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# Impact of child socioemotional and cognitive development on exam results in adolescence: findings from the UK Millennium Cohort Study

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## ABSTRACT

**Background** Cognitive ability and socioemotional behaviour during childhood have independently been shown to impact educational outcomes. The extent to which their co-development predicts these outcomes remains unclear. This study aimed to assess associations between concurrent cognitive and socioemotional development trajectories in childhood and exam results at age 16 years.

**Data and method** We analysed longitudinal data on 9084 children from the UK Millennium Cohort Study. Exposure trajectories of cognitive and socioemotional development from age 3 to 14 years were characterised using group-based multi-trajectory models. We used logistic regression to assess associations between these development trajectories and exam attainment, measured by passing five or more GCSE subjects at age 16, adjusting for confounders. Population-attributable fractions were calculated to quantify the contribution of cognitive and socioemotional problems to poor educational outcomes.

**Results** Compared with the 'no problem' trajectory group, the odds of not achieving a standard pass in GCSE was 2.5 times higher for the 'late socioemotional problems' trajectory group (adjusted OR 2.5, 95% CI 2.1 to 3.1) and four times higher for the 'early cognitive and socioemotional problems' trajectory group (adjusted OR 4.2, 95% CI 3.4 to 5.3). The OR was highest for the trajectory group with persistent cognitive and socioemotional problems (adjusted OR 4.4, 95% CI 3.3 to 5.8). Approximately 17% of poor exam results in adolescence were attributable to cognitive and socioemotional behaviour problems in childhood (adjusted population-attributable fraction 17%, 95% CI 15% to 19%).

**Conclusion** In a representative UK cohort, adverse development of cognitive and socioemotional behaviour in childhood was associated with a negative impact on exam results in adolescence, more so when the adverse development co-occurs or clusters early or persistently. Cross sector health and education policy that invests in reducing cognitive and socioemotional behaviour problems in children has the potential to improve educational outcomes in adolescence.

## INTRODUCTION

Improving education is a key strategy to improve health and reduce socioeconomic inequity.<sup>1</sup> Investing in education is an investment in health, with the benefits of years of schooling on reduced

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Cognitive and socioemotional behaviour co-occur or cluster together in childhood and are associated with poorer health in adolescence.
- ⇒ Cognitive ability and socioemotional behaviour, during childhood, have independently been shown to impact educational and school outcomes, but clustered impacts are unclear.

## WHAT THIS STUDY ADDS

- ⇒ Adverse co-development of cognitive ability and socioemotional behaviour in childhood is associated with poor exam results in adolescence. Assuming casual links, 17% of poor exam results in adolescents are attributable to cognitive and socioemotional behaviour problems in childhood.
- ⇒ The odds of not passing GCSEs are four times higher for children in whom adverse cognitive and socioemotional development co-emerge early or are persistent throughout childhood compared with those without adverse development.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

- ⇒ This study underscores the need for cross-sector health and education policy and targeted interventions to support redressing cognitive and socioemotional behaviour problems in children, particularly where they co-occur, as this may improve exam success and health in adolescence.

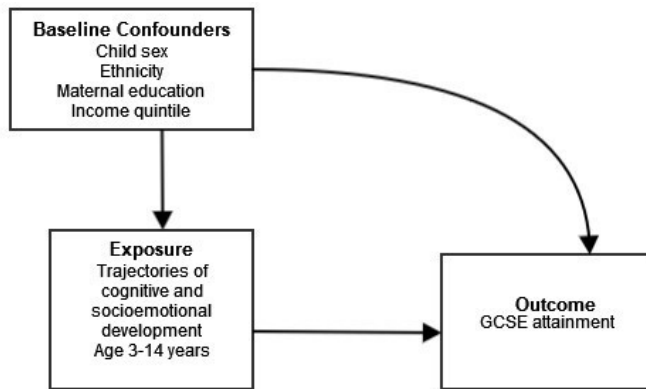
mortality being similar to public health interventions targeting diet, physical activity, smoking and alcohol consumption.<sup>2</sup>

There are stark and increasing inequalities in educational outcomes in England. The difference in average English and Maths GCSEs (General Certificate of Secondary Education) at age 16 years, between children who are eligible for free school meals and those who are not, is at the highest level in over a decade. The most recent results in 2023 highlight that those on free school meals achieve half a grade lower than their peers who are not on free school meals.<sup>3</sup> Tackling disadvantage through education is an opportunity to improve life outcomes for children and to improve health, as education has a greater effect on health in those



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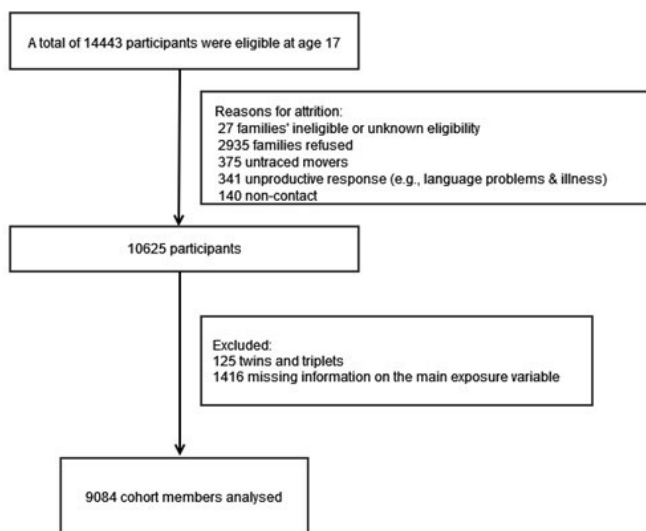


**Figure 1** Directed acyclic graph (DAG) for the current study.

born to poorly educated parents than on those born to better educated parents.<sup>4</sup>

Years in school matter, not just for exam results, but for skills and capacity development. It is this development which informs employment, economic well-being, social support and health behaviours, all of which ultimately affect health.<sup>5 6</sup> Additionally, exam results at age 16 improve financial, occupational and social-emotional outcomes in early adulthood, independent of later educational attainment, further supporting the importance of skills development in school.<sup>7</sup> This highlights the opportunity that schooling provides in and of itself, not just as a gateway to further educational attainment. Indeed, this is what organisations, policy makers and government focus on as there are tangible differences in future well-being and prosperity for those who fare well at school compared with those who do not.

If we are to reduce socioeconomic inequity through education in school, we need to consider skills and capacity development and exam results as both impact on later health, economic and well-being outcomes. Children's development comes before exam results, for example cognitive and socioemotional skills development, and continues throughout school. Better understanding of the relationship between these antecedent developmental attributes and exam results is important as it is these skills that enable children to learn while also embedding skills for later health gains.<sup>5</sup>



**Figure 2** Study flow diagram showing inclusion and exclusion of cohort participants.

There is evidence from the UK Millennium Cohort Study that cognitive and socioemotional behaviour co-occur or cluster together negatively impacting later health,<sup>8</sup> but impacts on education are unclear. We found that trajectories of persistent cognitive and socioemotional problems and late-onset socioemotional problems in childhood were strongly associated with overweight and mental ill-health in adolescence, with socioemotional development an important driver of adverse health.<sup>8</sup> Indeed, prior longitudinal cohort studies have shown that cognitive ability and socioemotional well-being, as separate attributes, may impact educational and school outcomes.<sup>9 10</sup> However, the extent to which their co-development predicts educational outcomes needs further investigation.

Understanding the impact of the co-occurrence of cognitive and socioemotional development across the childhood developmental stages on later educational outcomes could help inform both health and educational sectors to reduce inequity by targeting policy at different stages and levels of children's development. Therefore, this study aimed to build on our previous work by assessing the impact of concurrent cognitive and socioemotional development trajectories in childhood on exam results at age 16 years in a UK cohort.

## METHODS

### Study settings and participants

This longitudinal study used data from the Millennium Cohort Study (MCS). The MCS is a nationally representative UK population-based cohort study, tracking the lives of over 18 000 children born between September 2000 and January 2002, and followed over time (age 9 months, 3, 5, 7, 11, 14 and 17 years). The respective numbers of responding families at each wave were 18 552, 15 590, 15 246, 13 857, 13 287, 11 726 and 10 625. At each wave, information on a variety of topics, including socioeconomic circumstances, family structure, health, behavioural and cognitive development, were collected on cohort members from the primary caregiver, usually the child's mother. At age 17 years, parental involvement was minimal; cohort members provided information on a wide range of domains such as employment, qualification and education attainment. Detailed information on the survey design, sampling and the scope of the MCS is detailed elsewhere.<sup>11</sup> Ethical approval was gained from NHS Multi-Centre Research Ethics Committees.

### Exposures

The main exposures were longitudinal trajectories of cognitive and socioemotional development defined by Black *et al* in our previous work.<sup>8</sup> In this prior work, we identified four child cognitive and socioemotional development trajectory groups experienced by UK children from age 3 to 14 years, established using a group-based trajectory modelling approach.<sup>12</sup> Socioemotional behaviour was measured using the Strengths and Difficulties Questionnaire, completed by the parent when cohort members were age 3, 5, 7, 11 and 14 years. Cognitive development was measured from the results of standard cognition tests administered individually to cohort members at ages 3, 5, 7, 11 and 14 years. For both measures, children were classified into two groups to create binary categories using the validated cut-offs (for full details of the measures and trajectories, see online supplemental file 1 and 2). The four identified child developmental trajectories, based on predicted probabilities, were 'no problems' (76.5%); 'late socio-emotional problems' (10.1%); 'early cognitive and socioemotional problems' (8.6%); and 'persistent cognitive and socioemotional problems'

**Table 1** Sample descriptions

	Standard GCSE		Strong GCSE	
	Passed (n=6200)	Not passed (n=2884)	Passed (n=5464)	Not passed (n=3620)
<b>Trajectories of socioemotional and cognitive development</b>				
No problems	5323 (75.3)	1750 (24.7)	4730 (66.9)	2343 (33.1)
Late socioemotional problems	423 (50.0)	423 (50.0)	360 (42.6)	486 (57.4)
Early cognitive and socioemotional problems	345 (44.9)	423 (55.1)	281 (36.6)	487 (63.4)
Persistent cognitive and socioemotional problems	109 (27.5)	288 (72.5)	93 (23.4)	304 (76.6)
<b>Child's sex</b>				
Male	2808 (65.4)	1486 (34.6)	2489 (58.0)	1805 (42.0)
Female	3202 (71.5)	1274 (28.5)	2824 (63.1)	1652 (36.9)
Missing	190 (60.5)	124 (39.5)	151 (48.1)	163 (51.9)
<b>Maternal ethnicity</b>				
White	4964 (68.3)	2307 (31.7)	4443 (61.1)	2828 (38.9)
Mixed	55 (61.1)	35 (38.9)	44 (48.9)	46 (51.1)
Indian	200 (79.7)	51 (20.3)	168 (66.9)	83 (33.1)
Pakistani and Bangladeshi	459 (66.2)	234 (33.8)	371 (53.5)	322 (46.5)
Black or Black British	197 (70.4)	83 (29.6)	166 (59.3)	114 (40.7)
Other ethnic group	123 (73.7)	44 (26.3)	111 (66.5)	56 (33.5)
Missing	202 (60.8)	130 (39.2)	161 (48.5)	171 (51.5)
<b>Maternal education</b>				
Degree plus	1563 (82.9)	323 (17.1)	1470 (77.9)	416 (22.1)
Diploma	635 (74.8)	214 (25.2)	565 (66.5)	284 (33.5)
A-levels	680 (74.0)	239 (26.0)	611 (66.5)	308 (33.5)
GCSE A–C	1846 (66.4)	933 (33.6)	1585 (57.0)	1194 (43.0)
GCSE D–G	434 (55.3)	351 (44.7)	366 (46.6)	419 (53.4)
None	842 (55.0)	690 (45.0)	709 (46.3)	823 (53.7)
Missing	200 (59.9)	134 (40.1)	158 (47.3)	176 (52.7)
<b>Household income quintile</b>				
Lowest quintile	812 (51.1)	776 (48.9)	695 (43.8)	893 (56.2)
Second quintile	1042 (59.6)	706 (40.4)	876 (50.1)	872 (49.9)
Third quintile	1205 (71.3)	486 (28.7)	1053 (62.3)	638 (37.7)
Fourth quintile	1415 (78.1)	396 (21.9)	1268 (70.0)	543 (30.0)
Highest quintile	1520 (79.8)	385 (20.2)	1408 (73.9)	497 (26.1)
Missing	206 (60.4)	135 (39.6)	164 (48.1)	177 (51.9)

(4.8%).<sup>8</sup> ‘Late’ problems represent a trajectory group whereby problems in socio-emotional behaviour start to emerge from age 7 years. ‘Early’ problems represent a trajectory group whereby problems in both socioemotional and cognitive development are more apparent between the ages of 3 and 7 years. ‘Persistent’ represents a trajectory group whereby problems in both aspects of development are apparent from age 3 to 14 years. ‘No problems’ represents a trajectory group with no apparent problems in either aspect of development between the ages of 3 and 14 years.

### Outcome

The variable was education attainment at age 17. We measure education attainment using the GCSE and equivalent outcome for comparable examination. In England and Wales, students are required to take a minimum of five GCSE subjects at the end of secondary education.<sup>13</sup> The international GCSE (iGCSE), the National 4 and 5 examinations in Scotland, and level 1 and 2 of the BTEC (Br) are comparable attainments to the GCSE.<sup>14 15</sup> Cohort members sat their GCSE and similar examinations in 2017 and self-reported their grades when interviewed in 2018 (wave 7). The primary outcome is the standard GCSE pass, which we defined as cohort members who passed five or more GCSE subjects. Standard pass is defined as achieving a grade 4

in both English and Maths, and A\*–C in any three or more additional GCSE subjects.<sup>16</sup> The secondary outcome is the strong GCSE pass, defined as achieving a grade 5 in English, Maths and three other subjects. We categorised participants as ‘not passed’ (coded 1), if they failed to achieve a standard or strong GCSE pass, and the reference group are cohort members who achieved a standard or strong pass (coded 0).

### Confounders

Key confounders included child sex, maternal education level (degree or higher, diploma, A-levels, GCSE A–C, GCSE D–G, or no qualifications), maternal ethnicity (white, mixed, Indian, Pakistani and Bangladeshi, Black or Black British, or other ethnic groups), and income quintile at baseline. These variables were selected based on their association with the exposures and outcome, guided by a directed acyclic graph (figure 1).

### Analytical strategy

First, we characterised the trajectories of cognitive and socio-emotional development from ages 3 to 14 years using group-based multi-trajectory models with the ‘*traj*’ procedure in Stata (18.5) (see online supplemental file 2). Second, percentages

(%) were used to describe the sample characteristics. Third, we assessed the association between the four identified trajectory groups and educational outcomes using logistic regression models with 95% CIs. Two models were constructed: Model 1, the unadjusted model, and Model 2, the adjusted model. Both models used longitudinal weights to account for response bias, attrition and sampling design. Fourth, we applied population-attributable fraction (PAF)<sup>17</sup> to estimate the proportion of educational outcomes that could be improved if exposure to cognitive and socioemotional behavioural problems were eliminated or reduced to the levels of children in the no problem trajectory group (see online supplemental file 3 for more details on the model specification).

For robustness of our results, we conducted a number of additional analyses. We account for uncertainty that may arise in the trajectory group membership using the Vermunt<sup>18</sup> three-step approach. Also, we account for missing covariates by re-estimating the covariates-adjusted analyses using multiple imputation by chained equation (30 imputed data sets) with results pooled using Rubin's rules.<sup>19</sup> Statistical analyses were performed using Stata (version 18.5).

## RESULTS

Of the 14 443 families who were eligible at age 17 (wave 7), 9084 families were analysed (figure 2). Table 1 summarises the characteristics of the cohort participants by their GCSE attainment. A higher percentage of children who did not experience socioemotional and cognitive development problems passed their GCSEs. Conversely a lower proportion of children passed in each of the adverse development trajectory groups. The distribution of the participants by sex shows that more female cohort members passed their GCSEs, while there are more male participants who did not pass. The proportion of children who passed GCSEs increased as socioeconomic factors of maternal education and income level increase.

### Association between cognitive and socioemotional behaviour trajectories and GCSE outcomes

We present the estimated results for the association between the development trajectories and GCSE outcomes in

Table 2 and figure 3. The baseline and adjusted models indicate that the three adverse developmental trajectory groups were significantly associated with poor GCSE attainment, with associations slightly attenuated by confounders. The odds of not achieving a standard GCSE pass was 2.5 times higher for the 'late socioemotional problems' group (adjusted OR (aOR) 2.5, 95% CI 2.1 to 3.0) and four times higher for the 'early cognitive and socioemotional problems' group (aOR 4.2; 95% CI 3.4 to 5.3), compared with the 'no problem' group. The estimated OR, adjusted for confounders, was highest for the group with persistent cognitive and socioemotional problems at aOR 4.4 (95% CI 3.3 to 5.8).

Similarly, the estimated adjusted odds of not achieving a strong GCSE pass are higher across the three adverse developmental trajectory groups compared with the group with no cognitive and socioemotional behaviour problems. The estimated odds are more than twice higher for the cohort members with late socioemotional problems (aOR 2.3; 95% CI 2.0 to 2.8), and 3.4 and 3.3 times higher respectively for the group with early (aOR 3.4; 95% CI 2.7 to 4.3) and persistent (aOR 3.3; 95% CI 2.5 to 4.5) cognitive and socioemotional behaviour problems. Overall, the estimated odds attenuated after adjusting for the confounding factors. Nonetheless, this did not lead to a significant reduction

**Table 2** ORs (95% CIs) between multi-development trajectories and education attainment at age 17 in the UK Millennium Cohort Study

	Model 1		Model 2	
	Estimate	PAF	Estimate	PAF
<b>Outcome: did not achieve standard GCSE pass</b>				
Trajectories of socioemotional and cognitive development (reference: no problems)				
Late socioemotional problems	3.1 (2.6 to 3.7)	8% (6% to 9%)	2.5 (2.1 to 3.0)	6% (6% to 8%)
Early cognitive and socioemotional problems	5.1 (4.2 to 6.2)	7% (6% to 8%)	4.2 (3.4 to 5.3)	6% (5% to 7%)
Persistent cognitive and socioemotional problems	6.8 (5.2 to 8.9)	6% (5% to 7%)	4.4 (3.3 to 5.8)	4% (3% to 4%)
Total PAF		21% (19% to 23%)		17% (15% to 19%)
<b>Outcome: did not achieve strong GCSE pass</b>				
Trajectories of socioemotional and cognitive development (reference: no problems)				
Late socioemotional problems	2.8 (2.3 to 3.3)	6% (5% to 7%)	2.3 (2.0 to 2.8)	5% (4% to 6%)
Early cognitive and socioemotional problems	4.3 (3.5 to 5.2)	5% (4% to 6%)	3.4 (2.7 to 4.3)	4% (3% to 5%)
Persistent cognitive and socioemotional problems	5.2 (3.9 to 6.9)	4% (3% to 4%)	3.3 (2.5 to 4.5)	3% (2% to 3%)
Total PAF		15% (13% to 16%)		11% (9% to 13%)
Model 1 is the baseline model and Model 2 adjusts for confounders including child sex, maternal ethnicity and education, income quintile. The PAF column shows the proportional reductions in cohort members who did not achieve GCSE pass if they experienced no developmental problems. The PAF is calculated comparing two scenarios: scenario 1 (a hypothetical scenario in which all children were in the no problem trajectory) with scenario 0 (the real world in which there are children in no problem group and other trajectories). The reference group is the no problem trajectory group. PAF, population-attributable fraction.				

in the estimates and the associations when compared with the crude model.

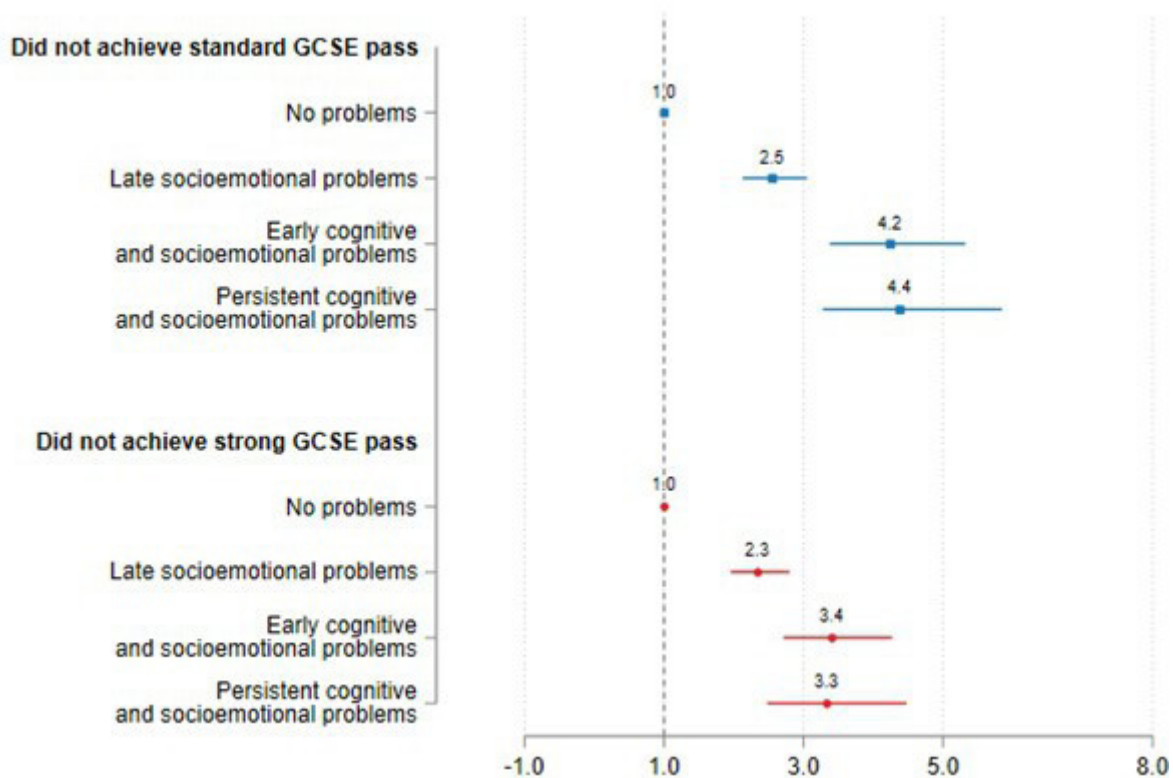
Table 2 further shows the burden of poor educational outcomes attributable to each trajectory group using population-attributable fractions, which assumes a cause-effect relationship. Overall, the identified exposure trajectories contributed to the burden of poor exam results. For example, about 17% of adolescents who did not achieve a standard GCSE pass (adjusted PAF 17%; 95% CI 15% to 19%) were attributable to cognitive and socioemotional behaviour problems in childhood.

The sensitivity analysis to account for the uncertainty in the trajectory class membership also showed similar results to the main estimation after including the adjusted weights following the three-step approach<sup>18</sup> (online supplemental file 4a). The additional analyses using the imputed data for the missing covariates showed similar patterns of associations between the development trajectories and GCSE performance as in the main analysis (online supplemental file 4b).

## DISCUSSION

Using the Millennium Cohort Study, a large nationally representative cohort sample of UK children, we showed that when socioemotional and cognitive development are studied concurrently, throughout childhood, adverse development that emerges late, early or is persistent is associated with poor educational outcomes at age 16 years. We quantified that 17% of poor exam





**Figure 3** Adjusted OR of GCSE attainment across developmental trajectories.

results in adolescence were attributable to adverse cognitive and socioemotional development in childhood, if causality is assumed.

Reducing cognitive and socioemotional behaviour problems which co-occur during childhood has the potential to improve educational outcomes in adolescence. Our findings indicate that problems in either aspect of development is associated with poor educational outcomes, but more so when they co-occur or cluster together in early childhood or are persistent throughout childhood. Investigating the co-development of cognitive ability and socioemotional behaviour is important as children develop holistically with evolving needs over time shaped by socioeconomic context.<sup>20</sup> Our analysis adds to existing evidence on the impact of these individual aspects of development on educational outcomes,<sup>9 10</sup> highlighting that a joint approach between the health and education sectors is needed to prevent and redress the potential effect of clustered adverse development on later exam success and indeed inequalities in exam success.

We know from our previous work that the adverse development trajectory groups are socially patterned,<sup>8</sup> in terms of neighbourhood deprivation, maternal education and maternal mental health. In sum, children from more disadvantaged backgrounds are more likely to be in an adverse development trajectory group and our results highlight the associations with subsequent poorer educational attainment. Therefore, addressing the wider determinants of education should form part of any strategy that seeks to reduce socioeconomic inequity in education outcomes for children and adolescents. Policy action which invests in the early years, promotes a positive home learning environment, and addresses child poverty through social and economic reform are broad reaching and warrant attention from a life course investment lens.

In addition to policy action to reduce the number of children living in disadvantage there is also a need for action that mitigates

the effect of disadvantage on educational outcomes. Our analysis highlights that when factors associated with disadvantage are accounted for, the relationship between adverse development and poor educational outcomes remains, although slightly attenuated, akin to Morris *et al*<sup>21</sup> who found that cognitive ability has a greater influence than socioeconomic background on educational outcomes. This highlights the potential benefit of further resourcing the education sector to intervene and support both cognitive and socioemotional development throughout the primary school years, which may improve educational outcomes for children from disadvantaged backgrounds.

Earlier we highlighted the role of education as a tool to reduce socioeconomic inequity in health, with skills development a key part of this pathway.<sup>5 6</sup> Drawing on our research, which demonstrated that children on a positive skills development path (no cognitive and socioemotional problems during childhood) are associated with better education (and health<sup>8</sup>) outcomes in adolescence than those with problems, suggests there is value in viewing and framing investment in childhood education as an investment in long-term health. We show that emergent positive development in childhood is antecedent to associated exam success in adolescence, which in turn leads to later prosperity and good health and well-being as an adult.<sup>7</sup>

Further our results suggest an alternate policy approach to social mobility. Rather than focus on getting the highest ability children out of poverty through harnessing that ability to reach the highest levels of educational attainment such as university degrees,<sup>22</sup> our results support reducing adverse development in all children regardless of level of ability. We show that adverse development (independent of socioeconomic disadvantage) is associated with poorer exam success in adolescence. Evidence shows that exam results at age 16, regardless of further educational attainment, are associated with better financial and occupational outcomes.<sup>7</sup> Hence focusing on the antecedent

development which is associated with adolescent exams may provide an opportunity for social mobility.

Another policy implication is the need to move away from siloed child health and education policy<sup>23</sup> to cross sector policy development, recognising the interdependent and interconnected nature of these two major determinants of children's futures. Sectors working together, for example through greater support from the health sector to improve socioemotional behaviour in schools and further resourcing from both sectors in addressing developmental problems, may reap greater rewards and the biggest beneficiaries will be children who were born into disadvantage.

As with any observational study, we cannot determine causality of the relationships between development trajectory and exam outcomes as we could not control for unknown confounders. More causally informed analyses are needed to better understand these associations. Our results are strengthened as we used the largest and most contemporary UK cohort and as such the findings are generalisable to UK policy. The strengths and limitations of the modelling technique used are discussed in our previous paper whereby the trajectories of development were derived.<sup>8</sup>

## CONCLUSION

In a representative UK cohort, adverse development of cognitive and socioemotional behaviour in childhood was associated with a negative impact on exam results in adolescence. Cross sector health and education policy which focuses on reducing cognitive and socioemotional behaviour problems in children, particularly when they co-emerge early or are persistent, has the potential to improve educational outcomes in adolescence.

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**Contributors** MB, LA, and NKA led the drafting of the manuscript. LA, MB, and NKA led the statistical analyses. LA and NKA contributed to the conception of the study, study design, and analysis plan. All authors contributed to the interpretation of results and critically reviewed the manuscript for intellectual content. MB, NKA, and LA accessed and verified the underlying data, and all authors had access. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. MB is responsible for the overall content (as guarantor).

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**Ethics approval** Ethical approval for the Millennium Cohort Study was sought from a UK National Health Service research ethics committee before each survey. Written consent was obtained from all participating parents at each survey; MCS1: South West MREC (MREC/01/6/19); MCS2 and MCS3: London MREC (MREC/03/2/022, 05/MRE02/46); MCS4: Yorkshire MREC (07/MRE03/32); MCS5: Yorkshire and The Humber-Leeds East (11/YH/0203); MCS6: London MREC (13/LO/1786), MCS7: REC North East–York (REC ref: 17/NE/0341). This study did not require additional ethical approval.

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**Data availability statement** All data relevant to the study are included in the article or uploaded as supplementary information. Millennium Cohort Study is available via the UK Data Archive. Further information about the study is found at <https://cls.ucl.ac.uk/cls-studies/millennium-cohort-study/>.

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