p < 0.05$) until the six-class solution. However, on inspection of graphs of class means, the trajectory patterns of the fifth and six-class solutions did not offer meaningful additional trajectories compared to the four-class solution. Indeed, the additional trajectory classes in the higher-class solutions followed broadly similar observed patterns, with additional symptom courses less than two points above the Low Stable class in the preceding

Table 2
Fit Indices for Latent Class Growth Analysis Models with Linear Growth Term for SDQ Internalising Scores.

Class	Parameters	LL	AIC	BIC	Sample size- adjusted BIC	Entropy	LMR LRT	LMR LRT p-value	Sample size based on most likely class membership
1	8	−20,142.66	40,301.32	40,344.06	40,318.65	–	–	–	1545
2	11	−18,998.371	38,018.742	38,077.512	38,042.568	0.839	2189.20	0.000	448 / 1097
3	14	−18,688.430	37,404.861	37,479.660	37,435.185	0.772	592.96	0.000	580 / 201 / 764
4	17	−18,597.330	37,228.661	37,319.488	37,265.483	0.751	174.288	0.0473	154 / 762 / 472 / 157
5	20	−18,509.103	37,058.206	37,165.061	37,101.526	0.734	168.79	0.0430	162 / 576 / 554 / 165 / 88
6	23	−18,466.400	36,978.801	37,101.685	37,028.619	0.738	81.70	0.4932	53 / 624 / 488 / 143 / 130 / 107
7	26	−18,436.985	36,925.969	37,064.882	36,982.286	0.730	56.28	0.1504	151 / 111 / 28 / 500 / 154 / 54 / 547

Note. $N = 1545$. LL = Loglikelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion; LMR LRT = Lo-Mendell- Rubin Adjusted LRT Test; SDQ = Strengths and Difficulties Questionnaire.

class solution and within average range cut-offs for internalising symptoms (Green, 2005). Moreover, numerous studieshave replicated the four-class internalising trajectory model in Australian and international contexts (Birrell et al., 2017; Klein et al., 2013; Papachristou & Flouri, 2020). The four-class model was therefore selected to reflect the most parsimonious and clinically useful solution and most consistent regarding model fit and theory. The entropy value of the four-class solution was satisfactory at 0.75, indicating good separation between classes (Weller et al., 2020). The selected model was re-run with varying start values, and the results remained consistent.

3.2.2. LCGA class identification

Fig. 1 illustrates the following four distinct mean trajectories of internalising symptoms during adolescence when weighted by estimated class probabilities: 1) Decreasing group ($n = 154$, 10 %) in which adolescents' internalising symptoms began relatively high at baseline (8.8) and then decreased over time, though remained above the population average, 2) Low Stable group ($n = 762$, 49.3 %) in which adolescents' symptoms remained low from Wave 1 to Wave 6 with little change, 3) Increasing group ($n = 472$, 30.6 %) characterised by symptoms starting low and increasing steadily into clinically raised ranges, and 4) High Increasing group ($n = 157$, 10.2 %) showing symptoms starting above clinical cut-off points and increasing over time. Appendix C shows individuals plotted trajectories by class. See Appendix D for the model estimated linear trajectories per trajectory class (derived from model estimates rather than observed values, and assuming full class membership, as opposed to a probability weighting of class membership per participant).

3.3. Multinomial logistic regression

Multinomial logistic regression results are shown in Table 3. The Low Stable Class 2 was used as the reference group. Comparisons to other classes as the reference group are found in Appendix B.

When examining the High Increasing class relative to the Low Stable reference group, a participant's IRSAD score at baseline significantly predicted group membership (OR = 0.99), controlling for other covariates. As a participant's area-level SES score improves by one unit, their odds of belonging to the High Increasing group decreases by 0.99, relative to the Low Stable group. This shows that those at baseline experiencing lower neighbourhood SES had greater odds of belonging to the High Increasing class compared to the Low Stable class, so that participants with lower internalising symptoms across the study had relatively higher neighbourhood SES. Controlling for all other variables in the model, higher age at baseline was associated with significantly increased odds of membership in the High Increasing class, compared to the Low Stable group (OR = 1.78), while female gender and greater externalising symptoms were associated with greater odds of membership in the High Increasing class compared to the Low Stable group (ORs of 6.02 and 1.61, respectively).

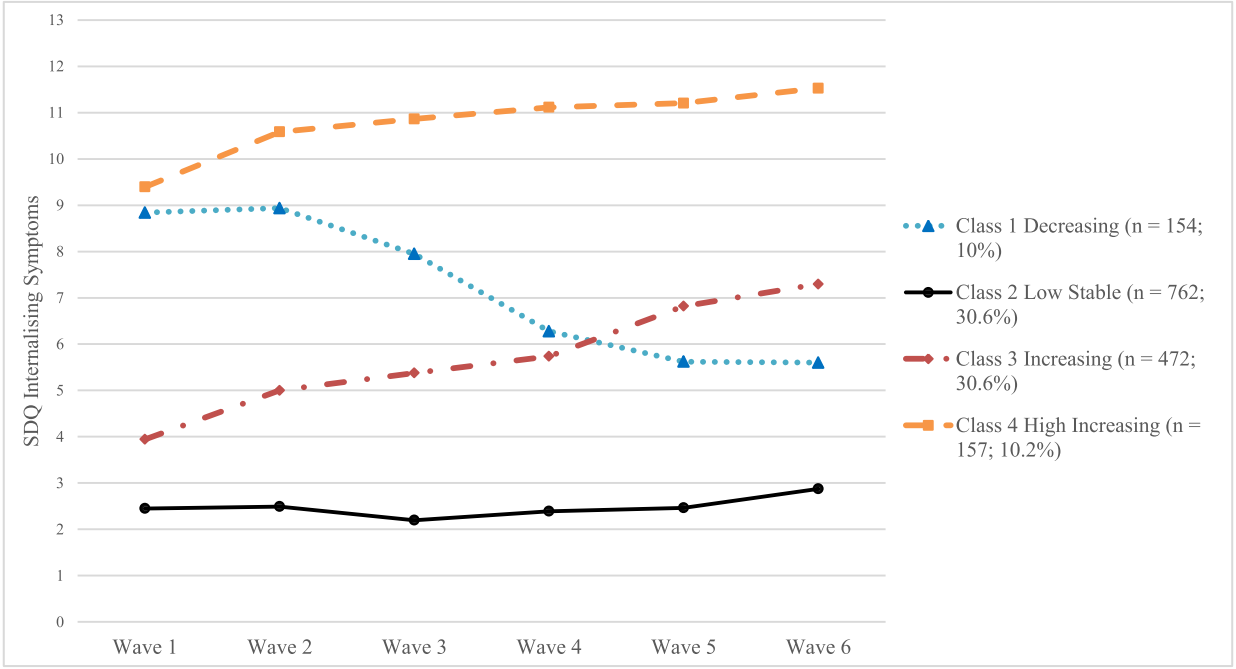

Fig. 1. Mean adolescent Internalising Symptom Trajectories weighted by estimated class probabilities for the four-class LCGA solution.

Table 3
Results of Multinomial Logistic Regression Identifying Significant Predictors of Internalising Trajectory Class Membership.

Reference Group: Class 2 (Low Stable symptoms 49.3 %)					
Comparison Class	*b* (Log Odds)	*SE*	*p*-value	Odds Ratio	95 % Confidence Interval
Class 4: High Increasing (10.2 %)					
IRSAD	**−0.006**	**0.002**	**0.006**	**0.994**	**[0.990, 0.998]**
Age	**0.575**	**0.285**	**0.044**	**1.778**	**[1.016, 3.111]**
Gender (Males)	**1.795**	**0.219**	**0.000**	**6.017**	**[3.918, 9.242]**
Truanted (No)	−0.727	0.426	0.088	0.484	[0.210, 1.114]
Grades	−0.012	0.021	0.580	0.989	[0.949, 1.030]
Externalising	**0.479**	**0.068**	**0.000**	**1.614**	**[1.413, 1.844]**
Class 3: Increasing (30.6 %)					
IRSAD	−0.002	0.002	0.165	0.998	[0.995, 1.001]
Age	0.479	0.252	0.057	1.615	[0.985, 2.648]
Gender (Males)	**0.444**	**0.219**	**0.043**	**1.559**	**[1.015, 2.394]**
Truanted (No)	**−1.327**	**0.426**	**0.002**	**0.265**	**[0.115, 0.611]**
Grades	−0.011	0.011	0.287	0.989	[0.969, 1.009]
Externalising	**0.177**	**0.044**	**0.000**	**1.194**	**[1.096, 1.301]**
Class 1: Decreasing (10 %)					
IRSAD	−0.004	0.003	0.087	0.996	[0.991, 1.001]
Age	−0.071	0.285	0.805	0.932	[0.533, 1.631]
Gender (Males)	**1.093**	**0.219**	**0.000**	**2.984**	**[1.942, 4.583]**
Truanted (No)	−0.345	0.426	0.418	0.708	[0.307, 1.632]
Grades	**−0.043**	**0.019**	**0.026**	**0.958**	**[0.923, 0.995]**
Externalising	**0.397**	**0.071**	**0.000**	**1.487**	**[1.294, 1.708]**

Note. $N = 773$. Statistically significant results are indicated in bold ($p < 0.05$). *SE* = Standard Error. IRSAD = Index of Relative Socioeconomic Advantage / Disadvantage. The reference group for binary and categorical variables are indicated in parentheses. Further comparisons can be found in Appendix B.

When examining the Increasing class relative to the Low Stable reference group, IRSAD was not a significant predictor of class membership, controlling for all covariates. However, female gender and greater levels of externalising symptoms were each associated with greater odds of membership in the Increasing class compared to the Low Stable class (ORs of 1.56 and 1.19, respectively) when controlling for all other variables in the model. Truancy was associated with significantly decreased odds of belonging to the Increasing group relative tothe Low Stable group (OR = 0.27), such that students at baseline who had any days off school without their parent's permission had reduced odds of membership in the Increasing Group.

The final section of Table 3 reports the results comparing the Decreasing class group to the Low Stable group. Controlling for all other variables in the model, IRSAD was not a significant predictor of Decreasing class membership relative to the Low Stable group. In contrast, female gender and greater levels of externalising symptoms were each associated with greater odds of membership of the Decreasing trajectory class compared to the Low Stable class (ORs of 2.98 and 1.49, respectively), controlling for all other variables in the model. Higher grades were associated with significantly decreased odds of membership in the Decreasing class compared to the Low Stable Class (OR = 0.96), controlling for covariates.

4. Discussion

This study identified heterogeneity in adolescent internalising symptom development during a critical period for mental illness onset. In line with expectations, four trajectories of internalising symptoms between 13 and 16 years were found, characterised by low-stable, increasing, decreasing, and high-increasing patterns. Within each of these trajectory groups, many participants nonetheless exhibited unstable trajectories of internal symptoms, reflecting fluctuating patterns of internalising symptoms, which may be common during adolescence (Van Oort et al., 2009). As hypothesised, findings show that Australian adolescents experiencing neighbourhood socioeconomic disadvantage were at greater risk of elevated internalising symptom trajectories, above and beyond the influence of individual characteristics (externalising symptoms, demographic and academic variables), compared to a low, stable group. Female adolescents and those with higher baseline externalising symptoms were consistently found to have an increased likelihood of membership in all risk-related trajectories other than the low stable, taking into account all other variables including SES. These findings fill a crucial research gap in demonstrating that neighbourhood disadvantage may be associated with persistent negative impacts on individual mental health trajectories.

As hypothesised, low and high internalising symptom trajectory patterns were identified. Most participants (49 %) followed a low, stable pattern. The findings are consistent with existing literature in community samples demonstrating that most adolescents do not develop internalising problems at clinical levels (Birrell et al., 2017; Reck et al., 2024; Vella et al., 2019).

A clinically elevated pattern of internalising symptoms (High Increasing) was observed in 10.2 % of adolescents, commencing at a high symptom range at 13.5 years old and progressively increasing to very high symptoms at 14 years. The pattern broadly aligns with literature demonstrating a chronically raised symptom trajectory and mirrors estimates of internalising clinical problems between 11 % and 30 % in general populations (Bayer et al., 2011). The increasing trajectory may be explained by the age of participants falling within a period in which mental disorders are known to onset (Solmi et al., 2022), in conjunction with rising mental health symptoms in recent cohorts (McGorry et al., 2024).

Two additional classes were observed: a subgroup of adolescents (10 %) that commenced in a high range at baseline and then continued to decrease over time and a subgroup (30.6 %) that began in the average range and followed an increasing trajectory into high levels at 14 years. A previous study of Australian adolescents found four trajectories of emotional symptoms (a component subscale of the SDQ internalising scale), when followed from 13 to 16 years of age (Birrell et al., 2017). Similar to the current study, the majority of adolescents (45 %) were best characterised by a low stable symptoms course, with 13 % following a high-stable symptoms course however, no decreasing trajectory was observed, and a small number followed a course of rapidly increasing symptoms that then dropped off (Birrell et al., 2017). An international study, using data from the Millennium Cohort Study in the United Kingdom, found that in younger children (aged 3–11 years), the majority (79 %) exhibited consistently low stable internalising symptoms (Papachristou & Flouri, 2020). A smaller proportion (3 %) followed a high and increasing trajectory, 8 % showed high but decreasing symptoms, and two additional groups displayed low and middle-range symptoms, with one group increasing over time (Papachristou & Flouri, 2020). Other trajectory studies have observed varying trajectory classes and shapes of growth over childhood and adolescence (Letcher et al., 2012; Vella et al., 2019), noting the age range of these studies are not directly comparable to the current study and that Letcher et al. (2012) examined trajectories separately for girls and boys.

Neighbourhood and individual risk factors of trajectory membership were identified. Greater socioeconomic disadvantage was associated with an increased likelihood of belonging to the High Increasing

trajectory than the Low Stable group, suggesting that macro-level factors may impact internalising symptom expression above and beyond the contribution of individual characteristics, including gender, age, externalising symptoms, and truancy and grades. These findings align with a social determinants framework that suggests biological, ecological, psychological, and social factors at multiple levels influence child and adolescent development over time (Bronfenbrenner, 2005) although the strength of association between socioeconomic disadvantage and trajectory class was admittedly small in the present sample. Possible mechanisms by which neighbourhood SES may influence mental health include heightened stressors such as diminished social and economic opportunity, elevated crime levels, and increased violence within socioeconomically disadvantaged neighbourhoods (Lund et al., 2018; Visser et al., 2021).

The current study is consistent with literature demonstrating that lower levels of SES are associated with an increased risk of internalising problems in adolescents (Christensen et al., 2017; Islam et al., 2021). Notably, in the current study, neighbourhood SES was associated with a stable high trajectory of internalising symptoms, suggesting the influence of SES on mental health may be embedded prior to adolescence. Indeed, in a sample of Australian children aged 4 to 14, Christensen et al. (2017) found that while lower neighbourhood SES was related to higher total mental health difficulty persistently across six time points, an interaction with age was not observed.

Findings from the current study point to the utility of programs seeking to improve neighbourhood SES in order to impart psychosocial and well-being benefits when delivered at the population level (van Agteren et al., 2021). However, we note caution is needed as the current study could not establish causal relationships and only a small magnitude of association was evident. It is also possible that other more proximal factors may have stronger associations with adolescent mental health than neighbourhood SES, including factors not accounted for in the present study such as maladaptive parenting, including hostility and rejection, which are known predictors of adolescent internalising trajectories (Balan et al., 2017; Kemmis-Riggs et al., 2020). It may be that neighbourhoods indirectly impact adolescents via their influence on parenting through persistent family stress, scarcity of resources, and reduced caregiving time due to economic disparity (Rothenberg et al., 2023).

The literature discussed thus far has examined average mental health patterns, assuming homogeneity in adolescent symptom expression. Developmental psychopathology paradigms suggest multiple pathways to similar outcomes, and risk factors may influence an outcome in many ways in child and adolescent mental health (Eme, 2017). This is supported by the current study findings that there are unique pathways to elevated levels of internalising symptoms, and neighbourhood SES impacts such courses differently. The results align with international contexts, demonstrating that neighbourhood socioeconomic disadvantage predicts membership in high symptomology trajectories (Reck et al., 2024; Shore et al., 2018).

Another noteworthy finding was that female gender and higher baseline externalising symptoms were associated with an increased likelihood of being in any raised symptom level trajectory compared to the Low Stable class (even after controlling for SES). These findings reinforce previous literature showing that adolescence is a critical period where patterns of mental health bifurcate between girls and boys, with increases in internalising symptoms in contemporary cohorts of adolescent girls (Flouri et al., 2018). The predictive strength of gender for high-risk symptom trajectories (OR = 6.017) indicates that female adolescents may be at particular risk for persistently elevated symptom courses. Intervention and prevention programs will be necessary to close this gender gap during adolescence. Moreover, higher levels of externalising symptoms at 13 years old may be used to screen for eligibility for internalising interventions, given their association with high-risk internalising trajectories in the current study and known co-occurrence and mutual reinforcement (Patalay et al., 2016).

Additionally, older age at baseline was associated with membership in the High Increasing group but not other classes. However, students were generally the same age with minimal variation as the sample was drawn from one year group at participating schools. Higher grades and truancy at baseline were associated with reduced odds of belonging to Decreasing and Increasing classes, respectively, compared to the low trajectory. This suggests that academic factors, as measured in this study, may not be linked to internalising symptoms, or may have more significant associations with externalising symptoms (Gubbels et al., 2019).

4.1. Implications for research, policy and practice

There are several implications of the current study. The relative disadvantage of an area in which an adolescent is situated impacts their mental health persistently across a critical development period. The findings suggest a need to consider upstream social and economic strategies that improve the socioeconomic gradients of communities including income, education, employment, and housing policies, thereby improving adolescent mental health. Indeed, Rothenberg et al. (2023) demonstrated that income increases can break intergenerational cycles of the impact of maternal parenting rejection on adolescents' internalising and externalising symptoms across cultures. To counter deficits-based approaches often associated with disadvantage, it will be imperative for future research and policy to consider protective factors that may positively shift trajectories over time, such as neighbourhood trust (Kingsbury et al., 2020) and community social support (Triana et al., 2019). The predictive significance of individual characteristics at baseline on later mental health trajectories suggests that student screening on entry to school may enable the provision of prevention and early intervention programs, both at the individual and family level (Chu et al., 2015; Grande et al., 2022). Indeed, schools may be well-placed as intervention sites given catchment areas and age at entry.

4.2. Strengths and limitations

The present study utilised a large contemporary community sample of Australian adolescents spanning three States, strengthening its generalisability to the general population.

We note a number of limitations to our study. While findings indicated that adolescents from neighbourhoods of greater socioeconomic disadvantage were at greater risk of elevated internalising symptoms across adolescence, the analytic approach employed could not determine whether reciprocal relationships existed, i.e. whether change over time in internalising symptoms influenced neighbourhood SES, or vice versa. Future research could examine the bidirectional nature of these relationships, as well as causal mechanisms underlying their association. Though beyond the scope of the current study, including a broader range of variables at multiple levels known to be associated with adolescent internalising symptoms will be necessary for future research to disentangle mechanisms. The use of IRSAD, a composite average of individual social and economic outcomes of individuals in an area was used to examine neighbourhood levels of socio-economic advantage and disadvantage. Data on individual SES was not collected in the current study therefore, it was not possible to examine these relationships at the individual level. Future studies could include family-level and individual-level measures of SES.. Finally, only 50 % of participants provided responses on risk factor variables, thereby reducing the statistical power of the multinomial regression analyses. Moreover, though controlled for in models by inclusion as covariates, gender, age, and externalising symptoms were related to attrition. The inclusion of baseline externalizing symptoms as a time-invariant predictor also meant that we could not account for change in externalizing symptoms over time and their relationship to internalising trajectories. Replicating the findings in larger representative samples will be an important future research endeavour.

5. Conclusions

The present study identified heterogeneity in internalising symptom development in a contemporary Australian sample, in line with previous literature. The study provides novel insight that neighbourhood socio-economic disadvantage negatively impacts adolescent internalising symptoms longitudinally across a critical risk period for mental disorder onset. While the relative influence of neighbourhood SES was small after controlling for individual characteristics such as gender and externalising symptoms, the findings demonstrate that the area in which an individual is placed shapes their mental health, independent of individual risk factors. The results suggest that interventions and policies targeting the social and economic landscape of neighbourhoods may play a part in reducing persistent and rising adolescent mental ill-health in the population.

CRediT authorship contribution statement

Ainsley Furneaux-Bate: Writing – review & editing, Writing – original draft, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Louise Birrell:** Writing – review & editing, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **David Berle:** Writing – review & editing, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nicola C. Newton:** Writing – review & editing, Project administration, Funding acquisition. **Cath Chapman:** Writing – review & editing, Resources, Project administration, Methodology, Funding acquisition. **Tim Slade:** Writing – review & editing, Methodology, Formal analysis. **Louise Mewton:** Writing – review & editing, Project administration, Funding acquisition. **Scarlett Smout:** Writing – review & editing. **Maree Teesson:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Maree Teesson and Nicola Newton reports a relationship with M.T. & NN are co-directors of Climate Schools Pty Ltd and OurFutures Institute Ltd. that includes: non-financial support. Louise Birrell reports a relationship with National Health and Medical Research Council that includes: funding grants. Nicola Newton, Cath Chapman, Tim Slade, Louise Mewton, Maree Teesson reports a relationship with National Health and Medical Research Council that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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