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ARTICLE

Overcoming socioeconomic adversity: Academic resilience in mathematics achievement among children and adolescents in Ireland

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Abstract

Although socioeconomic disadvantage is linked with academic underachievement, many children from low-income backgrounds perform well in school. Which modifiable factors predict this academic resilience? We examine between- and within-person predictors of one important academic metric – mathematics performance – across adolescence in 1715 (796 male, 919 female) youth living in poverty in Ireland, using data from three waves (9, 13, and 17/18 years) of the Growing Up in Ireland study. Using linear mixed models, math performance was worse when adolescents had more socioemotional and behavioural difficulties, more child–parent relationship conflict, parents had lower expectations of the adolescent's educational achievement, and when primary caregivers had less education. Adolescents who had better intellectual self-concept and attended a non-disadvantaged school had greater math performance. This research adds to the growing body of work suggesting academic resilience is dynamic and multisystemic; it provides potential targets at multiple levels to promote such resilience.

KEYWORDS

academic resilience, adolescence, Ireland, longitudinal, math performance, poverty

Natural disasters, war, poverty, neglect, and other adversities can significantly threaten optimal child development and result in educational disadvantage. Despite this, some children display high levels of academic resilience and perform well in school. Extensive research has focussed on the factors and processes that promote this positive adaptation to design interventions that mitigate risk and build resilience in children.

Key points

- Adolescent self-concept and socioemotional difficulties are associated with academic resilience.
- There are modifiable factors at the individual, household and school levels associated with mathematics achievement for socioeconomically disadvantaged kids in Ireland.
- Family factors (parental education expectations, parental education levels and parent–child conflict) were particularly strong associated with math performance.

Early research focussed on resilience as a trait with an emphasis on the existence of extraordinary qualities of resilient children (Cohler, 1987; Winders, 2014) or as an outcome focussing on the maintenance of adaptive functional outcomes despite serious risks (Glantz & Johnson, 1999). Evidence indicating positive developmental outcomes despite exposure to varying types of significant adversity acknowledged the role of internal and external factors and processes on the development of resilience (Garmezy, 1991; Garmezy et al., 1984; Rutter, 1981; Schoon, 2006; Ungar & Theron, 2020). Resilience became widely accepted as a 'dynamic process' (Luthar et al., 2000, p. 543) involving 'multiple biological, psychological, social, and ecological systems' interacting in ways that enable individuals to either maintain adequate functioning, bounce back, or thrive when faced with significant adversity (Ungar & Theron, 2020, p. 441). Resilience depends on an individual's access to resources within their social, societal, and natural environments, as well as individual behaviours and characteristics (Ungar & Theron, 2020). Resilience can change over time and depends both on the individual's environment and their interaction with it (Southwick et al., 2014; Ungar & Hadfield, 2019). Children's engagement with their environment is embedded within broader systems and organizations, which can directly and indirectly influence child development (Masten et al., 2021). Consequently, resilience is understood as a multisystemic process, with the outcomes of children shaped by the complex interplay and coactions of multiple interconnected systems (Ungar & Theron, 2020). This conceptualization of resilience as a process recognizes that factors promoting resilience will vary contextually and temporally (Fletcher & Sarkar, 2013; Panter-Brick et al., 2018); therefore, defining context-specific forms of resilience offers greater prediction specificity to resilience research (Cassidy, 2016). One context-specific form of resilience is academic resilience, which is 'a capacity to overcome acute and/or chronic adversity that is seen as a major threat to a student's educational development' (Martin, 2013, p. 488).

Within academic resilience research, various forms of adversity have been investigated, usually with a view of academic performance as a positive adaptation (Tudor & Spray, 2017). To evaluate academic success, standardized test scores in domains such as reading and mathematics are commonly used (Sandoval-Hernández & Białowolski, 2016), with some evidence suggesting that mathematics performance may be a stronger predictor of academic achievement than literacy (Duncan et al., 2007). Academic resilience in mathematics is linked to higher academic performance and motivation (Lazarides & Ittel, 2014), increased problem-solving abilities (Duncan et al., 2007), and increased likelihood of students persisting in their studies (Pekrun et al., 2009).

POVERTY

Socioeconomic adversity has substantial negative effects on children across a wide range of domains, including academic performance (Brooks-Gunn & Duncan, 1997). Socioeconomic status (SES) encompasses not only financial resources and income but also the social standing, privileges, and prestige associated with them (Duncan & Magnuson, 2012). SES remains one of the strongest

predictors of children's academic achievement (Reardon, 2018), and the association between SES and academic achievement is evident across the full socio-economic spectrum (Reardon, 2011). Given the difficulty in measuring SES directly, SES measurements typically rely on a single indicator or a combination of highly correlated indicators, such as household income, occupation, and parental education level, to form an SES index (Duncan & Magnuson, 2012). Poverty is typically defined by comparing a 'household's income with a threshold level of income that varies with family size and inflation' (Duncan & Magnuson, 2012, p. 379). Official definitions of poverty include absolute poverty, where people lack the necessities for survival; relative poverty, where people's income and standard of living are far lower than the country they live in; and at risk of poverty, where people are living below the relative money poverty threshold (60% of median equivalized household income) (EAPN, 2018).

Poverty is associated with numerous disadvantages that can put children at significant risk of academic failure (Chen et al., 2019; Kanevsky et al., 2008). A self-perpetuating cycle often exists (Torraco, 2018), whereby children experiencing poverty begin lagging in performance, particularly in reading and mathematics (Reardon & Portilla, 2016), and these gaps tend to persist or worsen (García & Weiss, 2017; Sirin, 2005). Children living in poverty are less likely than their more affluent peers to complete second-level education (Cairns et al., 1989), and when they do progress to third-level education, they are less likely to graduate (Bjorklund-Young, 2016). Effects of poverty often co-occur, for example, with children living in poverty often living in less safe communities and not having access to well-resourced schools (Williams et al., 2017). Despite this, the development trajectories of children facing these challenges are variable (Herbers et al., 2012; Schoon, 2006). Many students sustain high levels of academic performance despite substantial disadvantages (Considine & Zappalà, 2002).

Little is known about the mechanisms by which early gaps in academic performance emerge (James-Brabham et al., 2023). Poverty's association with academic underachievement may be mediated by atypical patterns in structural brain development, including reduced grey matter volumes in areas associated with school readiness skills (Hair et al., 2015). Poverty-related adversity often results in increased exposure to chronic stressors, which may impact the neural activity of the developing brain (Blair & Raver, 2016). Small-scale studies show significant differences between low- and middle-SES children regarding language, working memory, cognitive control, and spatial recognition (e.g., Farah et al., 2006). Studies involving teacher reports suggest differences in SES not only in math and reading skills but also in engagement and paying attention (Duncan & Magnuson, 2012).

THEORETICAL FRAMEWORK

This study was guided by Bronfenbrenner's (1995) Ecological Systems Theory, whereby the development of the person is understood to be impacted by multiple systems that interact with one another and with the child. We adopt a multisystemic social-ecological view of resilience (Ungar et al., 2012), focusing on factors at multiple levels that enable children and adolescents to overcome the disadvantages associated with poverty and succeed academically (Figure 1). Our project builds on similar work by LeWinn et al. (2020) and Wang et al. (2023), examining modifiable factors associated with cognitive performance.

Protective and risk factors

The presence or absence of several internal and external factors operating at multiple levels of the child's environment helps account for the individual differences observed in reactivity to adverse life circumstances (Luthar et al., 2000; Wolff, 1991). Various risk factors and protective factors can shape children's trajectories and outcomes. Depending on the context, the same variable can incur risk or protective

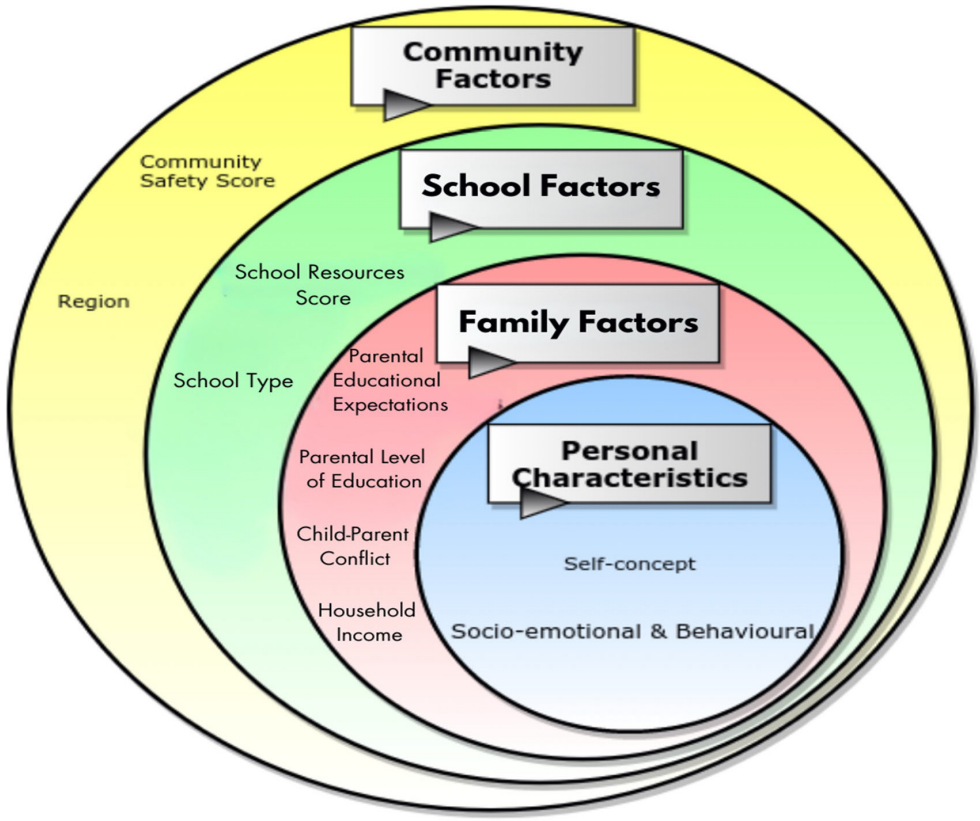

FIGURE 1 Modifiable factors tested in this analysis, at different levels of the child's environment.

effects (O'Connell et al., 2009). A common approach to examining the impact of risk and protective factors is to regard them as the extreme ends of a continuous variable (O'Connell et al., 2009). Risk and protective factors tend to have cumulative effects, where multiple risk factors amplify adverse outcomes, and multiple protective factors increase positive outcomes or may even dilute the effect of risk factors (Cooper, 2021). The process of resilience depends on the dynamic interplay between the aggregation of risk factors and protective factors in the face of significant adversity (Sölva et al., 2023). In this paper, we focus on the child's characteristics, family influences, the school, and the wider community environment.

Personal characteristics

Several studies have linked students' personal characteristics, including self-concept, composure/low anxiety (Martin & Marsh, 2006), and socioemotional behavioural problems, to academic performance, with Cassidy (2015) suggesting that some personal attributes are stronger predictors of academic success than ability or previous performance. A student's optimistic view of their intellectual ability increases the likelihood of academic success in Mexican American students (Alva, 1991) and promotes academic resilience in students living in poverty in Turkey (Gizir & Aydin, 2009). Self-concept impacts academic performance from early childhood into adolescence (Susperreguy et al., 2017).

In addition to self-concept, children's emotional and behavioural difficulties are linked to deficits in academic performance (Keilow et al., 2019). Nelson et al. (2004) found that behavioural problems resulted in significant academic shortfalls across performance domains, and these deficits appeared to

remain stable or, in many children, worsen in the domain of mathematics. Additional longitudinal studies have reported a negative relationship between students' emotional and behavioural difficulties and academic performance, with some of the associations enduring over time (Kremer et al., 2016).

Family factors

Parental education and parental educational expectations are consistently linked to children's academic outcomes (Carneiro et al., 2012; Chevalier, 2004; Wilson et al., 2020). More years spent in formal education may impact child–parent interactions (Duncan & Magnuson, 2011, 2012). Higher-educated parents often provide their children with a more cognitively stimulating environment (Raviv et al., 2004) and use more varied and complex language (Hoff, 2003). This more enriching environment may influence child behaviour, attitude, and education decisions (McLachlan et al., 2013). The introduction of compulsory schooling in the United States – resulting in a 1-year increase in parents' educational attainment – positively impacted children's academic outcomes (Oreopoulos et al., 2006). In young mothers with low levels of education, additional maternal schooling is associated with positive changes in children's academic achievement (Magnuson, 2007). However, there is still much disagreement as to whether increasing parental education has a direct causal effect on children's academic outcomes, and estimates vary considerably across studies (Holmlund et al., 2011). It is also possible that the skills acquired in these extra years of formal education enable parents to accomplish their parenting goals more effectively, thus impacting their child's developmental outcomes indirectly (Duncan & Magnuson, 2012).

In two meta-analyses, parental academic expectations were the strongest family-level predictor of academic performance for both elementary and secondary school children (Jeynes, 2005, 2007). Higher expectations are consistently associated with higher academic success and educational attainment (Castro et al., 2015; Davis-Kean, 2005; Sommerfeld, 2016; Wilder, 2013; Yamamoto & Holloway, 2010). Rutchick et al.' (2009) analysis of longitudinal data from 884 American children and their primary caregivers found that – over and above indicators of child ability, such as past performance – lower parental expectations reduced children's academic performance five years later.

Finally, the role that strong family relationships play in students' academic resilience is noteworthy. Disruptions to the relationship between a child and their primary caregiver can have long-lasting negative impacts on children's developmental outcomes (Bowlby, 1969). Insecure attachment representations – often more prevalent in families experiencing poverty (Wray, 2015) – can result in more child–parent relationship conflict and lower academic success (Jacobsen & Hofmann, 1997). Experiencing chronic stress, which is frequently linked to living in poverty, can influence the caregiving approach provided by parents and lead to decreased warmth and sensitivity (Blair & Raver, 2016). However, many parents who struggle to make ends meet manage to provide sensitive, nurturing, and responsive caregiving environments (Blair & Raver, 2016). Indeed, any negative differences in parenting observed in low-income parents are part of a broader income gradient extending across the full distribution (Cooper, 2021). Differing parenting styles may emerge due to varying economic contexts, where parents from lower-income families focus on providing basic needs to help their children grow, develop, and be healthy and happy (Lareau, 2002). Conversely, parents from middle-class families tend to promote talents and learning through organized leisure and attempt to pass on privileges and educational advantage through the transmission of specific skills such as assertion and a sense of entitlement (Lareau, 2002). Regardless of income, family environments where communication is encouraged between children and parents about school, school-related activities, and academic issues foster academic success (Jowkar et al., 2011; Shute et al., 2011).

The school environment

The school environment, including school resources and support, is associated with positive academic outcomes in students facing adversity (Greenwald et al., 1996). In Ireland, the DEIS (Delivering

Equality of Opportunity in Schools; *deis* means opportunity in Irish) – a government action plan implemented by the Department of Education and Skills – was introduced in 2007 to address the educational needs of children and adolescents (3–18 years) from disadvantaged communities (Department of Education and Science, 2005). It aimed to tackle disadvantages by bringing together and building upon existing interventions promoting educational equity. Increased financial support was provided for schools identified for inclusion. Efforts were made to enhance attendance and retention rates, improve literacy and numeracy outcomes, and measure progress systematically (Department of Education and Science, 2005). A 2017 evaluation report concluded that many changes achieved at the school level were in line with the original DEIS action plan (Department of Education and Skills, 2017), with high levels of programme implementation from participating schools (Weir & Archer, 2011). From 2007 to 2016, modest increases were observed in both reading and mathematics at the primary school level, with greater gains noted in mathematics (Department of Education and Skills, 2017). However, the majority of schools showed a mixed pattern of change in achievement. Despite the somewhat positive results, the 2014 National Assessment of English Reading and Mathematics indicated that the achievement gap has not significantly reduced (Department of Education and Skills, 2017) and there continues to be considerable scope for improvement in reducing inequality (Fleming & Harford, 2023). At the post-primary level, achievement outcomes are also still lower in DEIS than in non-DEIS schools. (Nelis et al., 2021).

The community

The neighbourhoods in which children grow up have an important impact on long-term child outcomes, including educational success and future earnings (Chetty & Hendren, 2018). Kong's (2020) study on academic resilience using Growing Up in Ireland (GUI) longitudinal data at 9 and 13 years old concluded that the community region was the strongest predictor of academic performance in low-SES students at age 13, with those living in a rural area having the most positive academic outcomes. However, there is some complexity within this: urban children experiencing poverty have more resources associated with positive academic outcomes, but also more stressors associated with academic deficits, whereas the opposite is true for rural children (Miller et al., 2019). Similar studies have concluded that region and geographical location are not significant predictors of academic resilience (Considine & Zappalà, 2002) but may be important under certain circumstances, such as for students with high academic expectations (Overstreet & Braun, 1999).

Data collection for Waves 1, 2, and 3 of the GUI data occurred in 2008/2009, 2011/2012, and 2015/2016, respectively. During this time, Ireland experienced a recession and the 'at risk of poverty' rate in Ireland rose from 14.1% in 2009 to 16.7% in 2014, returning to 14.0% by 2018 (CSO, 2020). Higher rates were noted in families where no one in the household was working and with those living in rural areas. In Ireland, the educational system consists of 6 years at primary school, followed by 5 or 6 years at secondary school. A state exam (the Leaving Cert) is then taken, the results of which dictate University acceptance. Because of the high-stakes nature of the Leaving Cert, children from more affluent backgrounds – already in a position of educational advantage – often have access to private tuition, after-school lessons ('grinds'), and science or language camps, all aimed at giving them an academic edge (Fenwick et al., 2022). This makes it increasingly challenging for school-based programmes and policies to tackle educational disadvantage in Ireland.

Purpose of this study

Using data from the three waves of the Growing Up in Ireland (GUI) study, we will examine what aspects of a low-income adolescents' environment are associated with achievement in mathematics, as well as what the relative influence of these factors is over time. Using Bronfenbrenner's ecological systems theory as a framework, we identified modifiable factors at different levels of the child's

environment (individual, family, school, and community) and will use linear mixed models (LMMs) to examine within- and between-person changes in math performance over time as a function of these modifiable factors. This directly builds on studies that have identified individual factors by exploring the combined contribution and relative influence of these factors in one model and examining their effects over time.

METHOD

Participants

This project uses data on 9–17/18-year-olds drawn from GUI Cohort 1998 (Child Cohort), a nationally representative, longitudinal, study of children and their caregivers in Ireland started in 2006 (CSO, 2010, 2014, 2018). Wave 1 included 8568 9-year-olds and their caregivers; 7,525 of them participated in Wave 2 aged 13 years and 6,216 in Wave 3 aged 17/18 years. The response rate was strongly related to primary caregiver education, income, and social class, with the lowest response rate from households experiencing the most disadvantage (Murphy et al., 2018).

Participants were sampled through a two-stage sampling design. Stage one involved recruiting a random sample of primary schools based on a comprehensive listing of all public and private primary-level schools in Ireland. Then, all 9-year-old pupils from the included schools were recruited, up to a maximum threshold of 40 pupils in any one school (Thornton et al., 2010). Participants were included in the current analyses if their equivalized household income at Wave 1 was in the 1st, 2nd, or 3rd decile, a threshold set by the European Anti-Poverty Network (EAPN) to identify people or households at risk of poverty in Ireland (EAPN, 2019). This resulted in a total of 1,715 participants and their families (Table 1). We chose to include this cut-off at Wave 1 because there are strong to moderate correlations in income deciles across the three timepoints in the full sample ($r = .5$ to 0.7, $p < .05$). However, given that some people do change decile during the 9-year study period, we conducted sensitivity analyses with income cut-offs at different timepoints, all of which had a similar pattern of results (these can be accessed at OSF).

Instruments

Before taking part in GUI, caregivers and child participants provided informed consent. Prior to commencing this analysis, further ethical approval was granted by the School of Psychology Research Ethics Committee at Trinity College Dublin (SPREC102020-03), and the authors were granted access to the GUI dataset via the Irish Social Science Data Archive (www.ucd.ie/issda). At all three GUI study waves, a comprehensive battery of data was collected from the child, parents, teachers, and principals using

TABLE 1 Demographic information for the respondents in this study.

	Study child	Primary caregiver	Secondary caregiver	Principal
Total	1715	1715	1174	1696
Gender				
Male	796	22	1169	867
Female	919	1693	5	829
Age in years				
≤26		18		
27–40		883		
≥41		814		

TABLE 2 Descriptive statistics for included numeric variables.

Variable	Wave 1		Wave 2		Wave 3	
	Mean	SD	Mean	SD	Mean	SD
Mathematics score	−0.91	0.92	−0.32	0.86	−0.32	1.06
SDQ total difficulties	8.51	5.56	7.6	5.7	7.17	5.19
Piers-Harris I&S	12.12	2.79				
Piers-Harris FA	10.48	2.96				
Equivalized household income	9502.51	2192.32	17,284.58	8938.76	16,411.42	9041.56
Pianta conflict (primary caregiver)	22.21	9.23				
Pianta conflict (secondary caregiver)	21.95	8.23				
School resources	11.03	2.14	11.18	2.18	10.81	2.33
Community safety	17.97	3.24	18.85	3.71	18.9	3.5

Abbreviations: Piers-Harris FA, freedom from anxiety subscale; Piers-Harris I&S, intellectual and school status subscale; SDQ, Strengths and Difficulties Questionnaire.

multiple methods. More detailed information on sampling design and instrumentation for Waves 1, 2, and 3 can be found in Murphy et al. (2019), Quail et al. (2014), and Thornton et al. (2010), respectively. See Table 2 for descriptive statistics of all numeric variables and Table 3 for correlations between variables at all timepoints.

Math performance

In Wave 1 of the GUI study, the Drumcondra Maths Test was used to measure math performance at age nine. This test contains 25 questions focussing on problem-solving, reasoning, and mathematical understanding (ERC, n.d.-a,b). In Wave 2, the Drumcondra Reasoning Test in Numerical Ability was used, which contains 20 questions evaluating students' ability to reason and manipulate numerical relationships. These are both curriculum-based, standardized tests developed by the Educational Research Centre for Irish schoolchildren, indicating their mathematics ability (ERC, n.d.-a,b). In Wave 3, the financial literacy/numeracy test was administered, as no appropriate versions of the earlier tests were available. It is a cognitive ability test containing three questions assessing the respondent's ability to work out mathematical calculations (see Murphy et al., 2019 for more detailed information). We standardized these Wave 3 math scores prior to analysis. All three measures of math performance were moderately correlated (Table 3). The individual items are not publicly available.

Child attribute measures

Gender

All students in the GUI study were identified by their primary caregivers as either male or female (796 male, 919 female).

Socioemotional and behavioural difficulties

Socioemotional and behavioural difficulties of the children in the GUI study were measured using the Strengths and Difficulties Questionnaire (SDQ), a behavioural screening tool (Goodman, 1997), completed by the primary caregiver about the study child in Wave 1, Wave 2, and Wave 3. It asks 25 questions, with five subscales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. Caregivers are asked to rate how true their child's items are, such as

TABLE 3 Correlations for all variables.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	T1 SDQ – total difficulties	–																	
2	T2 SDQ – total difficulties	.625**	–																
3	T3 SDQ – total difficulties	.511**	.621**	–															
4	T1 Piers-Harris – I&S	−.216**	−.188**	−.149**	–														
5	T1 Piers-Harris – FA	−.230**	−.201**	−.218**	.510**	–													
6	T1 Household income	−.070*	−.125**	−.104*	.084*	.104**	–												
7	T2 Household income	.022	−.002	−.007	−.011	−.031	−.028	–											
8	T3 Household income	−.030	.014	.004	.017	.002	.003	.057	–										
9	T1 Pianta Conflict PCG	.612**	.495**	.420**	−.115**	−.158**	−.032	−.016	.005	–									
10	T1 Pianta Conflict SCG	.383**	.325**	.219**	−.095*	−.141**	−.006	.054	.006	.479**	–								
11	T1 School resources	.005	−.022	.021	−.008	−.006	−.017	.059*	.031	.018	−.002	–							
12	T2 School resources	.016	.022	.003	−.051	−.042	−.028	−.027	−.048	−.011	.012	−.011	–						
13	T3 School resources	.001	.015	−.001	.016	−.019	−.022	−.076	−.081	−.004	−.028	−.014	.181*	–					
14	T1 Community safety	−.251**	−.228**	−.206**	.026	.074*	.054*	.012	.046	−.213**	−.146**	−.002	−.002	.045	–				
15	T2 Community safety	−.176**	−.227**	−.222**	−.016	.072*	.099**	−.010	.070*	−.137**	−.083*	.022	−.032	.021	.485**	–			
16	T3 Community safety	−.156**	−.204**	−.251**	−.021	.046	.113**	−.016	.019	−.131**	−.081*	.016	.001	.089*	.429**	.551**	–		
17	T1 Math score	−.292**	−.268**	−.260**	.227**	.199**	.128**	−.014	−.001	−.197**	−.122**	−.006	.021	.004	.160**	.123**	.135**	–	
18	T2 Math score	−.251**	−.262**	−.253**	.201**	.193**	.155**	−.013	.017	−.137**	−.131**	.046	−.012	−.013	.128**	.152**	.158**	.527**	–
19	T3 Math score	−.211**	−.244**	−.258**	.170**	.199**	.160**	.008	−.009	−.128**	−.061	.008	.015	−.022	.139**	.133**	.157**	.465**	.562**

Abbreviations: FA, freedom from anxiety; I&S, intellectual and school; PCG, primary caregiver; SCG, secondary caregiver; T1, variable measured at wave 1; T2, variable measured at wave 2; T3, variable measured at wave 3.

*Correlation is significant at the .05 level (2-tailed). **Correlation is significant at the .001 level (2-tailed).

'Many worries, often seems worried' on the emotional subscale or 'Often fights with other children or bullies them' on the conduct subscale (Goodman, 1997). Each item is scored from 0 to 2. All but the prosocial subscale are summed to produce a total difficulties score, with a higher score indicating more problem behaviours. The SDQ correlates highly with other similar measures (Goodman, 1997; Goodman & Scott, 1999) and has high internal consistency and test–retest reliability (Perkins, 2018; Stone et al., 2010).

Self-concept

The second edition of the Piers-Harris (PH) Self-Concept Scale was completed by the study child. It measured the study child's self-concept in Wave 1. The scale items are statements reflecting how respondents may feel about aspects of themselves, with Yes/No responses depending on whether they feel items apply to them or not (Piers & Herzberg, 2002). For this analysis, data from two subscales were used. The 16-Item Intellectual and School Status subscale reflects the respondent's judgement of their intellectual abilities and academic performance, while also tapping into future expectations about achievement (Murray et al., 2010). It contains items such as 'I am smart' and 'My classmates in school think I have good ideas'. The 14-Item Freedom from Anxiety subscale assesses anxiety and dysphoric mood tapping into various emotions, including worry, nervousness, shyness, sadness, and fear (Piers & Herzberg, 2002). It includes items such as 'I get worried when we have tests in school' and 'I give up easily'. Higher scores indicate favourable self-concept (self-esteem or self-regard), whereas lower scores are associated with more negative self-concept. The individual items were not included in the GUI dataset; however, previous studies using this scale report good internal consistency with Cronbach's alpha ranging from .74 to .81 for the subscales (Piers & Herzberg, 2007).

Family measures

Income

Equivalized income was measured at all three waves. This equivalized income measure is calculated by assigning a weight to each household member (1 for the first adult, 0.66 for each subsequent adult, and 0.33 for each child), the sum of which gives each household an 'equivalence size'. Disposable income corresponds to the household's gross income minus tax and social contributions. Equivalized income is calculated by dividing the household's disposable income by the equivalence size, allowing meaningful comparison across households of different sizes and compositions (ESRI, 2010).

Conflict in the child–parent relationship

The 15-item conflict subscale of the Pianta Child–Parent Relationship Scale – independently completed in Wave 1 by the primary caregiver and secondary caregivers – measures parent–child conflict (Pianta, 1992). Caregivers rate items such as 'My child and I always seem to be struggling with each other' on a five-point scale from 'Definitely does not apply' to 'Definitely applies', with a higher score indicating greater parent–child conflict (Perkins, 2018). Previous research using GUI data indicates good internal consistency for both primary caregiver and secondary caregiver ratings (Perkins, 2018).

Parental level of education

Primary caregivers self-reported their highest level of education at all three timepoints, with the following categories: primary school or none, lower secondary school (i.e., up to age 16), secondary school, some third level (college/university) education, undergraduate degree, and postgraduate degree (Table 4).

Parental educational expectations

The primary caregiver reported on their educational expectations for the study child at all three timepoints with the item: 'Taking everything into account, how far do you expect your child will go in his/

TABLE 4 Highest level of education completed by the primary caregiver.

Level of education	Wave 1 (%)	Wave 2 (%)	Wave 3 (%)
Primary School or None	10.4	1.2	1.8
Lower Secondary School	27.6	8.8	10.2
Secondary School	34.1	32.2	35.9
Third level (non-degree)	17.3	27	22.5
Primary degree	8.3	17.6	17.7
Postgraduate degree	2.2	13.3	11.8

TABLE 5 Parents' educational expectations for the study child.

Level of education	Wave 1 (%)	Wave 2 (%)	Wave 3 (%)
Junior Cert/Leaving Cert or Equivalent	14.8	5.0	3.0
Apprenticeship/Trade	8.5	3.3	7.2
Diploma/Certificate	12.0	6.7	11.9
Primary (Undergraduate) degree	44.3	49.4	48.2
Postgraduate degree	20.3	33.9	26.2
Don't know	0.0	1.6	3.5

her education or training?'. Response options were junior certificate or equivalent (e.g., some secondary school), leaving certificate or equivalent (e.g., completed secondary school), an apprenticeship or trade, third level diploma or certificate (e.g., some college or university), undergraduate degree or postgraduate or higher degree (Table 5).

School measures

School type

Principals reported school DEIS status at Wave 2 (DEIS: 26.3%, Non-DEIS: 73.7%).

School resources

School resources were assessed at Waves 1, 2, and 3 based on a composite index of four questions (each on a scale of 1–4) relating to principals' perception of the adequacy of school resources (see Appendix 1). A higher score indicated a perception of more adequate school resources. This measure of school resources had adequate internal consistency at Wave 1 (Cronbach's $\alpha = .6$).

Community measures

Household location

This was derived from an item in the primary caregiver questionnaire at Wave 1, which classified the household as rural (56.1%) or urban (43.9%).

Community safety

A measure of community safety was calculated at Waves 1, 2, and 3 based on a composite index derived from 6 items associated with perceived safety and risk in the community (Appendix 2). Scores range from 6 to 24, with a higher score indicating higher perceived safety. Internal consistency at Wave 1 was good ($\alpha = .7$).

Analysis strategy

We used LMMs (SPSS Version 26) to examine within- and between-person changes in math performance over time as a function of the modifiable factors. This method creates a two-level hierarchical model that nests time (Level 1) within participants (Level 2). LMM analysis overcomes the limitations of other statistical techniques by flexibly dealing with unbalanced data (listwise deletion due to inter-wave attrition, correlated data, and unequal sample size), common in studies involving longitudinal data (Shek & Ma, 2011).

Dichotomous scales were recorded as follows: gender (male = 0, female = 1), region (urban = 0, rural = 1), and DEIS status (yes = 0, no = 1), where 0 was the reference group in LMM analysis. All continuous variables were standardized across all three timepoints to have a mean of 0 and an SD of 1. In the two multi-level categorical variables, we used the largest category group as the reference group; for primary caregiver education level this was having completed secondary school, and for parental educational expectations for their child this was the child getting a university degree.

A series of LMMs using maximum likelihood estimation were fit to the data, in which math performance was modelled as a linear function of the modifiable factors over time. Intercepts (initial math performance level at Wave 1) and slopes (trajectories over time) were allowed to vary by participant. First, we ran an unconditional mean model to examine variation in math performance that exists in individuals without regard to time. We then ran an unconditional linear growth curve model to examine individual variation in math performance over time. Finally, we included all time-varying factors (SDQ total score, equivalized household annual income, primary caregiver education, parental educational expectations, perceived school resources, perceived community safety) and time-invariant factors (region [urban v. rural], school DEIS status, child self-concept intellectual and school subscale at Wave 1, child self-concept freedom from anxiety subscale at Wave 1, primary caregiver-child conflict at Wave 1, and secondary caregiver–child conflict at Wave 1). The last four factors were treated as time-invariant due to a measure not being available in all three waves. We included child gender as a time-invariant control variable; however, in a post-hoc sensitivity analysis, its exclusion did not significantly impact the pattern of results (see OSF). We used an unstructured covariance model as it offers the best fit when using longitudinal data and requires no assumption in the error structure (Shek & Ma, 2011).

A post-hoc power analysis was conducted using Soper's (2017) calculator for the LMM analysis. Sample size was based on the number of valid cases for each factor looking at within-person effects and between-person effects. Within-person power and between-person power were ≥90% to detect a significant effect ($p < .05$), except for level one of the categorical variable (parental educational expectations: less than secondary, where the number of valid cases was 50). As a result, we combined levels of parental educational expectations (combining options 'less than secondary' with 'secondary school') to ensure statistical power to detect an effect (see OSF for SPSS code and output).

RESULTS

The results of the unconditional mean model indicated that 45% of the total variation in math performance was due to interindividual differences. In the unconditional linear growth curve model, the mean estimated initial status ($\beta = -.84$; 95% CI: −0.88 to −0.8) and linear growth rate ($\beta = .31$; 95% CI: 0.27–0.33) were both significant ($\rho < 0.01$). The starting mean standardized math score was −0.84 and math performance improved over time.

In the final model, 6 of the 12 hypothesized factors predicted math performance ($\rho < 0.05$, Table 6). Attending a school without DEIS status was the strongest positive predictor, and the primary caregiver's education level (primary school or none) was the strongest negative predictor. When adolescents had more total difficulties on the SDQ, greater conflict with their primary caregiver, had a primary caregiver with less than a secondary school education, or their primary caregiver expected them to achieve

TABLE 6 Parameter estimates for the linear mixed model examining the relationship between the modifiable factors and math performance, controlling for gender.

	β	SE	*t*	*p*	95% CI
Modifiable factor					
Individual factors					
SDQ total difficulties[a]	−0.11	0.03	−4.16	**<.001**	−0.16, −0.06
Self-concept intellectual & school[a]	0.13	0.03	3.88	**<.001**	0.07, 0.2
Time*Intellectual & school	0.01	0.03	0.37	.72	−0.05, 0.07
Self-concept freedom from anxiety[a]	0.04	0.04	1.15	.25	−0.03, 0.11
Time*PH freedom from anxiety	−0.02	0.03	−0.67	.51	−0.08, 0.04
Family/household factors					
Equivalised income[a]	0.04	0.02	1.79	.07	−0.004, 0.09
Child-PCG conflict[a]	−0.09	0.04	−2.32	**.02**	−0.16, −0,01
Time*Child-PCG conflict	0.01	0.03	0.33	.74	−0.05, 0.07
Child-SCG conflict[a]	0.02	0.03	0.54	.58	−0.05, 0.08
Time*Child-SCG conflict	−0.01	0.03	−0.46	.65	−0.07, 0.04
Primary caregiver education					
Primary/none[b]	−0.20	0.09	−2.15	**.03**	−0.39, −0.02
Lower secondary[b]	−0.12	0.06	−2.15	**.03**	−0.23, −0.01
Some third level[b]	−0.03	0.05	−0.65	.52	−0.13, 0.07
Undergraduate degree[b]	0.08	0.06	1.39	.17	−0.04, 0.21
Postgraduate degree[b]	0.08	0.07	1.07	.29	−0.07, 0.23
Educational expectations for child					
Junior/Leaving cert[b]	−0.18	0.07	−2.4	**.02**	−0.32, −0.03
Apprenticeship[b]	−0.07	0.08	−0.9	.37	−0.23, 0.08
Diploma/certificate[b]	−0.09	0.07	−1.28	.20	−0.23, 0.05
Postgraduate[b]	0.02	0.04	0.37	.72	−0.07, 0.1
School factors					
Not a DEIS school[b]	0.16	0.07	2.28	**.02**	0.02, 0.3
Time*DEIS status	0.07	0.06	1.13	.26	−0.05, 0.2
School resources[a]	−0.002	0.02	−0.1	.92	−0.04, 0.035
Community factors					
Region (rural)[b]	0.04	0.06	0.56	.57	−0.09, 0.16
Time*Region	−0.01	0.05	−0.14	.89	−0.11, 0.09
Community safety[a]	0.03	0.02	1.32	.19	−0.03, 0.08

Note: Where a measure was not available in all three waves, the measurement at Wave 1 was used, and the factor was treated as time-invariant. Variables which significantly predict math performance are bolded.

Abbreviations: PCG, primary caregiver; SCG, secondary caregiver.

[a]Continuous variable. All continuous variables were standardised using a mean of 0 and an SD of 1. Thus, the reported difference in math performance corresponds with an increase of 1 SD in this variable.

[b]Categorical variable: The reference group was coded as zero for dichotomous categorical variables. For DEIS status Yes = 0, the result produced represented those in schools without DEIS status compared to those with DEIS status. For multivariate categorical variables, the largest category group was the reference group. In PCG education level, this was upper secondary/tech school. For parental educational expectations, the highest category group was undergraduate degree. Categories were compared to these for significance in relation to math performance.

a secondary school education or less, this was associated with worse math performance. Adolescents who felt self-confident in their intellect in school or who went to a non-DEIS school had better math performance (Figure 2).

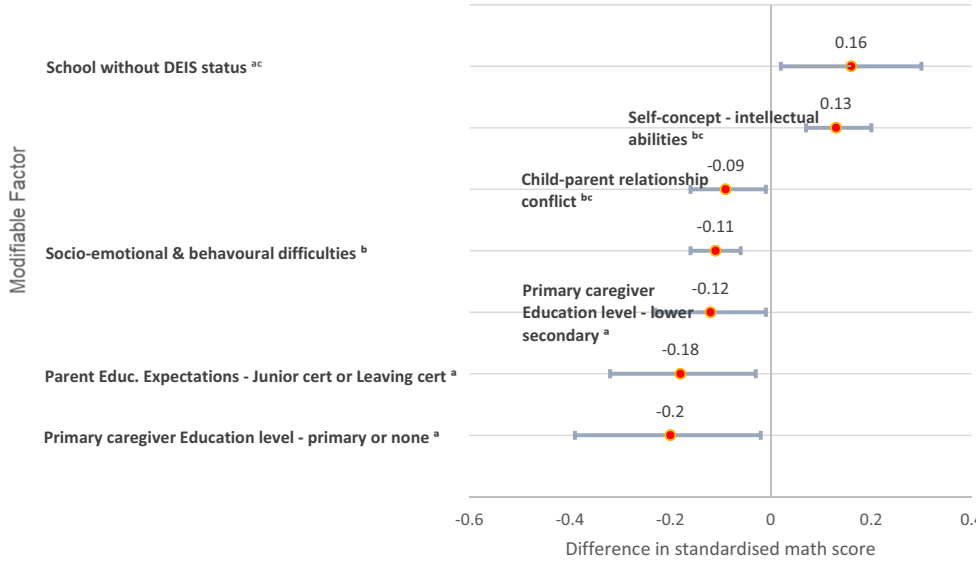

FIGURE 2 Parameter estimates for the modifiable factors significantly associated with mathematics performance, controlling for child gender. Parameter estimates of the difference in standardized math score and 95% CIs for the modifiable factors significantly associated with math performance, controlling for gender ($p < .05$). −2 Log Likelihood = 3823.73. [a]Categorical factor. For dichotomous categorical variables, the reference group was that which was coded as zero. For DEIS status Yes = 0; therefore, the result produced represented those in schools without DEIS status compared to those with DEIS status. For multivariate categorical variables, the largest category group was the reference group. In PCG education level, this was upper secondary/tech school. For parental educational expectations, the highest category group was degree. Categories were compared to these for significance in relation to math performance. [b]Continuous factor. All continuous variables were standardized using a mean of 0 and an SD of 1. Thus, the reported difference in math performance corresponds with an increase of 1 SD in the continuous variable. [c]Variable treated as time-invariant. For variables where a measure was only available in Wave 1, the reported difference in math performance corresponds here to a significant difference in children's starting point and is not a measure of concurrent effects.

Children who judged their intellectual and academic abilities more positively performed better in math at age 9; however, the trajectory of their math performance did not differ from the trajectory of children who viewed their intellectual and academic abilities less positively. What this means in practice is that children who judged their intellectual and academic abilities more positively have better mathematics ability at age 9 as compared to children who view their abilities more negatively, and that this pattern persists over time, with the difference maintaining to age 17/18 but not increasing or narrowing. Similarly, those who had more conflict with their primary caregiver had worse math performance at age 9, but they had the same trajectory of change in math performance as those with less conflict. Students attending a school without a DEIS status had significantly better math scores at age 9, although no difference in the trajectory of their math performance over time from students attending a DEIS school.

If the primary caregiver increased their education level during the study period from completing primary or lower secondary school to finishing secondary school, this was associated with increased adolescent math performance. Additionally, when primary caregivers changed their expectations for their child's academic attainment from completing secondary school or less to the expectation of completing an undergraduate degree, this was associated with significantly better adolescent math performance. Child self-concept (freedom from anxiety), child–secondary caregiver conflict, equivalized income, school resources, region, and perceived community safety were not significant predictors of math performance.

DISCUSSION

We aimed to identify the modifiable factors associated with mathematics achievement in children and adolescents facing socioeconomic adversity in Ireland. We find that there are aspects of adolescents' individual characteristics, household environment, and school environment which predict math performance, with school DEIS status and primary caregiver's education level accounting for the most variance in math performance. These factors are potential intervention targets for improving the academic resilience of young people living in poverty.

Regarding the child's characteristics, our results are in line with previous research linking self-concept (Alva, 1991; Cassidy, 2015) and socioemotional difficulties (Keilow et al., 2019; Kremer et al., 2016; Nelson et al., 2004) to academic resilience, with self-concept and socioemotional difficulties having a similarly sized effect. This association between socioemotional behavioural difficulties and math performance persists over time (Kremer et al., 2016). If a child's level of socioemotional and behavioural problems changes throughout their academic life, this may result in an associated change in math performance.

We found that children with a more positive belief in their intellectual and academic abilities at age 9 are better at math and that this difference persists – although does not increase – over time. One explanation for this association is that children are aware of their own abilities: they believe they are good at math because they are good at math. However, evidence suggests reciprocal effects occur between math self-concept and math achievement (Arens et al., 2017; Marsh & Martin, 2011). Low performance in math may diminish self-concept, and a negative self-concept may result in reduced effort to excel in math (Passiatore et al., 2023).

Family factors were particularly strongly associated with math performance: parental education expectations, parental education levels, and parent–child conflict were associated with math performance. In line with the meta-analyses by Jeynes (2005, 2007), parental educational expectations were among the strongest predictors of math performance. When parents expected their children to succeed academically, they did. As above, this may be that caregivers were aware of their child's abilities and calibrated their educational expectations accordingly, although note that we focused specifically on mathematics performance, whereas the educational expectation variable was not specific to mathematics. Parents' own increase in education was associated with improved adolescent math performance; in this, our findings mirror Magnuson (2007), who found a similar pattern in low-income families in the United States. Finally, when primary caregivers had more conflict with their child at age 9, the child had worse math performance. Secondary caregiver–child conflict, however, was not associated with child math performance. Together, these findings point to the potential importance of a primary caregiver's own education and their views of and relationship with a child for that child's math performance. Although this study cannot make causal links, these findings tentatively suggest that interventions which seek to promote academic resilience may be well served by helping the caregivers to enhance their parenting and further their education (Bryan, 2005; Bryan & Henry, 2008).

Contrary to our expectations based on other research (e.g., Greenwald et al., 1996), school resources were not significantly associated with math performance. It is possible other factors not included in this study, such as child–teacher relationships, may have offered greater insight into the impact of school-level factors on academic resilience (Li et al., 2022). Our findings are in line with those of the Department of Education and Skills (2017), suggesting that adolescents attending DEIS schools have worse math performance than those attending non-DEIS schools and that attendance at DEIS schools does not positively impact their trajectory of achievement.

Other research using the GUI data found that living in a rural area was the strongest predictor of academic resilience (Kong, 2020), but region was not a significant predictor of math performance in our study. This may be because we included many different predictors, and the variability in math performance was better explained by some of these other predictors. Alternatively, Kong's (2020) composite measure of socioeconomic adversity, using income, welfare dependency, and economic stress as well as

their focus on comparing low-SES to high-SES participants rather than within economically disadvantaged children may have resulted in different associations.

Limitations and future directions

This study has many strengths, including a large, nationally representative sample; following children and their caregivers over three timepoints from age 9 to 17/18 years old; the inclusion of potential modifiable factors at the individual, household, school, and community levels; direct assessments of math performance; and the inclusion of youth, caregiver, and principal perspectives. However, it has several limitations. *First*, while we have included the factors in the model as predictors of academic performance, the directionality of this relationship may be the opposite: math performance may predict self-concept or parents' educational expectations for their child, etc. *Second*, some of the variables were only available at one timepoint and so we could not look at how changes in those factors predicted changes in performance. Future studies would benefit from assessing modifiable factors at multiple timepoints. *Finally*, we used only one assessment of academic performance (math scores) and one measure of socioeconomic adversity (income). Future studies could compare results across income levels within this group to determine if the factors that enhance academic resilience vary depending on the poverty level experienced. Given the importance of and challenges associated with the transition from secondary school to work or further study – particularly for youth living in poverty (Byrne & McCoy, 2017; Leitch & Cownie, 2020), it would be useful to examine predictors of academic resilience in late adolescence.

CONCLUSION

Our findings underscore the importance of taking a multisystemic approach to academic resilience by targeting multiple internal and external factors operating at and interacting with various levels of the child's environment (Masten et al., 2021; Ungar & Theron, 2020). The resilience of a person goes beyond their individual characteristics and includes various factors that contribute to positive adaptation in the face of significant adversity (Ungar & Theron, 2020). Therefore, the processes, support, and resources influencing academic resilience can be addressed through various approaches at multiple levels of the child's environment.

Young people growing up in poverty face multiple challenges and their academic performance tends to be poorer than their wealthier peers; these differences in performance have proven challenging for interventions to close. In this study, we identified potentially modifiable factors at the individual, household, and school levels that are associated with math performance in children and adolescents experiencing poverty in Ireland. This adds to a growing body of work which suggests that academic resilience is dynamic and multisystemic, and it provides potential targets at multiple levels for programmes which aim to promote such resilience.

AUTHOR CONTRIBUTIONS

Jillian Sheehan: Conceptualization; investigation; writing – original draft; writing – review and editing; visualization; methodology; formal analysis; project administration. **Kristin Hadfield:** Supervision; project administration; writing – review and editing; formal analysis; methodology; conceptualization.

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CONFLICT OF INTEREST STATEMENT

There are no conflicts to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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APPENDIX A

Items used to calculate a measure of perceived school resources

Wave 1

The following four questions were coded in the raw data as follows:

1 = poor, 2 = fair, 3 = good, 4 = excellent, 8 = refusal, 9 = don't know; therefore, a higher score indicates higher perceived adequacy of school resources. Eight and nine were treated as missing data points.

- 14a. How adequate – no. of teachers.
- 14b. How adequate – no. of classrooms.
- 14c. How adequate – books and worksheets.
- 14m. How adequate – Learning support provision.

Waves 2 and 3

Same as above except 14c. was replaced with "How adequate – Computer facilities/IT".

APPENDIX B

Items used to calculate a measure of community safety

Wave 1

The following three questions in the raw data were coded as follows:

1 = very common, 2 = fairly common, 3 = not very common, 4 = not at all common, 8 = refusal, 9 = don't know, therefore a higher score indicates a safer community.

- M2b. How common in your area: homes and gardens in bad condition.
- M2c. How common in your area: vandalism.
- M2d. How common in your area: people being drunk/taking drugs?

The following three questions in the raw data were coded as follows:

1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree, 8 = refusal, 9 = don't know, therefore a lower score indicates a safer community.

- M3a. Safe to walk alone in this area after dark.
- M3b. Safe for children to play outside during the day.
- M3c. There are safe parks, playgrounds and play spaces.

The last three were recoded so that a higher score indicated higher safety.

The results of the six questions were then summed to give a total safety score out of a max of 24. Eight and nine were considered missing data points.

Waves 2 and 3

Same as above except M3c was replaced with "There are places in this area where teenagers can safely hang out."