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DATA NOTE

Starting School: a large-scale start of school assessment within the 'Born in Bradford' longitudinal cohort [version 1; peer review: awaiting peer review]

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Abstract

The Born in Bradford (BiB) cohort of 13,776 children born between 2007-2011 and their parents provides a rich data resource for researchers exploring protective and risk factors influencing long-term developmental and health outcomes. Educational attainment is a critical factor related to later health. Literacy and communication, fine motor skills and social and emotional health are key 'early' predictors of educational attainment and can be used to identify children in need of additional support. We describe our BiB 'Starting School' data collection protocol which assessed literacy and communication, fine motor skills and social and emotional health on 3,444 BiB children aged 4-5 years old. These measures supplement the existing dataset, and complement the routine educational, health and social care data available for the cohort.

Keywords

longitudinal cohort, school-readiness, educational attainment

Open Peer Review

Reviewer Status *AWAITING PEER REVIEW*

Any reports and responses or comments on the article can be found at the end of the article.

This article is included in the Born in Bradford gateway.

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Introduction

The Born in Bradford (BiB) longitudinal cohort study was established in 2007 in response to the high rates of childhood ill-health seen in the City of Bradford (Wright *et al.*, 2013). BiB was set up with the aim of examining the genetic, environmental, behavioural and social factors that influence the health and development of children in the city. All mothers who gave birth at Bradford Royal Infirmary between 2007 and 2011 were invited to take part, which resulted in a cohort of 13,776 children and their families. Mothers recruited into the study provided a rich dataset through detailed questionnaire data, measurements and samples. Mothers also consented to the linkage of routine data (such as primary and secondary care records and local education records) concerning themselves and their child. A full list of all available data provided at baseline recruitment, during pregnancy and at birth can be found on the BiB website (https://borninbradford.nhs.uk/research/documents-data/).

Sub-samples of the cohort provided additional measures on growth, physical and mental health, and diet between birth and 3 years of age (Bryant *et al.*, 2013), whilst further measurements relating to physical health (in particular allergies and infections) were collected on sub-cohorts as part of the 'MeDALL' (Bousquet *et al.*, 2011) and 'ALL IN' studies (Pembrey *et al.*, 2013). Children in the UK typically begin primary school in the September following their 4th birthday and thus an ideal opportunity presented itself to enrich the dataset further with in-school measurements of children during their first year of schooling, on abilities that were directly relevant to their later educational attainment and development.

In this Reception year of primary school in the UK (a compulsory year of Early Years education before the start of formal education), children are also assessed by their teachers using the EYFSP (Department for Education, 2012, Department for Education, 2013). The current assessment summarises each child's ability on 17 learning goals, covering the areas: Communications and language development, Physical development, Personal, social and emotional development, Literacy, Understanding of the World, and Expressive arts and design. For each of the learning goals, teachers are asked to judge whether the child is meeting the level of expected development (expected), exceeding it (exceeding), or not yet reaching it (emerging). Since the mothers consented to the collection of routine data on their children, it was possible to link the children's BiB data to these education records too[1].

The factors that contribute to children's 'school readiness' covers a large range of domains, and so we planned to supplement the information from the EYFSP with some complementary objective measurements of assessments shown to be important for positive developmental and educational outcomes of the cohort. The United Nations Children's Fund (UNICEF) describe 'school readiness' as encompassing five domains: (i) Physical well-being and motor development; (ii) Social and emotional development; (iii) Approaches to learning; (iv) Language development and cognition; (v) General knowledge (including mathematics) (United Nations Children's Fund, 2012). Since we only had limited time in which to assess each child, we were not able to run an extensive battery of tests covering all possible fields within these domains. We therefore adopted a pragmatic approach and focused on a limited number of measures that: (a) fit into one of the 'school readiness' domains; (b) could be practically completed within a total 20–30-minute assessment timeframe per child; (c) showed good evidence of predicting future development or attainment.

The three school readiness domains chosen for the 'Starting School' study were physical well-being and motor development, language development and cognition, and social and emotional development. Within the first domain, we specifically identified fine motor skills as having repeatedly being identified as predictors of later academic attainment in both reading, writing and mathematics (Cameron *et al.*, 2012; Dinehart & Manfra, 2013; Giles *et al.*, 2018; Grissmer *et al.*, 2010; Roebers *et al.*, 2014). In addition to predicting later academic attainment, motor control difficulties in childhood are also noted to predict certain aspects of physical and mental health later in childhood (Kantomaa *et al.*, 2013; Lingam *et al.*, 2010, Lingam *et al.*, 2012) and into adulthood (Hill & Brown, 2013; Kirby *et al.*, 2013).

Within the language development and cognition domain, the development of early literacy and communication skills is a key area. The British Picture Vocabulary Scale (BPVS) measures receptive vocabulary. It has proven to be highly correlated with later literacy acquisition and is suitable for use with children aged 3 to 16 (Dunn *et al.*, 2009). The Letter Identification (Letter ID) sub-test of the Woodcock Reading Mastery Tests (WRMT-NU/R) was also used as a measure of children's emerging literacy. Literacy skills are fundamental for success in education, employment and community participation and for higher levels of well-being (Clark, 2011; Dugdale & Clark, 2008; Marmot & Bell, 2012). Vocabulary during preschool has also been shown to predict future writing ability (Dunsmuir & Blatchford, 2004).

The final domain chosen was social and emotional health. Children with good social skills experience better outcomes, including more positive peer relationships and better mental and physical health (Carneiro *et al.*, 2007), and data from the Avon Longitudinal Study of Parents and Children (ALSPAC) showed that difficulties such as defiant behaviour at 7 years old, were predictive of academic outcomes at 16 years old (Sayal *et al.*, 2015).

To summarise, the Starting Schools project was nested within the larger BiB longitudinal cohort study and aimed

[1]It should be noted that a different version of the EYFSP was introduced in September 2012, with the previous incarnation involving 69 learning goals and a 119-point scale. This means that 705 children within the BiB cohort have EYFSP data stemming from the earlier version of the assessment, with the remainder of the cohort being assessed on the newer version.

to collect additional measurements of specific key domains predictive of later attainment and development. This goal was to link to the health and routine educational data already held (as well as data captured in the future) on these children, providing researchers with an enriched resource for examining longitudinal developmental trajectories, and potential avenues for improving educational attainment. We provide a description of the data collection process and the measures used, a brief overview of the process for harmonising these data with the existing BiB database, and a descriptive summary of the data collected.

Methods

Setting

Dates. Data collection for Starting School took place between September and July over two academic years (2012/13 and 2013/14).

Location. At the time of the Starting School study, the Bradford District (West Yorkshire) was the fifth largest metropolitan district in the UK (over half a million people), with nearly a quarter (23.5%) of residents aged under 16 years old (Office for National Statistics, 2013). Just over a quarter of the District's children were classified as living in poverty (Department for Communities and Local Government, 2011; Office for National Statistics, 2011). The largest proportion of Bradford District's population (63.9%) self-identified as White British. However, the District also had the largest proportion of people of Pakistani ethnic origin (20.3%) in England.

Participants

Schools

Eligibility

Starting School aimed to assess children in their Reception year (aged 4–5 years old) in schools where there were ≥ 10 children from the BiB cohort enrolled in reception class that academic year. In the UK, every child has a Unique Pupil Number (UPN) that identifies them at a national level and is allocated on the child's entry into the formal educational system (typically primary school). The number of BiB children in each school was identified via their UPN on the Bradford educational services database, with the UPN used to forge links between participants' cohort data and their routine educational data (e.g. EYFSP profile at the end of reception year). Of the 142 primary schools in Bradford in existence at the time of this study, 94 were identified as eligible for the project.

Method of recruitment

Schools were recruited by BiB researchers via individual letters and emails addressed to Head teachers. If no response was received, then telephone calls and personal visits to schools were made. Non-respondent schools were re-contacted on at least three occasions to maximise recruitment to the study. The Head teachers provided written, informed consent for the school to participate. Once consent was received, a date for the visit was arranged via the school office and/or Reception class teachers.

Children

Eligibility

All children in the identified schools who were in their Reception class of school either in September 2012 or September 2013 were eligible to take part in the fine motor and literacy assessments (not just children who were part of the BiB cohort). This was due to school preference, who as part of their participation in the study received the results from these assessments, therefore enabling them to enhance their identification of areas of support that might be needed by individuals.

Method of recruitment

Parents received an information sheet via the school that detailed the Starting School study and instructed them to inform their child's teacher if they did not wish their child to take part. A parental 'opt-out' approach to consent was adopted because of the high numbers of pupils targeted for recruitment (>3,000), the low risks of participation, and the increased risks of inadvertently excluding groups of children from homes where school-forms are typically not returned. Such homes are over-represented in ethnic minority and lower socio-economic groupings and thus more prevalent within this cohort because of Bradford's demographics (Cruise *et al.*, 2015; Goodman & Gatward, 2008). At the start of each testing day, assessors checked with class teachers for any child whose parent had not given consent to participate. Any child so identified was not included in the assessments. The researchers also obtained the assent of the children, i.e. the child's agreement (expressed verbally and/or behaviourally) to take part in the study before every assessment.

Ethical approval. Ethical approvals for this study were obtained from ethics committees at the University of Leeds (reference number 13-0220) and the University of York (reference number 12/26). Ethical approval for data linkage within the BiB cohort was obtained from the Bradford Leeds Research Ethics Committee (reference 07/H1302/112).

Measurements

Fine motor skills. To assess fine-motor control, an objective computerised assessment (Culmer *et al.*, 2009) was used: the Clinical-Kinematic Assessment Tool (CKAT). The CKAT battery assesses manual visuomotor Tracking, Aiming and Tracing performance and was presented on a tablet computer (Hewlett-Packard EliteBook 2760p tablet PC) that used a digital stylus for input. Flatters *et al.* (2014) provides a detailed description of the three subtests and the specific outcome measures that each test records.

Raw positional (X,Y) movement data were post-processed to produce the outcome measures for each task - providing quantitative measurements of various kinematic features of the participants' movements. For example, the temporal and spatial accuracy of movements, reaction times, movement times and smoothness of movement were all captured during the tracking task under conditions with different difficulty levels (see Flatters *et al.*, 2014 for details of outcome measures

used). At the end of each academic year, individual participant responses to each sub-test were standardised relative to the rest of the recorded response (to-date) using a z-scoring standardisation procedure. A mean average of the three standardised CKAT battery sub-test scores was then calculated to create an overall CKAT battery-score.

Literacy and communication. Two validated assessments, the British Picture Vocabulary Scale – Second Edition (BPVS II; Dunn *et al.* (1997)) and the Letter Identification (Letter ID) sub-test from the Woodcock Reading Mastery Tests – Revised-Normative Update battery (WMRT-R/NU; Woodcock (1998)), were used to determine the level of children's language and emerging literacy skills. Letter ID was chosen from this battery as the most appropriate measure for children at 4 to 5 years of age (Foulin, 2005) due to the anticipated wide response variability in children of this age on this particular (brief) measure. Both assessments were delivered according to standard instructions, and the Letter ID always followed the BPVS. Responses were entered into a purpose-built Microsoft Access database interface on the same laptops used for the motor assessments, developed by researchers at the Institute for Effective Education at the University of York. A pop-up message advised researchers when performance ceilings were reached for each child (i.e. when to terminate assessments).

Social and emotional health. Data were collected on social and emotional health using the Strengths and Difficulties Questionnaire (SDQ). This is a widely used measure for children aged 3–16 years (Goodman & Goodman, 2011; Goodman *et al.*, 2010), is suitable for multicultural samples (Goodman *et al.*, 2000), and can be completed by teachers (as in this study) or parents (Johnson *et al.*, 2014).

Procedure

The Starting School data collection was carried out over two consecutive academic years (2012–13 and 2013–14). Once a school had agreed to participate and prior to the assessment team's visit, they were asked to provide class lists including: children's name; date of birth; UPN; home post code; gender; ethnicity; English as an additional language (Yes or No); first language. These data allowed the children to be identified for assessment within classes and were used to link the Starting Schools data collected to the wider BiB cohort database. These multiple data fields helped enable data entry errors to be resolved easily (e.g. if the UPN was missing or mis-entered then linkage could be made using other identifiable information). The data were housed securely and followed the robust data governance rules that protect all of the Born in Bradford studies (following the Bradford Teaching Hospitals Foundation Trust procedures).

The assessment team were trained by senior staff within the Born in Bradford (BiB) cohort study and the Universities of York and Leeds on administration of the tasks. 'Refresher' training at the beginning of the second year of the study was mandatory.

Schools were asked to allocate a quiet room or area within the school to the research team (e.g. library), in which they could then conduct the assessments. Children were taken out of class two at a time, and each sat one-to-one with an assessor. Each assessor administered either the Fine motor or Communication and Literacy tasks, with children swapping between assessors so that both sets were completed by each child during the same session. Assessors explained task requirements to the child at the beginning of each assessment and checked their understanding. Assessments took approximately 20 to 30 minutes per child and each team of two researchers typically assessed between 15 and 20 children per school day.

In addition to this, teachers were asked to complete a Strengths and Difficulties Questionnaire (Teacher-report version) for each participating child in their class who was also part of the BiB cohort study. This was only completed after the child had been attending primary school for at least six months, as it is a requirement of the questionnaire that the adult completing it must know the child for this amount of time. Sufficient paper copies of the questionnaires were delivered in sealed envelopes to schools by the assessment team. Schools were asked to ring or email the researchers when questionnaires were ready for collection. If notification of completion wasn't received, then schools were contacted via telephone or email. Completed questionnaires were handed back in sealed envelopes.

All data collection and storage procedures were conducted according to the guidelines set out in the Data Protection Act 1998 and followed those of the Bradford Teaching Hospitals Foundation Trusts guidelines. Transfer of data onto the secure central archive at the BiB research office was via encrypted devices (e.g. tablets, memory sticks) or encrypted emails.

Feedback to schools

The results of all the assessments were compiled for each child, and individual reports were delivered back to Reception class teachers, along with a covering four-page document to explain why the skills measured are developmentally important, how the children were assessed, what was measured, what the scores meant, and how they should be interpreted (this is available as *Extended data* (Shire, 2020)). These feedback documents could then be used by schools, in conjunction with their own data, to consider where children might warrant further assessment or testing. Teachers were provided with information on where to find extra information and resources relating to supporting children's development in these areas.

Dataset description

Recruitment

Schools. A total of 77 schools were recruited from the 94 Bradford primary schools that were approached to take part in the project (See Table 1 for description of their demographics). Two schools declined the invitation and the remainder failed to return a decision about participating.

Children. Although all children in their Reception year of schooling at the recruited schools were eligible to take part, the data presented here only relates to the children who are part of the BiB cohort study. This is due to the focus on data linkage with the wider cohort dataset.

Very few parents chose to opt-out their children from the study (19 over the two years). The vast majority of children also consented to take part, with only 10 choosing not to participate when asked. In total, 3,444 children initially consented to participate.

Data collection

Over the two academic years, 120 school visits were made to assess children in 251 classes. Complete CKAT battery scores were collected successfully on 3,109 BiB children, BPVS and Letter ID were collected successfully on 3,292 and 3,258 children respectively, and SDQ data were collected successfully on 2,335 children. Performance outcomes for each measure, along with demographic information of recruited participants can be seen in Table 2, and Figure 1–Figure 4 show the distribution of scores on each of these outcomes (raw results available as *Extended data* (Shire, 2020)).

Data cleaning and harmonisation

Complete data sets were obtained for 90% of the children who were assessed for fine motor skills, 97% for literacy and communication, and 78% for social and emotional health (SDQ). The reasons for data not being collected for the fine motor and literacy and communication skills included non-compliance with task instructions, skipping the subtest during testing, or the child being unable to complete the task due to issues relating to SEN. The lower data acquisition rate for SDQ assessment was mainly due to teachers not completing the questionnaires.

Each dataset (CKAT, BPVS, Letter ID and SDQ) was cleaned and cross referenced against the remaining data sets to identify and resolve any inconsistencies before the separate data sets were linked. This raised a few issues with a small number of cases. These mainly resulted from the free text entry fields within the fine motor task, where researchers had to input school name, DOB, and UPN manually. This led to a small number of inaccuracies which were corrected via cross-referencing against class lists, the LEA database, and the main BiB cohort database. Once these issues had been resolved, a consolidated Starting Schools dataset was created by entering the UPN as a unique identifier against each piece of data-capture. This Starting Schools database was then harmonised with the existing BiB database.

Summary

The Starting School study described in this report was a nested study within the wider Born in Bradford project, and aimed to collect data on three specific domains of school readiness hypothesised to be predictive of later attainment and development: fine motor skills, literacy and communication, and social and emotional health.

The percentage of complete data sets for motor and literacy and communication data was high; while the percentage of SDQ data sets was lower due to non-completion by teachers the response rate was still more than tolerable (i.e. > 75%). The outcome measures were clearly defined and it can be seen that the data were reasonably well described by a Gaussian distribution.

Table 1. School characteristics (range of percentages of pupils).

	Single form entry (~30/year group) n=13	2 form entry (~60 per year group) n=48	3 form entry (~90/year group) n=16
SEN / SA+ (%)	0.4 – 14.5	0.8 – 17.0	3.1 – 13.1
English NOT first language (%)	2.8 – 96.2	1.7 – 97.3	6.2 – 95.8
FSM eligible (%)	2.8 – 60.2	6.1 – 61.5	17.6 – 37.4
Overall absences (%)	3.2 – 6.1	3.6 – 7.0	4.3 – 6.6
Expected progress in Reading KS2 (%)	73 – 100	67 – 100	61 – 97
Expected progress in Writing KS2 (%)	88 – 100	80 – 100	81 – 97

SEN, special educational needs; SA+, school action plus; FSM, free school meals; KS2, Key Stage 2.

Table 2. Performance outcomes by gender and ethnicity.

	Literacy and communication (mean (SD))		Fine motor skills (mean (SD))				Social and emotional health (mean (SD))
	BPVS	**Letter ID**	**Tracking**	**Aiming**	**Tracing**	**Overall**	**SDQ Total Difficulties Score**
Total sample (n=3,444)	100.74 (15.66) (n=3,292)	106.45 (12.60) (n=3,258)	31.41(13.66) (n=3,243)	2.81 (1.26) (n=3,235)	1.73 (1.55) (n=3,245)	-.03 (.68) (n=3,109)	5.69 (5.14) (n=2,335)
Gender							
Boys (n=1,763)	100.07 (16.14) (n=1,687)	104.91 (12.57) (n=1,668)	32.6 (13.9) (n=1,658)	2.90 (1.35) (n=1,652)	1.82 (1.61) (n=1,657)	.07 (.71) (n=1,578)	6.63 (5.39) (n=1,141)
Girls (n=1,681)	101.45 (15.10) (n=1,605)	108.07 (12.44) (n=1,590)	30.3 (13.3) (n=1,585)	2.71(1.16) (n=1,583)	1.64 (1.48) (n=1,588)	-.12 (.63) (n=1,531)	4.80 (4.72) (n=1,194)
Ethnicity							
Pakistani origin (n=1,863)	97.02 (14.62) (n=1,795)	105.69 (12.41) (n=1,764)	31.9 (13.7) (n=1,758)	2.94 (1.33) (n=1,753)	1.83 (1.38) (n=1,762)	.04 (.71) (n=1,749)	5.69 (5.26) (n=1,192)
White British (n=988)	107.32 (14.57) (n=933)	107.06 (12.27) (n=936)	30.6 (13.1) (n=932)	2.61(1.11) (n=931)	1.59 (1.25) (n=932)	-.12 (.63) (n=929)	5.77 (5.02) (n=755)
Other (n=581)	101.82 (16.96) (n=552)	107.71 (13.58) (n=547)	31.3 (13.7) (n=542)	2.65(1.22) (n=540)	1.63 (1.38) (n=540)	-.11 (.68) (n=538)	5.58 (5.03) (n=380)

Means and standard deviations (SD) for each outcome measure, for whole sample and split by gender and ethnicity. Only cases where complete data is available are included. Literacy and communication outcomes given are British Picture Vocabulary Scale (BPVS) standardised score, Letter Identification (Letter ID) standardised score. Fine motor skills outcome measures are all absolute values of the median score. Tracking = Root Mean Square Error; Aiming = Movement Time; Tracing = penalised path accuracy (pPA). Details of these measures can be found in Flatters *et al.* (2014). The Overall Score is an average of these 3 median values and is scaled and centred. The social and emotional health outcome given is the Strengths and Difficulties Questionnaire (SDQ) Total Difficulties Score

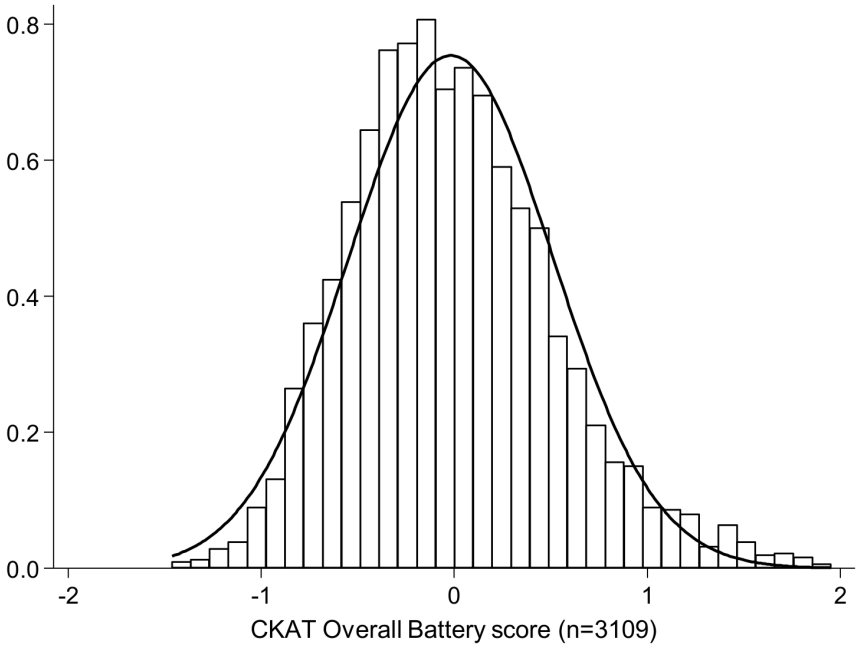

Figure 1. Histogram with normal distribution curve for CKAT Overall Battery Score. Overall CKAT battery score an average of the 3 z-score standardised sub-test performances.

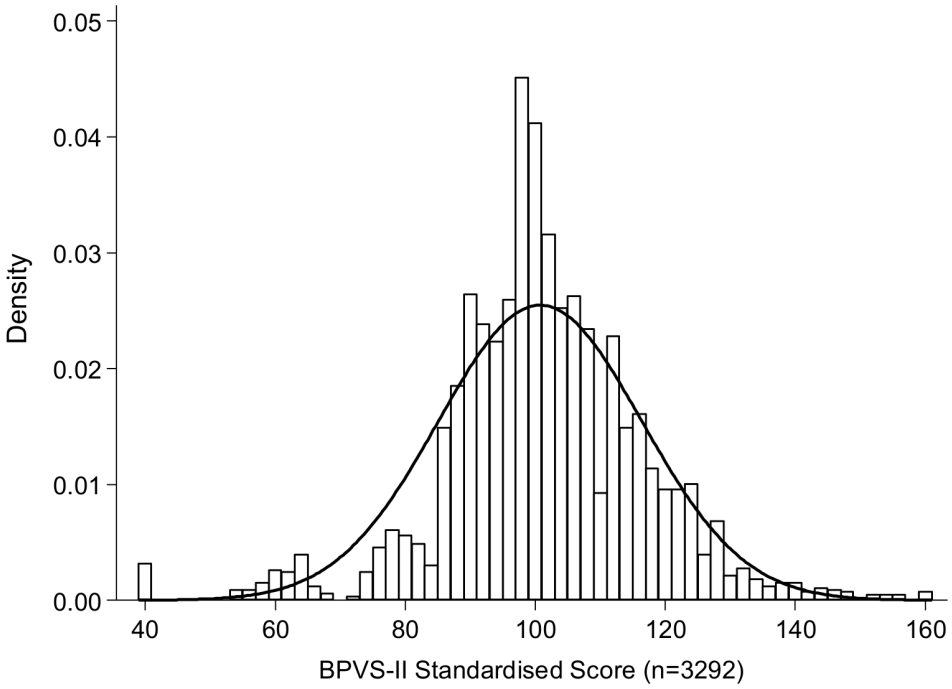

Figure 2. Histogram with normal distribution curve for BPVS-II standardised score. Standardised score is normed for age with a mean of 100 and range of (39 to 161).

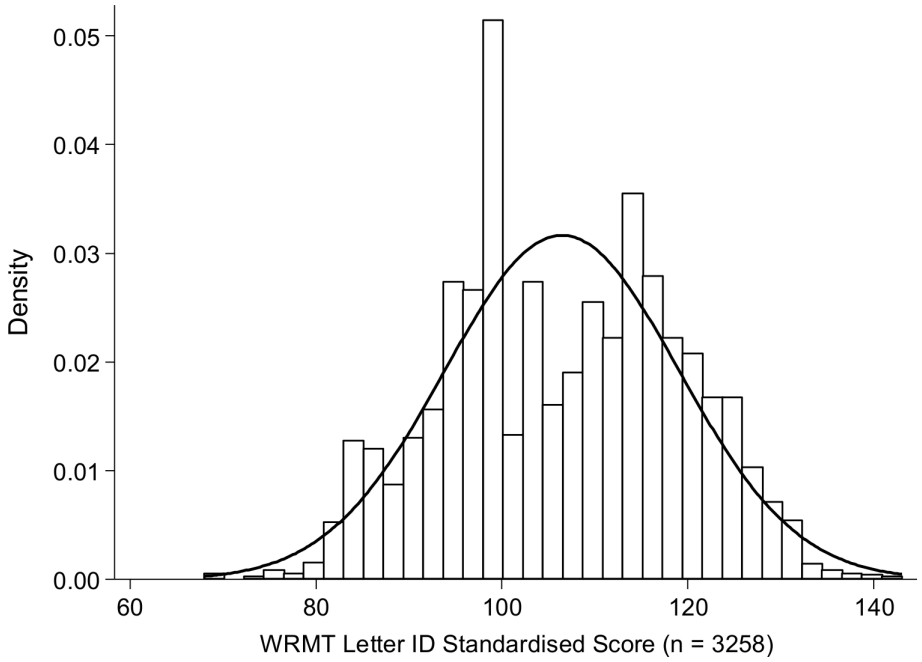

Figure 3. Histogram with normal distribution curve for Letter ID subtest standardised score. Standardised score is normed for age with a mean of 100 and range of (68 to 143).

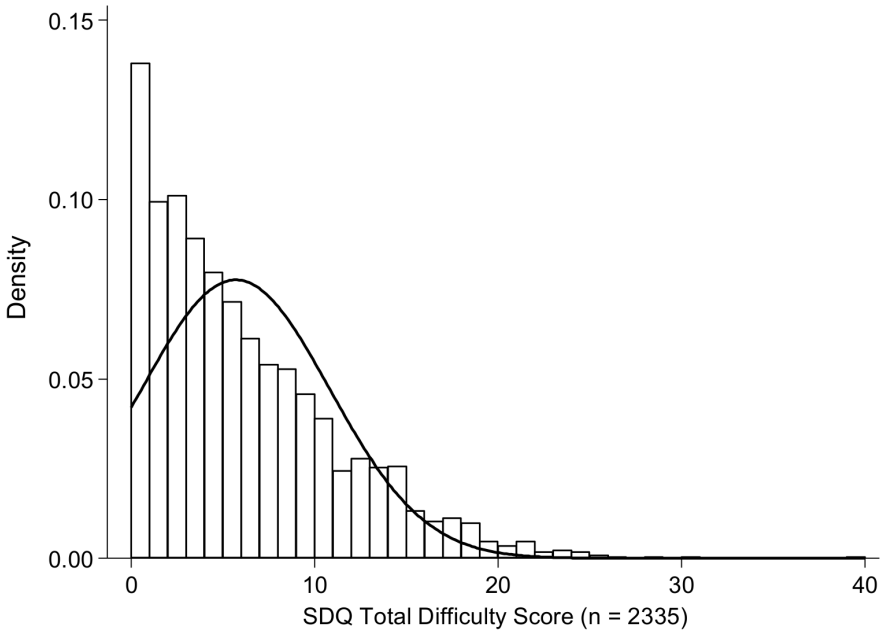

Figure 4. Histogram with normal distribution curve for SDQ Total Difficulty Score. Score can range from 0 to 40.

The Total Difficulties Score for the SDQ (social and emotional health) did not exhibit a normal distribution, but the range of scores was in line with previous distributions on this measure. The majority of the BiB children with available data appeared to have adequate social and emotional development at the time of testing (a total difficulty score of 14 to 16 indicates only slightly raised levels of difficulty). Nevertheless, a number of children were doing less well (Total Difficulty Score between 17 and 19 suggests a high level of difficulty, and a score above 19 indicates serious difficulties).

The data collected as part of Starting School is linked with the wider BiB database, and thus it provides a key set of information about approximately 3000 children in the cohort (N dependent on specific measure) at a particularly important stage of their lives. It is hoped that this information will be used to identify ways of better screening for difficulties early on in a child's education, promoting more effective provision of intervention and support earlier - given the importance of early intervention for any developmental and learning difficulties experienced by children. For example, this dataset has been utilised to examine the impact of visual acuity on developing literacy (Bruce *et al.*, 2016).

Full details of this dataset, along with instructions for how to access this data (along with other data kept on the BiB cohort) can be found at https://borninbradford.nhs.uk/research/documents-data/.

Data availability

Underlying data

Scientists are encouraged and able to use BiB data, which are available through a system of managed open access. The steps below describe how to apply for access to BiB data.

- Before you contact BiB, please make sure you have read our Guidance for Collaborators. Our BiB executive review proposals on a monthly basis and we will endeavour to respond to your request as soon as possible. You can find out about the different datasets which are available here (the datasets described in this article can be found in the Born in Bradford Data Dictionary). If you are unsure if we have the data that you need please contact a member of the BiB team (borninbradford@bthft.nhs.uk).
- Once you have formulated your request please complete the 'Expression of Interest' form available here and send to the BiB Programme Director (rosie.mceachan@bthft.nhs.uk).
- If your request is approved we will ask you to sign a collaboration agreement; if your request involves biological samples we will ask you to complete a material transfer agreement.

Extended data

Open Science Framework: Starting School: a large-scale start of school assessment within the 'Born in Bradford' longitudinal cohort. https://doi.org/10.17605/OSF.IO/JEY5H (Shire, 2020).

This project contains the following extended data:

- Starting School data for histograms (data used to generate histograms in Figure 1–Figure 4).
- Starting School Feedback document for teachers.

Extended data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public domain dedication).

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