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Writing hand preference and child mental health in the general population: Findings from the Millennium Cohort Study

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ABSTRACT

Non-right-handed individuals appear to face greater risks for some psychiatric disorders than those right-handed. Whether an analogous association exists in the general child population and for whom (non-right-handed, left-handed, or mixed-handed children) is unclear. To fill these gaps, we used data from 7,951 children (49.48% girls) of the UK's Millennium Cohort Study. The parent-reported Strengths and Difficulties Questionnaire (SDQ) subscales measured mental health difficulties: emotional, conduct, hyperactivity/inattention, peer difficulties, and prosocial behaviour, at ages 3, 5, 7, 11, and 14 years. Handedness (writing hand preference: right/left/either hand) was self-reported at 14 (a retrospective measure). Adjusted growth curve models explored the association between children's handedness and SDQ trajectories across 3–14. Non-right-handed (left-handed and mixed-handed) children exhibited elevated hyperactivity/inattention symptoms compared to those right-handed, with the association becoming nonsignificant after excluding the mixed-handed. Sex-stratified models did not show any association for girls. Among boys, the non-right-handed, compared to the right-handed, had higher hyperactivity/inattention and peer difficulties scores, though not after excluding the mixed-handed group. All effects were very small. Results suggest that left-handedness is not conferring risk for mental health in the general child population. Mixed-handed children, particularly boys, may face greater risks for social difficulties and hyperactivity/inattention, but effects were very small.

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KEYWORDS Growth curve models; handedness; mental health trajectories; Millennium Cohort Study

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Introduction

Handedness is an umbrella term describing an individual's relative hand skill (strength, speed, and/or accuracy of hand use), as well as their hand preference (i.e., the individual's preference of hand to use; Scharoun & Bryden, 2014). Regarding the reasons underlying the development of handedness, twin studies have shown that genetic effects account for around 25% of the variance, with the remaining attributed to non-shared environmental influences (Cuellar-Partida et al., 2021; De Kovel et al., 2019; Medland et al., 2009; Ocklenburg et al., 2025). While handedness starts to emerge prenatally, at 10–12 weeks (Hepper, 2013), it does not get fully established until the early primary school years (around 6 years of age; Scharoun & Bryden, 2015). Most of the population is right-handed, around 10.6% are left-handed, and 9.3% are mixed-handed (i.e., showing inconsistent hand preference for tasks), including the ambidextrous (Papadatou-Pastou et al., 2020). Ambidextrous individuals (those using both hands equally well) are a very small group; estimated prevalence is 1–3% (Cuellar-Partida et al., 2021). Being left-handed or mixed-handed is seen more frequently in males than females (Cuellar-Partida et al., 2021; Papadatou-Pastou et al., 2020).

The link between handedness and psychiatric or neurodevelopmental disorders has received much interest, with the existing evidence suggesting that, compared to the right-handed, non-right-handed (left-handed and ambidextrous/mixed-handed) individuals may be facing higher risks for some psychiatric or neurodevelopmental disorders (Borawski et al., 2023; Markou et al., 2017; Nastou et al., 2022). The strength of this link, however, seems to vary by type of disorder and classification of handedness. For instance, a meta-analysis by Nastou et al. (2022) showed that non-right-handedness (but not left-handedness or mixed-handedness) is overall more common in people with attention-deficit/hyperactivity disorder (ADHD) compared to neurotypical individuals. A more recent second-order meta-analysis (Packheiser et al., 2025) revealed that hand preference was not linked at all to depression, but atypical hand preference patterns appeared more frequently in individuals with schizophrenia, or neurodevelopmental conditions, compared to the rest of the population. It also concluded that left-handedness (but not mixed-handedness) was associated with an earlier age at onset of disorder (Packheiser et al., 2025).

While the reasons behind such associations are not yet clear, it seems that genetic mechanisms may underlie the development of both handedness and certain mental health disorders, such as schizophrenia and bipolar disorder (Cheng et al., 2020; Cuellar-Partida et al., 2021). Atypical brain lateralization, observed in both non-right-handedness and many mental health and neurodevelopmental conditions, is further evidence of a common link (Irani et al., 2023; Li et al., 2023). Another possibility is that non-right-handed individuals encounter more daily challenges, leading to increased stress, which could negatively impact their well-being and thus affect their mental health (Wagner et al., 2016). Although everyday frustrations affecting well-being cannot be presumed to be causes for severe neurodevelopmental or mental health conditions, there is frequently a bidirectional relationship between poor well-being and symptoms of disorder, a link particularly important at population-level (Thakur et al., 2025).

Studies examining the mental health of children or adolescents by handedness indicate that mental health differences between the right-handed and the non-right-handed are small (Irani et al., 2023; Rodriguez et al., 2010; van der Hoorn et al., 2010). When exploring these associations at general-population level, whereby youth mental health is frequently approximated by internalizing and externalizing difficulties (Achenbach & Edelbrock, 1978), differences tend to be smaller and less consistent. For example, in a sample of approximately 8,000 cases, Rodriguez and Waldenström (2008) explored the association of handedness with child internalizing and externalizing difficulties using the Strengths and Difficulties Questionnaire (SDQ), a symptoms-based assessment tool. ADHD symptoms were additionally measured with an 18-item list based on DSM-IV. In covariate-adjusted models these researchers showed that mixed-handed children presented more ADHD symptoms (especially inattention) at 16 years than their right-handed counterparts. Interestingly, no such differences were observed when comparing right-handed to left-handed children, or the right-handed to the non-right-handed (left-handed and mixed-handed together). Moreover, using Child Behavior Checklist scores of 2,096 adolescents, van der Hoorn et al. (2010) concluded that the non-right-handed were more likely to experience emotional and social difficulties, as well as psychotic symptoms. However, there was no influence of handedness on conduct and hyperactivity difficulties. Similarly, in a sample of 64 primary school children, Irani et al. (2023) found that left-handed children had increased emotional and social difficulties (measured with the SDQ), but there were no differences for conduct and inattention difficulties. In all these studies, effects sizes were very small.

Together, these studies suggest that handedness may have a small and likely complex association with internalizing and externalizing difficulties in the general youth population. For example, it is not clear if handedness is primarily linked to internalizing (emotional and social) or externalizing (conduct and hyperactivity/inattention) difficulties. Furthermore, it is uncertain if it is the left-handed, the mixed-handed, or both groups of non-right-handed children, who are mostly affected. Drawing from the existing research, it seems that left-handed and mixed-handed children may be at risk for different types of difficulties, but further investigation using large samples, especially given the low prevalence of mixed-handedness and, particularly, ambidexterity in the general population, is needed. Should a relationship between handedness and child mental health in the general population exist, then one would be able to identify which children may be most vulnerable to which risks, thus targeting support.

This study aimed to address this gap using longitudinal data from the UK's Millennium Cohort Study (MCS), a large birth cohort. Given the inconsistencies in the existing research findings regarding hand preference and youth internalizing/externalizing difficulties in the general population (i.e., are left-handed, mixed-handed, or non-right-handed children more at risk, and for what type of difficulties), this study was exploratory and did not draw any prior hypotheses. MCS, a large general-population sample, included data on writing hand preference and tracked children's specific mental health difficulties (measured by internalizing and externalizing symptoms on the SDQ) over time. It over-sampled children and families from minority groups, aiming to represent the whole of the UK population and increase research findings' generalizability. Importantly, its longitudinal design allowed us to examine children's internalizing and externalizing trajectories from the early years until adolescence. In this way, we could identify at what point differences (if any) by handedness emerge and how they develop.

Methods

Participants

We analysed data from the UK's MCS (https://www.cls.ioe.ac.uk/mcs), an ongoing birth cohort survey, including information on 19,243 UK families (19,517 children) who had a child born in 2000–2002. To ensure that UK minority groups and disadvantaged areas were sufficiently represented, participating families had been disproportionately selected (Plewis, 2007). Currently, MCS includes data from 7 data waves ("sweeps"), conducted when the children were aged 9 months, and 3, 5, 7, 11, 14, and 17 years old, respectively. A total of 18,552 families were involved in sweep 1, 15,590 in sweep 2, 15,246 in sweep 3, 13,857 in sweep 4, 13,287 in sweep 5, 11,726 in sweep 6 (when handedness was measured in MCS), and finally, 10,625 in sweep 7. This study included data from sweeps 2–6 (child ages 3–14). Ethical approval for MCS has been obtained from NHS Multi-Centre Ethics Committees, parents gave informed consent, and children themselves gave their assent at age 11 and their consent at age 14. A total of 7,951 children (49.48% girls) met the following criteria, and were therefore included in our study (referred to as the "analytic sample"):

(1) were either a singleton or a first-born twin or triplet
(2) reported their handedness
(3) had data on covariates, measured at baseline (more details under "key covariates").

The remaining 11,292 children of the MCS who did not meet the criteria to be included in the analysis are referred to as the non-analytic sample.

Measures

Handedness (writing hand preference) was measured at child age 14 (sweep 6), by asking children "with which hand they wrote best", an item with three response options: "right", "left" and "either hand". Handedness is established at around the age of 6 (Scharoun & Bryden, 2015), so we were able to use this measure retrospectively. In our sample, 6,904 children (86.83%) were right-handed and 1,047 (13.17%) were non-right-handed (938 (11.80%) and 109 (1.37%) were left-handed and mixed-handed, respectively). Out of the 4,017 boys, 3,437 (85.56%) were right-handed and 580 (14.44%) were non-right-handed (12.99% and 1.44% were left-handed and mixed-handed, respectively). Out of the 3,934 girls, 3,467 (88.13%) were right-handed and 467 (11.87%) were non-right-handed (10.57% and 1.30% were left-handed and mixed-handed, respectively).

Internalizing and externalizing difficulties were assessed at ages 3, 5, 7, 11, and 14, with the 5 subscales of the parent-reported Strengths and Difficulties Questionnaire (SDQ) (Goodman, 2001): emotional symptoms, peer problems (together capturing internalizing difficulties), conduct problems, hyperactivity/inattention (together capturing externalizing difficulties), and prosocial behaviour (the "strengths" scale of the SDQ). Each subscale includes 5 items, answered on a 0–2 scale; 0 corresponds to "not true", 1 to "somewhat true" and 2 to "certainly true". The total score for each subscale ranges from 0 to 10, with higher scores suggesting more difficulties (except for prosocial behaviour where higher scores indicate greater prosocial behaviour). Across sweeps 2–6, respectively, Cronbach's alphas were: for emotional symptoms, .48, .57, .63, .72, and .73; for conduct problems, .66, .53, .58, .60, and .63; for hyperactivity/inattention, .72, .77, .79, .79 and .78; for peer problems, .48, .53, .60, .67, and .65; and finally, for prosocial behaviour, .66, .67, .69., .65, and .73.

Key covariates included child sex (boy/girl), child ethnicity, family income, family structure, maternal education, and maternal psychological distress, all measured at child age 3 (baseline). Ethnicity was assessed with a set of binary variables indicating whether the child was of white, mixed, Indian, Pakistani/Bangladeshi, Black, or any other ethnicity. Family income was measured with a binary variable showing if it was below, or above, 60% of the UK's equivalised household median income (i.e., the poverty line), while family structure was a binary variable showing if there were one or two caregivers in the household. To assess maternal education, we again used a binary variable of whether the mother was university-educated or not. Finally, maternal psychological distress was measured with the Kessler-6 psychological distress scale (Kessler et al., 2002). For this analytic sample, its Cronbach's alpha was 0.86.

Analytic strategy

All analyses were run in Stata 18. First, for all study variables, the analytic sample was compared to the non-analytic sample to detect any selection bias. Next, we compared the SDQ scores (on emotional, conduct, hyperactivity/inattention, and peer difficulties, as well as prosocial behaviour) between the right-handed and non-right-handed children of our analytic sample and examined the correlations between these scores. Considering the large number of comparisons (25 for the bias analysis and 300 for the zero-order correlations), we applied the Bonferroni correction. *P*-values were therefore set to 0.002 and 0.00017, respectively.

In terms of the main analysis, we fitted growth curve models (GCMs) to identify children's trajectories of emotional, conduct, hyperactivity/inattention, and peer difficulties, as well as prosocial behaviour, across ages 3–14. GCMs allow one to explore intra-individual developmental patterns over time, while also considering inter-individual differences. They can provide insight on how specific predictors (in this case, writing hand preference) affect these developmental patterns, including their starting point (intercept) and rate of change over time (slope) (Curran et al., 2010). In our analysis, the models had two levels: occasions (level 1) nested in children (level 2). Children's exact age was grand mean centred, so the intercept was around 93.66 months (around age 8 years). Given the curved shapes of children's trajectories of scores on the conduct, hyperactivity/inattention, peer difficulties and prosocial behaviour scales, a quadratic age term was also included in those models. This term was not included in the models exploring the course of emotional difficulties, as this trajectory was linear. We fitted each model first unadjusted and then adjusted for covariates. We compared unadjusted and adjusted models using the Akaike Information Criterion (AIC), with lower values demonstrating better fit. To account for the stratified design of the MCS, we additionally included the MCS "stratum" variable (which classifies the MCS families' areas at study entry into nine strata: England ethnic, England advantaged, England disadvantaged, Scotland advantaged, Scotland disadvantaged, Wales advantaged, Wales disadvantaged, Northern Ireland advantaged, and Northern Ireland disadvantaged). Given there were five main outcomes (the SDQ scale scores), we set the alpha to $p < .01$ (a = .05/5) for all models. Moreover, to ensure that any non-right-handedness effects were not driven by the mixed-handed group, for each SDQ outcome we ran a sensitivity analysis excluding the mixed-handed children (resulting in comparisons between left-handed and right-handed children). To explore differences between boys and girls, we also ran all models as sex-stratified (with and without the mixed-handed children).

Results

Descriptive statistics

The comparisons between the analytic and non-analytic sample, for all study variables, can be found in Table S1 (Supplement). Overall, families in the analytic sample were less disadvantaged; they were more likely to be two-parent and to be living above the poverty line. Mothers were more likely to be university-educated and experienced lower levels of psychological distress. Children were more likely to be females, and less likely to belong to an ethnic minority. Additionally, children in the analytic sample demonstrated consistently fewer difficulties (except for prosocial behaviour at age 3), and their exact age (in months) on the day of data collection was lower (except for age 14). Importantly though, there were no significant differences in terms of handedness.

Table 1 shows the comparisons between the right-handed and non-right-handed groups of our analytic sample, for all SDQ outcomes, across ages 3-14. After Bonferroni correction, significance was set at 0.002, as explained. Independent samples t-tests revealed significant differences for conduct problems at age 5, and hyperactivity/inattention at age 5, 7, 11, and 14. In all cases, the non-right-handed group had more difficulties than the right-handed.

Correlations

Correlations between SDQ outcomes, both within/across time and within/across domain, across ages 3–14 are presented in Table S2 (Supplement). They ranged from weak (.06) to strong (.75) and were all statistically significant at $p < 0.00017$, after Bonferroni correction.

Growth curve models

Across ages 3-14, children's emotional symptoms increased linearly. Conduct problems lowered non-linearly until age 11 and then rose again. Hyperactivity/inattention decreased non-linearly, while peer problems also decreased non-linearly until age 7; afterwards, they increased. Prosocial behaviour rose non-linearly until the age of 11 and then declined.

In the unadjusted models, writing hand preference was a significant predictor of children's emotional, conduct, hyperactivity/inattention, and peer problem trajectories, with the non-right-handed presenting more difficulties.

Table 1. Comparison between the right-handed and non-right-handed children on all SDQ outcomes, across ages 3–14.

	Right-handed group		Non-right-handed group			
	N	*M (SD)*	N	*M (SD)*	t	*p*-value
1. Emotional difficulties age 3	6,880	1.22 (1.34)	1,041	1.25 (1.39)	−0.76	0.45
2. Emotional difficulties age 5	6,625	1.24 (1.47)	1,011	1.24 (1.47)	−0.01	0.99
3. Emotional difficulties age 7	6,504	1.38 (1.66)	985	1.46 (1.67)	−1.39	0.17
4. Emotional difficulties age 11	6,562	1.72 (1.91)	987	1.89 (2.07)	−2.49	0.01
5. Emotional difficulties age 14	6,740	1.85 (2.05)	1,031	2.02 (2.17)	−2.33	0.02
6. Conduct difficulties age 3	6,881	2.58 (1.93)	1,043	2.69 (1.92)	−1.68	0.09
7. Conduct difficulties age 5	6,629	1.30 (1.37)	1,010	1.45 (1.44)	−3.23	**0.001**
8. Conduct difficulties age 7	6,506	1.19 (1.42)	985	1.25 (1.42)	−1.34	0.18
9. Conduct difficulties age 11	6,564	1.20 (1.44)	984	1.28 (1.52)	−1.56	0.12
10. Conduct difficulties age 14	6,740	1.23 (1.50)	1,031	1.33 (1.57)	−1.98	0.05
11. Hyperactivity/inattention difficulties age 3	6,841	3.66 (2.27)	1,042	3.78 (2.35)	−1.63	0.10
12. Hyperactivity/inattention difficulties age 5	6,615	3.00 (2.27)	1,009	3.29 (2.40)	−3.72	**0.0002**
13. Hyperactivity/inattention difficulties age 7	6,501	3.08 (2.43)	984	3.34 (2.46)	−3.09	**0.002**
14. Hyperactivity/inattention difficulties age 11	6,561	2.86 (2.37)	987	3.21 (2.49)	−4.24	**0.0001**
15. Hyperactivity/inattention difficulties age 14	6,739	2.77 (2.3)	1,031	3.02 (2.47)	−3.19	**0.001**
16. Peer difficulties age 3	6,836	1.39 (1.52)	1,033	1.47 (1.55)	−1.61	0.11
17. Peer difficulties age 5	6,617	0.99 (1.34)	1,007	1.08 (1.39)	−2.12	0.03
18. Peer difficulties age 7	6,499	1.03 (1.44)	982	1.18 (1.59)	−2.98	0.003
19. Peer difficulties age 11	6,565	1.19 (1.60)	986	1.32 (1.72)	−2.36	0.02
20. Peer difficulties age 14	6,740	1.58 (1.76)	1,031	1.70 (1.87)	−1.96	0.05
21. Prosocial behaviour age 3	6,849	7.38 (1.83)	1,032	7.35 (1.80)	0.39	0.70
22. Prosocial behaviour age 5	6,630	8.45 (1.61)	1,010	8.35 (1.66)	1.89	0.06
23. Prosocial behaviour age 7	6,509	8.68 (1.56)	984	8.59 (1.60)	1.64	0.10
24. Prosocial behaviour age 11	6,565	8.88 (1.46)	987	8.88 (1.44)	−0.02	0.98
25. Prosocial behaviour age 14	6,739	8.42 (1.75)	1,029	8.35 (1.78)	1.33	0.18

For prosocial behaviour, writing hand preference was also a significant predictor, with the non-right-handed presenting less prosocial behaviour. Writing hand preference did not influence the fixed-effects slope of any of the five SDQ subscale scores.

For all models, adjusting for covariates improved model fit, as the AIC values lowered. Specifically, for emotional difficulties, the value changed from 195715.1 (unadjusted) to 138694.1 (adjusted); for conduct, it changed from 189615.2 (unadjusted) to 134682 (adjusted); for hyperactivity/inattention, it changed from 216304.2 (unadjusted) to 155841.2 (adjusted); for peer, it changed from 185215.1 (unadjusted) to 132428.5 (adjusted); and last, for prosocial behaviour, it changed from 196702.4 (unadjusted) to 141964 (adjusted).

The results of the adjusted models for emotional, conduct, hyperactivity/inattention and peer difficulties, and prosocial behaviour, are shown in Tables 2–6, respectively. Being non-right-handed was associated with

Table 2. Fixed effects estimates and variance covariance estimates for the adjusted model predicting emotional difficulties (N = 7,951).

Fixed Effects			
Variables	Coefficient	SE	95% CI
Constant	1.12*	0.03	1.06, 1.18
Age	0.005*	0.0002	0.005, 0.006
Non-right-handed*age	0.001	0.0005	0.0003, 0.002
Non-right-handed	0.07	0.04	−0.009, 0.14
Girl	0.10*	0.02	0.05, 0.15
Mixed (ref. white)	0.01	0.08	−0.15, 0.17
Indian (ref. white)	−0.03	0.10	−0.23, 0.16
Pakistani/Bangladeshi (ref. white)	0.21	0.09	0.04, 0.38
Black (ref. white)	−0.11	0.09	−0.30, 0.07
Other (ref. white)	0.16	0.15	−0.15. 0.46
One-parent household	0.01	0.04	−0.07, 0.09
Below the poverty line	0.23*	0.04	0.16, 0.30
Mother university educated	−0.12*	0.03	−0.17, -0.07
Maternal psychological distress	0.09*	0.004	0.08, 0.10
Stratum (ref: England-Advantaged)			
England-Disadvantaged	0.09	0.03	0.02, 0.15
England-Ethnic	0.09	0.07	−0.04, 0.22
Wales-Advantaged	−0.04	0.06	−0.15, 0.07
Wales-Disadvantaged	0.007	0.04	−0.08, 0.09
Scotland-Advantaged	−0.10	0.05	−0.20, -0.004
Scotland-Disadvantaged	−0.01	0.06	−0.13, 0.11
Northern Ireland-Advantaged	−0.04	0.06	−0.16, 0.08
Northern Ireland-Disadvantaged	0.05	0.06	−0.06, 0.17
Random Effects			
Level 2 (child)			
Intercept variance	0.0001	0.0001	0.0001, 0.0001
Slope variance	1.02	0.02	0.98, 1.06
Intercept-slope covariance	0.006	0.0002	0.006, 0.007
Level 1 (occasion)			
Between-occasion variance	1.40	0.01	1.38, 1.43

*$p < 0.01$.

higher levels of hyperactivity/inattention. There were no other effects of writing hand preference.

Sensitivity analyses

The main results of the adjusted models for all five SDQ subscales, after excluding the mixed-handed children, are presented in Tables S3–S7 (N = 7,842). The significant effect of writing hand preference on hyperactivity/inattention did not persist. Next, we explored sex-stratified models. Findings for boys, with (N = 4,017) and without (N = 3,959) the mixed-handers, are presented in Tables S8–S17. In the first case (with the mixed-handers included) being non-right-handed was associated with more hyperactivity/inattention and peer difficulties. This effect was not significant after the mixed-handed boys were excluded. When it comes to girls (N = 3,934 and N = 3,883 with and without the mixed-handers, respectively), no significant associations with writing hand preference were found (Tables S18–S27).

Table 3. Fixed effects estimates and variance covariance estimates for the adjusted model predicting conduct difficulties (N = 7,951).

Fixed Effects			
Variables	Coefficient	SE	95% CI
Constant	0.92*	0.03	0.86, 0.98
Age	−0.01*	0.0002	−0.01, -0.01
Age^2	0.0002*	0.0001	0.0002, 0.0002
Non-right-handed*age	−0.0002	0.0004	−0.001, 0.0007
Non-right-handed	0.06	0.04	−0.01, 0.13
Girl	−0.20*	0.02	−0.15, -0.15
Mixed (ref. white)	−0.09	0.08	−0.25, 0.06
Indian (ref. white)	−0.08	0.10	−0.28. 0.11
Pakistani/Bangladeshi (ref. white)	−0.17	0.09	−0.34, -0.003
Black (ref. white)	−0.18	0.09	−0.36, 0.003
Other (ref. white)	−0.19	0.15	−0.49, 0.11
One-parent household	0.20*	0.04	0.12, 0.29
Below the poverty line	0.34*	0.03	0.27, 0.41
Mother university educated	−0.27*	0.03	−0.32, -0.21
Maternal psychological distress	0.08*	0.004	0.07, 0.09
Stratum (ref: England-Advantaged)			
England-Disadvantaged	0.21*	0.03	0.15, 0.28
England-Ethnic	0.14	0.07	0.02, 0.27
Wales-Advantaged	−0.03	0.06	−0.14, 0.08
Wales-Disadvantaged	0.12*	0.04	0.03, 0.21
Scotland-Advantaged	0.02	0.05	−0.08, 0.12
Scotland-Disadvantaged	0.02	0.06	−0.10, 0.13
Northern Ireland-Advantaged	−0.09	0.06	−0.21, 0.03
Northern Ireland-Disadvantaged	0.009	0.06	−0.11, 0.12
Random Effects			
Level 2 (child)			
Intercept variance	0.0001	0.0001	0.0001, 0.0001
Slope variance	0.96	0.02	0.93, 1.00
Intercept-slope covariance	−0.001	0.0002	−0.002, -0.001
Level 1 (occasion)			
Between-occasion variance	1.13	0.01	1.11, 1.15

*$p < 0.01$.

Discussion

Using a large longitudinal sample, this study investigated whether writing hand preference is related to children’s trajectories of prosocial behaviour and internalizing and externalizing difficulties (i.e., emotional symptoms, peer problems, hyperactivity/inattention, and conduct problems) across ages 3–14 years in the general UK population. Growth curve models adjusted for confounders revealed that non-right-handed children experienced higher levels of hyperactivity/inattention. The effect was very weak. After excluding the mixed-handed children from the non-right-handed group (resulting in comparisons between the left-handed and the right-handed children), this difference did not persist. There were no other differences by writing hand preference.

In addition, sex-stratified models suggested that among girls, writing hand preference did not have any association with any of the symptom scores

Table 4. Fixed effects estimates and variance covariance estimates for the adjusted model predicting hyperactivity/inattention difficulties (N = 7,951).

Fixed Effects			
Variables	Coefficient	SE	95% CI
Constant	3.09*	0.05	2.99, 3.19
Age	−0.007*	0.0002	−0.007, -0.006
Age^2	0.0001*	0.0001	0.0001, 0.0001
Non-right-handed*age	0.0008	0.0006	−0.0003, 0.002
Non-right-handed	0.16*	0.06	0.05, 0.28
Girl	−0.75*	0.04	−0.83, -0.67
Mixed (ref. white)	−0.06	0.13	−0.30, 0.20
Indian (ref. white)	0.06	0.16	−0.26, 0.37
Pakistani/Bangladeshi (ref. white)	0.02	0.14	−0.26, 0.29
Black (ref. white)	−0.10	0.15	−0.39, 0.20
Other (ref. white)	−0.18	0.25	−0.67, 0.30
One-parent household	0.24*	0.07	0.11, 0.37
Below the poverty line	0.35*	0.06	0.24, 0.47
Mother university educated	−0.61*	0.04	−0.69, -0.52
Maternal psychological distress	0.11*	0.006	0.10, 0.13
Stratum (ref: England-Advantaged)			
England-Disadvantaged	0.23*	0.05	0.12, 0.33
England-Ethnic	0.19	0.11	−0.02, 0.39
Wales-Advantaged	−0.04	0.09	−0.22, 0.14
Wales-Disadvantaged	0.17	0.07	0.03, 0.31
Scotland-Advantaged	−0.13	0.08	−0.29, 0.03
Scotland-Disadvantaged	0.08	0.10	−0.11, 0.27
Northern Ireland-Advantaged	−0.19	0.10	−0.38, 0.003
Northern Ireland-Disadvantaged	−0.07	0.09	−0.25, 0.12
Random Effects			
Level 2 (child)			
Intercept variance	0.0002	0.0001	0.0001, 0.0002
Slope variance	2.65	0.05	2.55, 2.74
Intercept-slope covariance	0.002	0.0004	0.0009, 0.002
Level 1 (occasion)			
Between-occasion variance	1.97	0.02	1.94, 2.00

*$p < 0.01$.

examined here. Some neuroimaging evidence suggests that while there are distinct brain lateralization differences between right-handed and non-right-handed boys, these are not so prevalent for girls (Szaflarski et al., 2012). The present study's null associations of handedness with mental health in girls may be due to this sex difference in the link between brain lateralization and handedness. By contrast, among boys, writing hand preference had a small, but very specific, association with mental health: non-right-handedness was linked to hyperactivity/inattention and peer difficulties, but not when excluding the mixed-handers. This suggests therefore that left-handedness, compared to right-handedness, does not confer risk for any of the symptom scores explored here.

Earlier research by Irani et al. (2023) and van der Hoorn et al. (2010) suggested that there was no association between handedness and hyperactivity/inattention symptoms in children and adolescents. Our study found a

Table 5. Fixed effects estimates and variance covariance estimates for the adjusted model predicting peer difficulties (N = 7,951).

Fixed Effects			
Variables	Coefficient	SE	95% CI
Constant	0.81*	0.03	0.75, 0.87
Age	−0.0002	0.0002	−0.0006, 0.0001
Age^2	0.0001*	0.0001	0.0001, 0.0001
Non-right-handed*age	0.0003	0.0005	−0.0007, 0.001
Non-right-handed	0.09	0.03	0.02, 0.16
Girl	−0.17*	0.02	−0.22, -0.13
Mixed (ref. white)	0.08	0.08	−0.07, 0.22
Indian (ref. white)	0.25*	0.09	0.06, 0.43
Pakistani/Bangladeshi (ref. white)	0.44*	0.08	0.27, 0.60
Black (ref. white)	−0.002	0.09	−0.18, 0.17
Other (ref. white)	0.23	0.15	−0.06, 0.51
One-parent household	0.12*	0.04	0.05, 0.20
Below the poverty line	0.27*	0.03	0.20, 0.33
Mother university educated	−0.19*	0.03	−0.24, -0.14
Maternal psychological distress	0.07*	0.003	0.06, 0.08
Stratum (ref: England-Advantaged)			
England-Disadvantaged	0.17*	0.03	0.11, 0.24
England-Ethnic	0.18*	0.06	0.06, 0.30
Wales-Advantaged	−0.09	0.05	−0.19, 0.02
Wales-Disadvantaged	0.09	0.04	0.002, 0.17
Scotland-Advantaged	−0.03	0.05	−0.12, 0.07
Scotland-Disadvantaged	0.03	0.06	−0.08, 0.14
Northern Ireland-Advantaged	−0.06	0.06	−0.17, 0.06
Northern Ireland-Disadvantaged	0.07	0.06	−0.04, 0.18
Random Effects			
Level 2 (child)			
Intercept variance	0.0002	0.0001	0.0001, 0.0001
Slope variance	0.85	0.02	0.82, 0.89
Intercept-slope covariance	0.003	0.0002	0.003, 0.003
Level 1 (occasion)			
Between-occasion variance	1.16	0.01	1.14, 1.18

*$p < 0.01$.

modest association, but this was likely driven by the few mixed-handed children. When these were removed from the analysis, there was no difference in hyperactivity/inattention between the right-handed and the left-handed children. This echoes the results by Rodriguez et al. (2010), who found hyperactivity/inattention effects only for the mixed-handed group. Furthermore, a recent meta-analysis (Nastou et al., 2022) exploring the link between ADHD and handedness concluded that there is a slightly higher ADHD prevalence in non-right-handed individuals (versus the right-handed), but no difference in prevalence between the right-handed and the left-handed. Our results are consistent with these conclusions. Although we examined patterns by population-level hyperactivity/inattention symptoms, rather than an ADHD diagnosis, high levels of such symptoms could indicate an underlying clinical condition in some cases (Nastou et al., 2022).

Our study therefore tentatively suggests that mixed-handedness rather than left-handedness has a small association with hyperactivity/inattention

Table 6. Fixed effects estimates and variance covariance estimates for the adjusted model predicting prosocial behaviour (N = 7,951).

Fixed Effects			
Variables	Coefficient	SE	95% CI
Constant	8.67*	0.03	8.60, 8.73
Age	0.01*	0.0002	0.01, 0.01
Age^2	−0.0002*	0.0001	−0.0002, -0.0002
Non-right-handed*age	0.0001	0.0005	−0.001, 0.001
Non-right-handed	−0.02	0.04	−0.10, 0.05
Girl	0.49*	0.03	0.44, 0.54
Mixed (ref. white)	−0.01	0.08	−0.18, 0.15
Indian (ref. white)	0.17	0.11	−0.03, 0.38
Pakistani/Bangladeshi (ref. white)	0.12	0.09	−0.06, 0.30
Black (ref. white)	0.29*	0.10	0.10, 0.48
Other (ref. white)	0.22	0.16	−0.10, 0.54
One-parent household	−0.01	0.04	−0.10, 0.07
Below the poverty line	−0.13*	0.04	−0.20, -0.05
Mother university educated	0.11*	0.03	0.05, 0.16
Maternal psychological distress	−0.04*	0.004	−0.04, -0.03
Stratum (ref: England-Advantaged)			
England-Disadvantaged	−0.05	0.07	−0.12, 0.02
England-Ethnic	−0.07	0.06	−0.21, 0.06
Wales-Advantaged	0.17*	0.06	0.06, 0.29
Wales-Disadvantaged	0.16*	0.05	0.07, 0.25
Scotland-Advantaged	−0.06	0.05	−0.16, 0.05
Scotland-Disadvantaged	0.01	0.06	−0.11, 0.14
Northern Ireland-Advantaged	0.02	0.06	−0.11, 0.15
Northern Ireland-Disadvantaged	0.15	0.06	0.03, 0.27
Random Effects			
Level 2 (child)			
Intercept variance	0.0001	0.0001	0.0001, 0.0001
Slope variance	1.04	0.02	1.00, 1.08
Intercept-slope covariance	−0.0009	0.0002	−0.001, -0.0005
Level 1 (occasion)			
Between-occasion variance	1.35	0.01	1.32, 1.37

*$p < 0.01$.

symptoms in the general child population, likely driven by boys. Research suggests that there are distinct genetic mechanisms underlying left-handedness and ambidexterity/mixed-handedness (Cuellar-Partida et al., 2021). These genetic mechanisms could predispose ambidextrous and mixed-handed children to greater risks. Other research has suggested that mixed-handedness is linked to dyslexia, while the association between left-handedness and dyslexia is weaker (Packheiser et al., 2023), which is in line with other evidence that language difficulties are more common in mixed-handers (Rodriguez et al., 2010). Such cognitive difficulties could have an adverse impact on mixed-handers' academic performance (O'Connell & Marks, 2022), in turn affecting their confidence and mental well-being (Dias et al., 2022; Lloyd-Esenkaya et al., 2020). In relation to ADHD-related symptoms specifically (hyperactivity/inattention), these have been linked to right-hemisphere dysfunctions (Rentería, 2012), which are not associated with left-handedness. The weaker brain lateralization exhibited by ambidextrous and mixed-handed individuals could be involved in the development of inattention/hyperactivity, though further research is needed to explore this possibility and underpin the exact mechanisms.

Together, our results suggest slight differences between right-handed and non-right-handed children in hyperactivity in the general population that emerge in the early primary school years and persist to the end of our study period, in middle adolescence. Although our effects were very small, they imply that atypical writing-hand preference is associated with hyperactivity/inattention, especially in boys. However, it is also important to emphasize that there were no differences in any of the symptom scores we explored between right-handed and left-handed children.

These findings should be seen in light of some important study limitations. First, comparisons between the analytic and non-analytic sample highlighted sample selection bias, meaning that our results may not be applicable to those of less privileged backgrounds. Second, the SDQ measures we used are parent-reported, which could reflect biases. Third, for some SDQ scores (particularly for emotional, conduct, and peer difficulties), internal consistency was low. Fourth, while the SDQ can accurately describe children's internalizing and externalizing behaviours, it is not a diagnostic tool and therefore cannot identify clinical cases. Fifth, there are limitations with our measurement of handedness, a complex construct, as individuals' ability to use their non-dominant hand varies (Corey et al., 2001). Our study could not capture this complexity since children were only administered a single-item question (asking them with which hand they write best) in adolescence instead of a validated questionnaire (e.g., the Edinburgh Handedness Inventory; Oldfield, 1971). According to past literature, single-item measures may not be capturing the complexity of mixed-handedness accurately, leading to misclassification and inconsistency (De Kovel et al., 2019). Furthermore, only the direction of handedness was measured, and not the strength of it. However, the distribution of handedness in our sample is in line with what has been previously reported (Papadatou-Pastou et al., 2020), which reassures. Last, the study was not pre-registered.

Future studies could aim to address these limitations, by investigating how hand preference (including objectively measured hand skill) may be linked to children's externalizing and internalizing difficulties. Should links exist, then exploring the reasons (genetic, biological and environmental) behind them would be very beneficial, for both research and practice. For example, if links with mixed-handedness are replicated and explained then understanding the underlying mechanisms would help identify ways to best support mixed-handed children if and when they struggle. It is though important to note that atypical brain lateralization is often observed in neurotypical/mentally healthy individuals as well (Ocklenburg et al., 2025).

In summary, our study aimed to extend current research by exploring associations between writing hand preference and youth prosocial behaviour and internalizing and externalizing difficulties from the preschool period to middle adolescence in the general population. The findings indicate that writing hand preference has a very small association with children's hyperactivity/inattention, with mixed-handed children, particularly boys, being at risk. Left-handedness did not confer risk. There was no association between writing hand preference and emotional symptoms, conduct problems or prosocial behaviour, for any age, suggesting that the link as well as very small is also very specific. It does, however, emerge in the early primary school years and persist across childhood and adolescence. Practitioners working with atypically-handed children could monitor their progress from a young age to offer help early, if needed.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability statement

The data used in this study are publicly available from UK Data Service (https://ukdataservice.ac.uk/find-data/). The datasets that were used are SN 4683, SN 5350, SN 5795, SN 6411, SN 7464, and SN 8156, corresponding to MCS sweeps 1-6, respectively. Syntax is available from the authors upon request.

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