Public Health England

Protecting and improving the nation's health

Feasibility study: developing the capability for population surveillance using indicators of child development outcomes aged 2 to 2 and a half years

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Purpose of the report

To share what we have found when testing the viability of using data, which is already collected at a local level from the application of the Ages and Stages Questionnaire (ASQ-3), to enable population surveillance of child development outcomes aged 2 to 2 and a half years. The report also tests the suitability of indicators in discrete areas of child development for publication in the Public Health Outcomes Framework at national and local levels and the possibilities for using this data to assess inequalities in these outcomes at a level of granularity which is currently hidden.

This will be of interest to policy makers, commissioners and providers of early year's services as it provides greater insight into their own data on the under-5s; allowing comparison of progress with geographic neighbours, similar areas of the country and the England average. It also demonstrates the extent to which these outcomes are socially distributed.

Background

From 2015 all children in England became eligible for a Healthy Child Programme development review, delivered as part of the universal health visitor service, around their second birthday. The Ages and Stages Questionnaire (ASQ-3) was identified through research to be suitable for generating data for a population measure of child development outcomes and from testing with parents and professionals to be acceptable for use in practice.

ASQ-3 is not a screening tool, but does provide an objective measure of development and allows comparisons to be made helping to identify children who are not developing as expected and supporting decisions on closer monitoring of progress or targeting of services. Dimensions of development which are tested include communication, gross motor, fine motor, problem solving and social/emotional skills.

Data generated from the ASQ-3 at local level flows from service providers to NHS Digital in a standard format as part of the Community Dataset (formerly the Children and Young Peoples Dataset). This data, which is intended to support the generation of indicators for the Public Health Outcomes Framework, is continually increasing in coverage and quality.

MethodologyIn this study anonymised data on individual children was collected directly from 3 local services. For each record it was noted whether the child was at or above

the expected level of development for that age in each of the separate domains of development and overall development (all domains combined).

Results

It was found that just over 89% of children were at or above the expected level of development in all 5 development domains of the ASQ-3. Results for individual development domains differed slightly as did the scores between boys and girls.

It was possible to generate indicators at a local level which would be statistically significant when considered on an annual basis, and where it was possible to distinguish between one local area and another for benchmarking purposes. This was true for overall development of the child as well as the individual domains of development.

In terms of inequalities it was found that children living in the most deprived areas have a lower chance of achieving the overall expected level of development than those living in the least deprived areas. This pattern was also seen the individual domains of development with communication skills being the most socially distributed at this age.

In particular, children living in the most deprived areas are around 8 percentage points less likely to have the expected level of communication skills than children living in the least deprived areas.

Conclusion

The data generated from the application from ASQ-3 is suitable for population surveillance, generating outcome indicators for child development which are sensitive to local variation and suitable for tracking inequalities in outcomes. It is therefore recommended that new indicators for child development outcomes aged 2 to 2 and a half are included in the Public Health Outcomes Framework just as soon as the data collated in the national datasets reaches suitable levels of coverage and quality.

This study confirms findings from previous cohort studies such as the Millennium Cohort Study and The Language Epidemic, which report on associations between deprivation and child development. However, this whole population approach is much more powerful given the greater volume of data, the statistical significance at local levels and the level of granularity which will support assessment of need and inform targeting of services.

This approach also benefits from the efficiencies and economies of scale of using an existing national data collection and reporting infrastructure. This approach enables linkage to other routine datasets, within and beyond health, to form a longitudinal view

of children on a continuum of development; generating evidence of impact on outcomes in early and later life and in time informing decision on the allocation of resources.

Introduction

All children in England are eligible for a development review, led by the local health visiting service, around their second birthday. This is an opportunity to identify children who are not developing as expected and who may require additional support in order to maximise their learning and development to be ready for school by age 5.

Between 1 January 2017 and 31 March 2017 77.4% of all children in England were reviewed by the health visiting service between 2 and age 2 and a half years (24 months to 30 months) and 91.2% of these were assessed using the Ages and Stages Questionnaire (ASQ-3^{TM}).

During the review health professionals work with parents to complete the ASQ-3 questionnaires which cover 5 domains of development including:

- communication - babbling, vocalising, listening and understanding
- gross motor skills - arm, body and leg movement
- fine motor skills - hand and finger movement
- problem solving - learning and playing with toys
- personal-social development - solitary social play, play with toys and play with other children

There are 3 possible questionnaires (24, 27, 30 months) depending on age of child at time of review. The Department of Health has developed a public health measure of child development outcomes for children aged 2 to 2 and a half years using ASQ-3. This considers the percentage of children at or above the expected level of development within each development domain and also across all 5 domains

The data is collected from local areas by NHS Digital as part of a national data collection, the Community Services Data Set (formerly the Children and Young People's Health Services Data Set). Service coverage and outcomes will start to be published in the Public Health Outcome Framework as soon as coverage and data quality allow.

The measure will help monitor child development outcomes across England so that changes in population health from year to year can be observed and the data can be used to track children's outcomes as they grow up. The data will also help to assess the impact and of services for 0 to 2 year olds and support future planning.

In addition the Community Services Data Set also collects background information on protected characteristics (gender, ethnicity, disability) and family circumstances (area of residence, main carer, child protection status) in a way which supports our understanding of the way in which outcomes may be socially distributed or that vulnerable groups maybe disadvantaged.

Feasibility Study

Local areas who are leading the way in the collection and use of data from ASQ-3 have been invited to submit their data for exploratory analysis. The aim of this is to test indicator production for the Public Health Outcomes Framework and suitability of the data for evaluation of inequalities related to the social determinants of health in advance of these being published on a more routine basis by NHS Digital. The Children's and Young Peoples Dataset went live in 2015 and has not yet achieved the levels of coverage and data quality required to routinely produce these statistics via that mechanism.

This study relates to 3 service providers in the North of England, and is divided into 3 parts.

1. Part 1 approximates a single year's worth of data for the areas separately and assesses whether the data items can be used to create a meaningful indicator at local authority level.
2. Part 2 considers all the data as a whole in order to gain as much insight as possible into the inequalities in child development outcomes in the early years. The sample used in this instance is unlikely to be representative of the England population as the localities are more deprived than the England average, and therefore these conclusions should be interpreted with care and may suggest areas to be monitored further as data quality and coverage improve.
3. Part 3 compares what the study shows in terms of inequalities to the findings from a similar piece of work undertaken by NHS Digital and Ofsted, looking at the data in the Community Services Dataset.

Feedback from the local areas suggests that the ASQ-3 questionnaires are used locally, along with other data and professional judgement to help identify children who may require additional support to meet developmental needs. Children whose scores fall within the shaded grey area (see Appendix B) are likely to have further action, for example support in the specific area of development, or further assessment. Any additional support proposed for each child is discussed and agreed with parents and included in the child's plan of care.

Data and Methodology

The data presented in this study relates to 25,914 children. The data from the 3 areas covered slightly different periods. The data was supplied by each provider in an Excel file, containing a sheet holding results for each questionnaire (24, 27 and 30 months). Each sheet row related to one assessment and provided the following information:

Feedback

- Super Output Area (SOA) (lower layer)
- SOA (middle layer) no used for the purposes of this analysis
- ASQ-3 problem solving score
- ASQ-3 communication score
- ASQ-3 personal -social score
- ASQ-3 gross motor score
- ASQ-3 fine motor score
- Sex
- Age in months or years (not used for the purposes of this analysis)

While each row relates to a child, it is not possible to identify individuals from the information received.

The scores were categorised into whether they were at or above the expected level of development (threshold) for that domain and the totals from the 3 questionnaires (24, 27 and 30 months) were combined.

Each small area of residence is associated with a deprivation 'score', using the English indices of deprivation 2015 (IMD 2015). These scores were used to establish a national deprivation decile, with decile 1 relating to the 10% most deprived areas nationally, and decile 10 holding the least deprived 10%. As the localities studied as a whole are more deprived than the national average, more children than would otherwise be expected appear in the deciles relating to higher deprivation; in fact 9,412 of the 25,914 children live in areas classed as within the highest deprived 10% nationally, which equates to over one third of the children considered. The conclusions in this document must be considered with this known limitation of the data in mind.

For each domain of development, the percentage of children scoring above the threshold (at or above the expected level of development) within each national deprivation decile was calculated and the results are shown in Part 2. The slope index of inequality (SII) was calculated which describes the extent to which deprivation affects the indicator: a high SII is evidence of higher deprivation inequality for the indicator considered. On the whole outcomes are worse for children living in more deprived areas and better for children living in less deprived areas. See Appendix C for more detail of the SII.

95% confidence intervals are shown in the tables and on the charts. A confidence interval is a range of values that is used to quantify the imprecision in the estimate of a particular indicator. Specifically it quantifies the imprecision that results from random variation in the measurement of the indicator. A wider confidence interval shows that the indicator value presented is likely to be a less precise estimate of the true underlying value.

More details on the analytical methodologies are available in Appendix B and Appendix C.

Part 1: Potential for production of annual local-area indicator of child development outcomes at 2 to 2 and a half years which are suitable for the Public Health Outcomes Framework

The data supplied varied in quantity, and in timescale, and this affected suitability for breaking down into individual years. Please see Appendix A for more detail of the areas and their data submissions. The data supplied were analysed and results are shown below, with 95% confidence intervals shown as 'I' on the figure, and in brackets in the table.

Figure 1-1: Proportion of children in Area A at or above the expected level of development at 2-2$^1/_2$ years, by individual development domain and all domains, 1 July 2016 to 30 April 2017

Table 1-1: Proportion of children in Area A at or above the expected level of development at 2 to 2 and a half years, by individual development domain and all domains, 1 July 2016 to 30 April 2017 (scaled up to represent one year)

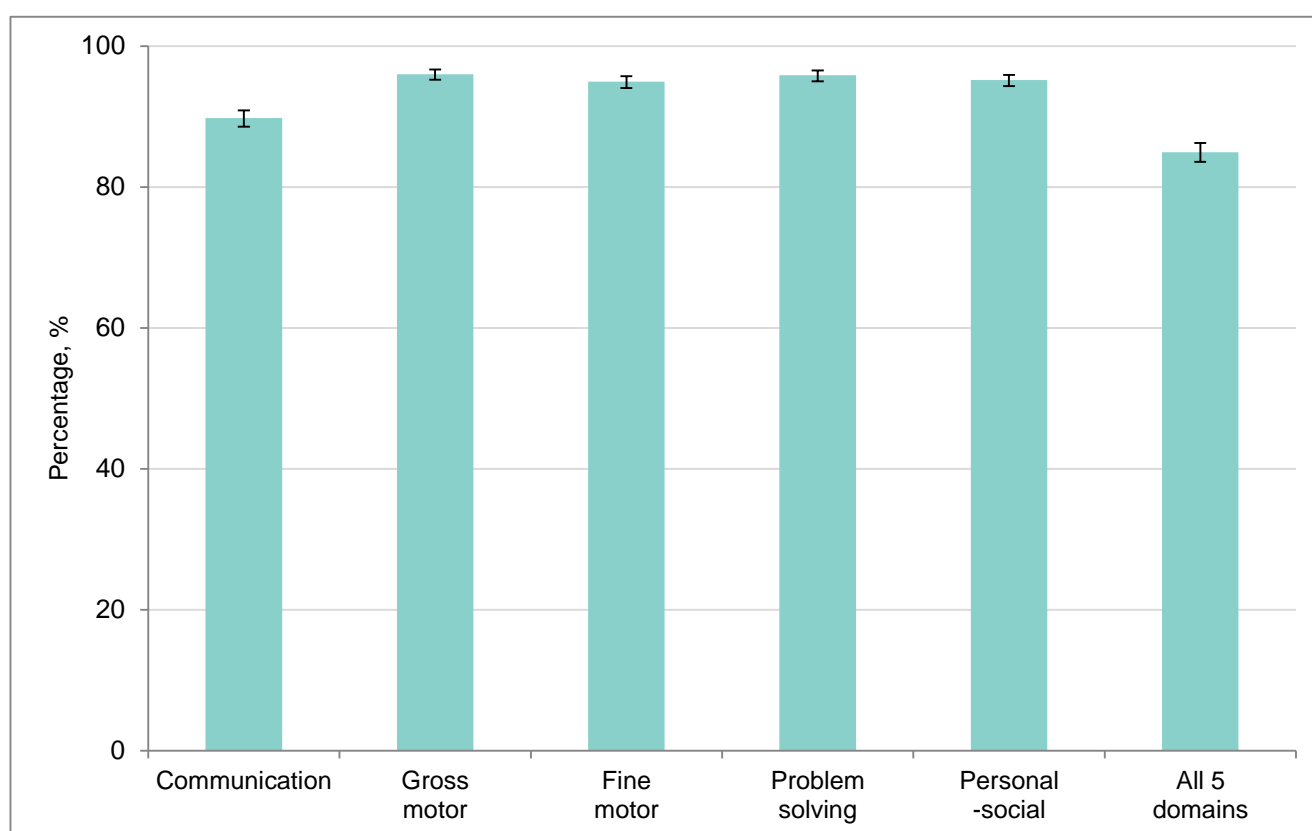|	Communication	Gross motor	Fine motor	Problem solving	Personal-social	All 5 domains
Children at or above the expected level	2,432	2,602	2,573	2,597	2,579	2,302
All children with a score	2,710	2,710	2,710	2,710	2,710	2,710
Proportion	89.8 (88.6-90.9)	96.0 (95.2-96.7)	95.0 (94.1-95.7)	95.8 (95.0-96.5)	95.2 (94.3-95.9)	84.9 (83.5-86.2)

Figure 1-2: Proportion of children in Area B at or above the expected level of development at 2 to 2 and a half years, by individual development domain and all domains, July 2015 to June 2016 and July 2016 to June 2017
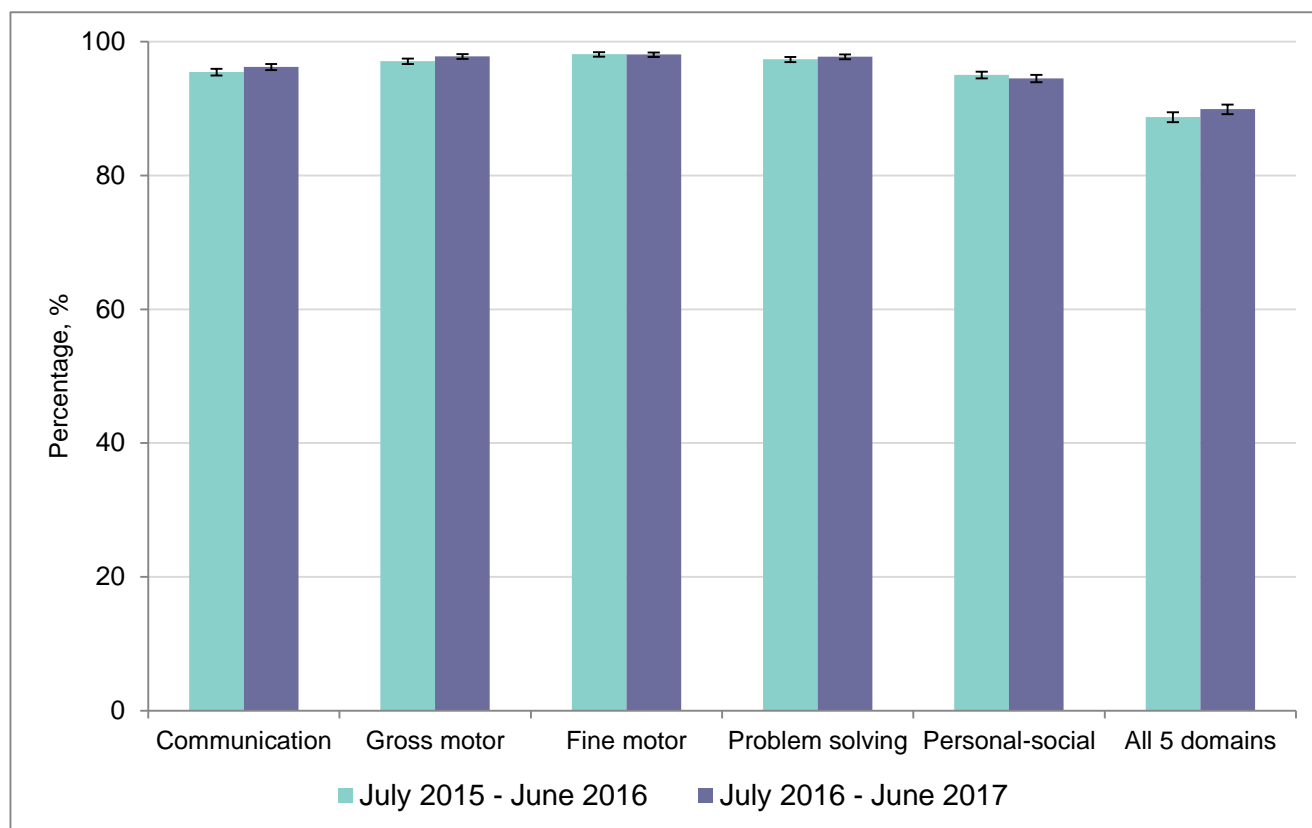

Table 1-2: Proportion of children in Area B at or above the expected level of development at 2-2$^{1}/_{2}$ years, by individual development domain and all domains, July 2015 – June 2016 and July 2016 – June 2017

July 2015 to June 2016	Communication	Gross motor	Fine motor	Problem solving	Personal-social	All 5 domains
Children at or above the expected level	6,496	6,607	6,677	6,626	6,467	6,038
All children with a score in the period	6,806	6,806	6,806	6,806	6,806	6,806
Proportion (confidence interval shown in brackets)	95.4 (94.9-95.9)	97.1 (96.6-97.5)	98.1 (97.8-98.4)	97.4 (96.9-97.7)	95.0 (94.5-95.5)	88.7 (87.9-89.4)
July 2016 to June 2017	Communication	Gross motor	Fine motor	Problem solving	Personal-social	All 5 domains
Children at or above the expected level	6,530	6,637	6,654	6,634	6,412	6,100
All children with a score in the period	6,786	6,786	6,786	6,786	6,786	6,786
Proportion (confidence interval shown in brackets)	96.2 (95.7-96.7)	97.8 (97.4-98.1)	98.1 (97.7-98.4)	97.8 (97.4-98.1)	94.5 (93.9-95)	89.9 (89.2-90.6)

Figure 1-3: Proportion of children in Area C at or above the expected level of development at 2 to 2 and a half years, by individual development domain and all domains, September 2015 to August 2016 and September 2016 to August 2017
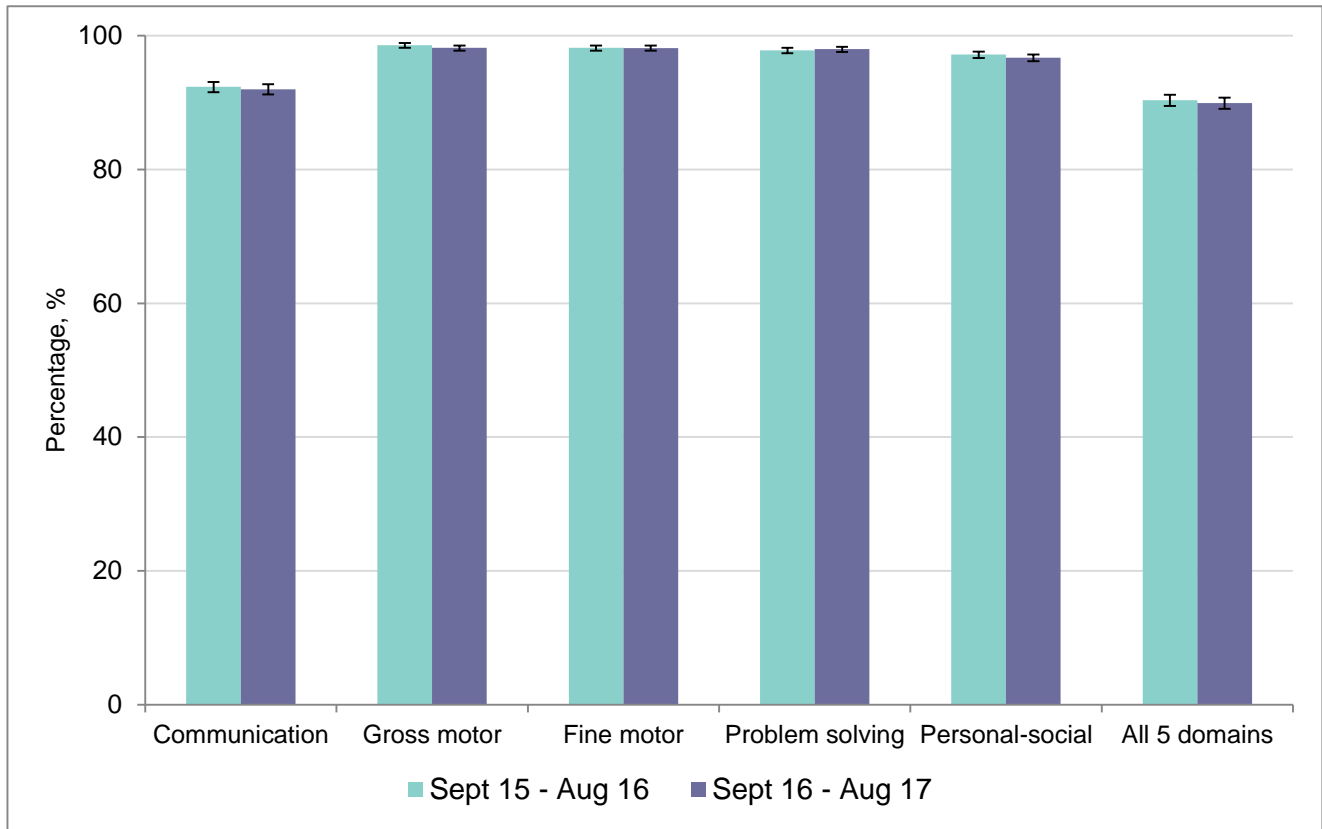

Table 1-3: Proportion of children in Area C at or above the expected level of development at 2-2$\frac{1}{2}$ years, by individual development domain and all domains, Sep 2015 to Aug 2016 and Sep 2016 to Aug 2017

September 2015 to August 2016	Commu nication	Gross motor	Fine motor	Problem solving	Personal- social	All 5 domains
Children at or above the expected level	4,367	4,662	4,643	4,626	4,595	4,273
All children with a score in the period	4,730	4,730	4,730	4,730	4,730	4,730
Proportion (confidence interval shown in brackets)	92.3 (91.5-93.1)	98.6 (98.2-98.9)	98.2 (97.7-98.5)	97.8 (97.3-98.2)	97.1 (96.6-97.6)	90.3 (89.5-91.1)
September 2016 to August 2017	Commu nication	Gross motor	Fine motor	Problem solving	Personal- social	All 5 domains
Children at or above the expected level	4,603	4,912	4,911	4,902	4,838	4,499
All children with a score in the period	5,004	5,004	5,004	5,004	5,004	5,004
Proportion (confidence interval shown in brackets)	92.0 (91.2-92.7)	98.2 (97.8-98.5)	98.1 (97.7-98.5)	98.0 (97.5-98.3)	96.7 (96.1-97.1)	89.9 (89.0-90.7)

Conclusion

The charts shown above present a similar view to how the data will be presented as indicators of child development outcomes in the Public Health Outcomes Framework. A single year of data from all 3 local areas has sufficiently small confidence intervals to allow for meaningful interpretation, and, as the outcome indicator is related to a universal service, it therefore seems likely this will be the same for the majority of areas once data are available. Unfortunately none of the areas considered were smaller than average (because of the availability of data) and smaller areas are likely to have wider confidence intervals, indicating a lower certainty of the values, and therefore for those areas the value of local inequalities information may be limited.

Part 2: Inequalities in child development outcomes at 2 to 2 a half years

For the local areas which submitted data for this study as a whole just over 89% of children were at or above the expected level of development in all 5 development domains of the ASQ-3: 86% of boys and 93% of girls. Results for individual development domains ranged from slightly under 94% of children at or above the expected level of development in communication skills to 98% at or above the expected level of development in fine motor skills. Individual development domains for boys ranged from slightly under 92% at or above the expected level in communication skills to 97% at or above the expected level in gross and fine motor skills. For girls, the domains of development range from just below 96% in communication skills to 98% in gross and fine motor skills, as well as problem solving. The gap between boys and girls is most pronounced in the communication and personal-social domains, as shown in Figure 2-1 and Table 2-1.

Figure 2-1 – Percentage of boys and girls at or above the expected level of development each domain and overall
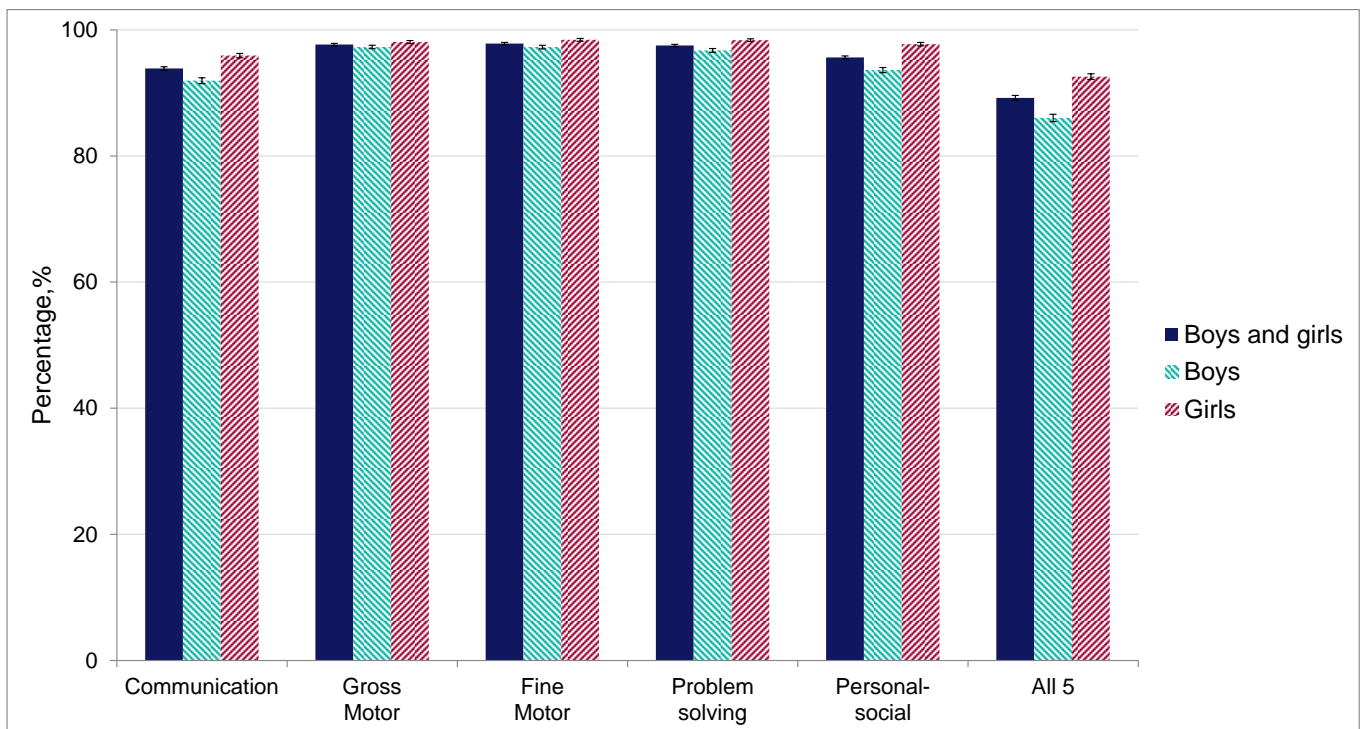
Table 2-1 – Percentage of children at or above expected level of development in each domain

Development Domain	Percentage of children at or above the expected level of development	Percentage of boys at or above the expected level of development	Percentage of girls at or above the expected level of development
Communication	93.9% (93.6-94.2)	91.9% (91.5-92.4)	95.9% (95.6-96.3)
Gross Motor	97.7% (97.5-97.8)	97.3% (97.0-97.6)	98.1% (97.8-98.3)
Fine Motor	97.8% (97.7-98.0)	97.3% (97-97.5)	98.4% (98.2-98.6)
Problem solving	97.5% (97.3-97.7)	96.7% (96.4-97.0)	98.4% (98.1-98.6)
Personal-social	95.6% (95.4-95.9)	93.6% (93.2-94.0)	97.7% (97.5-98.0)
All 5	89.2% (88.8-89.6)	86.1% (85.5-86.6)	92.6% (92.1-93.0)

When considering the deprivation of the area in which the children live, the percentage of children at or above the expected level of development in all development domains ranged from 86% in the most deprived areas to 93% in the third-least deprived. For individual domains, communication ranged from 91% to just under 98% (most to second-least deprived); gross motor, fine motor and problem solving showed little or no clear gradient; personal-social ranged from 94% in the most deprived areas to 97% in the least deprived.

Figure 2-2a – Percentage of boys and girls at or above the expected level of development in all 5 development domains, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right
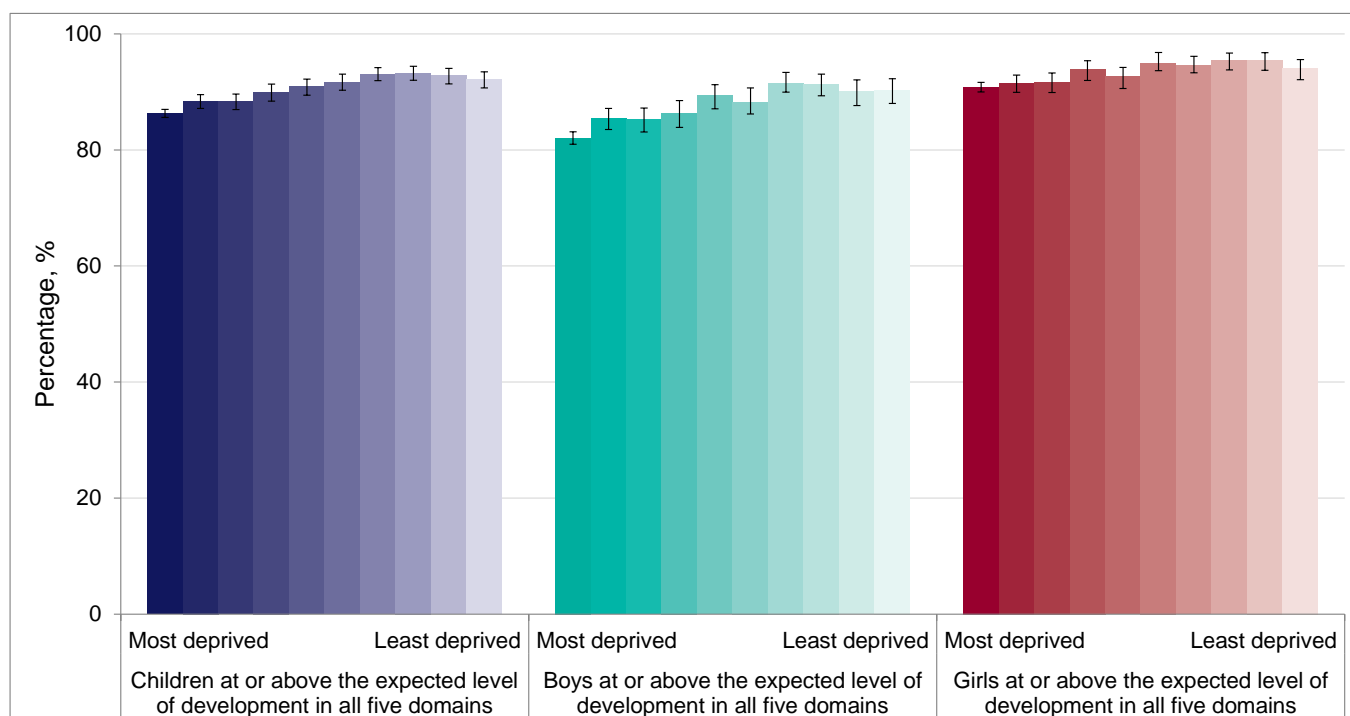
Table 2-2a – Percentage of boys and girls at or above the expected level of development in all 5 development domains, by decile of deprivation of residence

	Most deprived									Least deprived
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Children at or above the expected level of development in all five domains	86.3% (85.6-87.0)	88.4% (87.2-89.5)	88.4% (86.9-89.6)	90.0% (88.4-91.3)	90.9% (89.4-92.2)	91.6% (90.1-92.9)	93.0% (91.8-94.0)	93.3% (92.0-94.4)	92.8% (91.4-94.0)	92.2% (90.7-93.4)
Boys at or above the expected level of development in all five domains	82.1% (81.0-83.1)	85.4% (83.5-87.2)	85.3% (83.1-87.2)	86.4% (83.9-88.5)	89.3% (87.1-91.2)	88.3% (85.8-90.3)	91.5% (89.6-93.0)	91.4% (89.3-93.1)	90.1% (87.6-92.1)	90.3% (88.0-92.3)
Girls at or above the expected level of development in all five domains	90.9% (90.0-91.7)	91.5% (89.9-92.9)	91.7% (89.9-93.3)	93.9% (92.0-95.4)	92.6% (90.6-94.2)	95.0% (93.2-96.3)	94.5% (92.9-95.8)	95.5% (93.8-96.7)	95.5% (93.7-96.8)	94.1% (92.1-95.6)

Figure 2-2b – Percentage of boys and girls at or above the expected level of development in the communication domain, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right
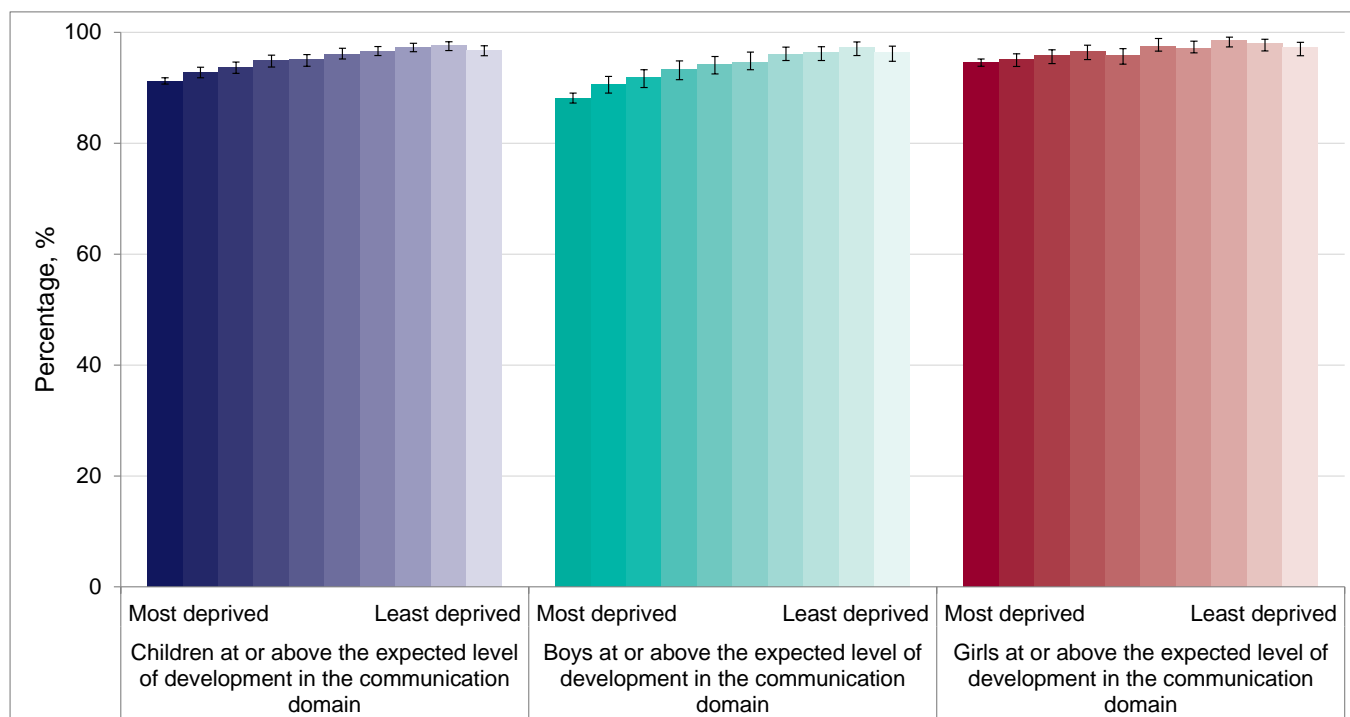

Table 2-2b – Percentage of boys and girls at or above the expected level of development in the communication domain, by decile of deprivation of residence

	Most deprived								Least deprived	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Children at or above the expected level of development in the communication domain	91.3% (90.7-91.8)	92.8% (91.8-93.7)	93.7% (92.6-94.6)	94.9% (93.7-95.9)	95.0% (93.9-96.0)	96.0% (95.0-96.9)	96.5% (95.7-97.3)	97.4% (96.5-98.0)	97.6% (96.7-98.3)	96.8% (95.8-97.6)
Boys at or above the expected level of development in the communication domain	88.2% (87.2-89.1)	90.7% (89.1-92.0)	91.8% (90.1-93.3)	93.4% (91.5-94.8)	94.3% (92.5-95.6)	94.6% (92.8-96.0)	95.9% (94.6-97.0)	96.4% (94.9-97.4)	97.3% (95.8-98.3)	96.4% (94.8-97.5)
Girls at or above the expected level of development in the communication domain	94.6% (93.9-95.2)	95.1% (93.8-96.1)	95.8% (94.4-96.8)	96.6% (95.1-97.7)	95.9% (94.3-97.0)	97.5% (96.1-98.4)	97.2% (95.9-98.0)	98.5% (97.4-99.1)	97.9% (96.6-98.8)	97.2% (95.8-98.2)

Figure 2-2c – Percentage of boys and girls at or above the expected level of development in the gross motor domain, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right

Table 2-2c – Percentage of boys and girls at or above the expected level of development in the gross motor domain, by decile of deprivation of residence

	Most deprived								Least deprived	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Children at or above the expected level of development in the gross motor domain	97.3% (96.9-97.6)	97.5% (96.9-98.0)	97.5% (96.7-98.1)	97.8% (97.0-98.4)	98.4% (97.7-98.9)	97.6% (96.7-98.3)	98.6% (97.9-99.0)	98.1% (97.4-98.7)	98.3% (97.5-98.9)	97.5% (96.6-98.2)
Boys at or above the expected level of development in the gross motor domain	96.8% (96.2-97.2)	97.2% (96.2-97.9)	97.1% (95.9-97.9)	97.6% (96.4-98.5)	98.5% (97.4-99.1)	96.8% (95.3-97.8)	98.5% (97.5-99.0)	97.6% (96.4-98.4)	97.9% (96.5-98.7)	97.6% (96.2-98.5)
Girls at or above the expected level of development in the gross motor domain	97.8% (97.3-98.2)	97.9% (97.0-98.5)	97.9% (96.8-98.6)	98.1% (96.8-98.8)	98.4% (97.2-99.0)	98.4% (97.3-99.1)	98.7% (97.8-99.2)	98.7% (97.7-99.3)	98.8% (97.7-99.4)	97.4% (95.9-98.3)

Figure 2-2d – Percentage of boys and girls at or above the expected level of development in the fine motor domain, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right
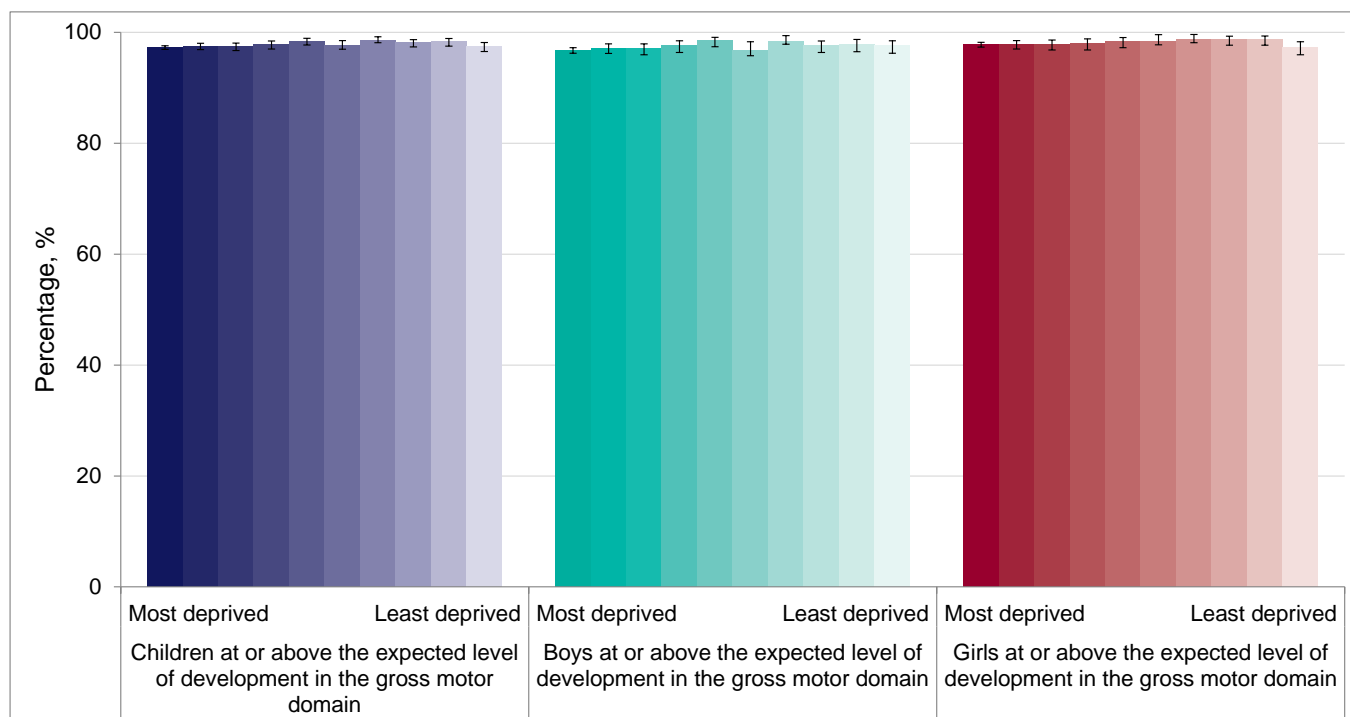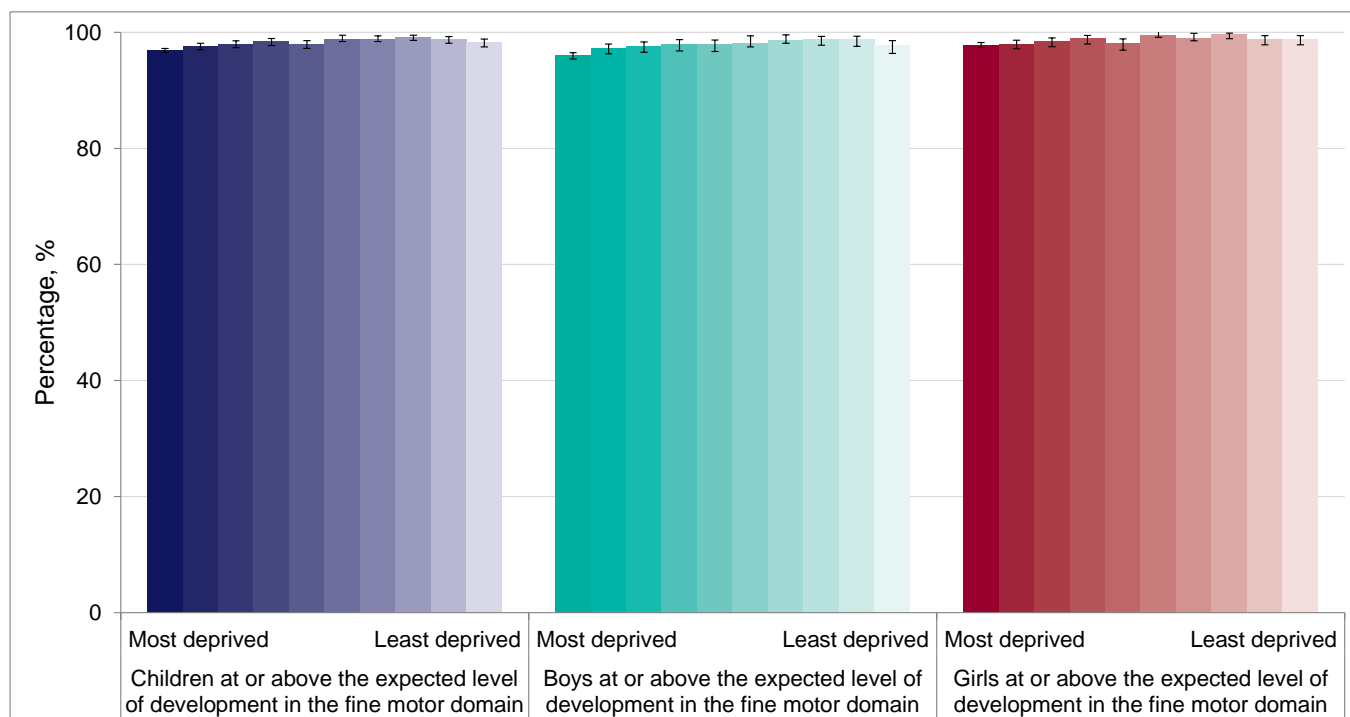

Table 2-2d – Percentage of boys and girls at or above the expected level of development in the fine motor domain, by decile of deprivation of residence

	Most deprived								Least deprived	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Children at or above the expected level of development in the fine motor domain	96.9% (96.5-97.2)	97.6% (97.0-98.1)	98.0% (97.3-98.5)	98.5% (97.7-98.9)	98.0% (97.2-98.6)	98.8% (98.2-99.3)	98.8% (98.2-99.2)	99.2% (98.6-99.5)	98.8% (98.1-99.3)	98.3% (97.5-98.8)
Boys at or above the expected level of development in the fine motor domain	96.0% (95.4-96.5)	97.3% (96.3-98.0)	97.6% (96.6-98.4)	98.0% (96.8-98.7)	97.9% (96.7-98.7)	98.2% (97.0-98.9)	98.6% (97.7-99.2)	98.8% (97.8-99.3)	98.7% (97.6-99.3)	97.7% (96.4-98.6)
Girls at or above the expected level of development in the fine motor domain	97.8% (97.4-98.2)	98.0% (97.1-98.6)	98.5% (97.5-99.1)	99.0% (98.0-99.5)	98.1% (96.9-98.9)	99.5% (98.7-99.8)	99.0% (98.1-99.4)	99.6% (98.9-99.9)	98.9% (97.9-99.4)	98.9% (97.8-99.4)

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Figure 2-2e – Percentage of boys and girls at or above the expected level of development in the problem solving domain, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right
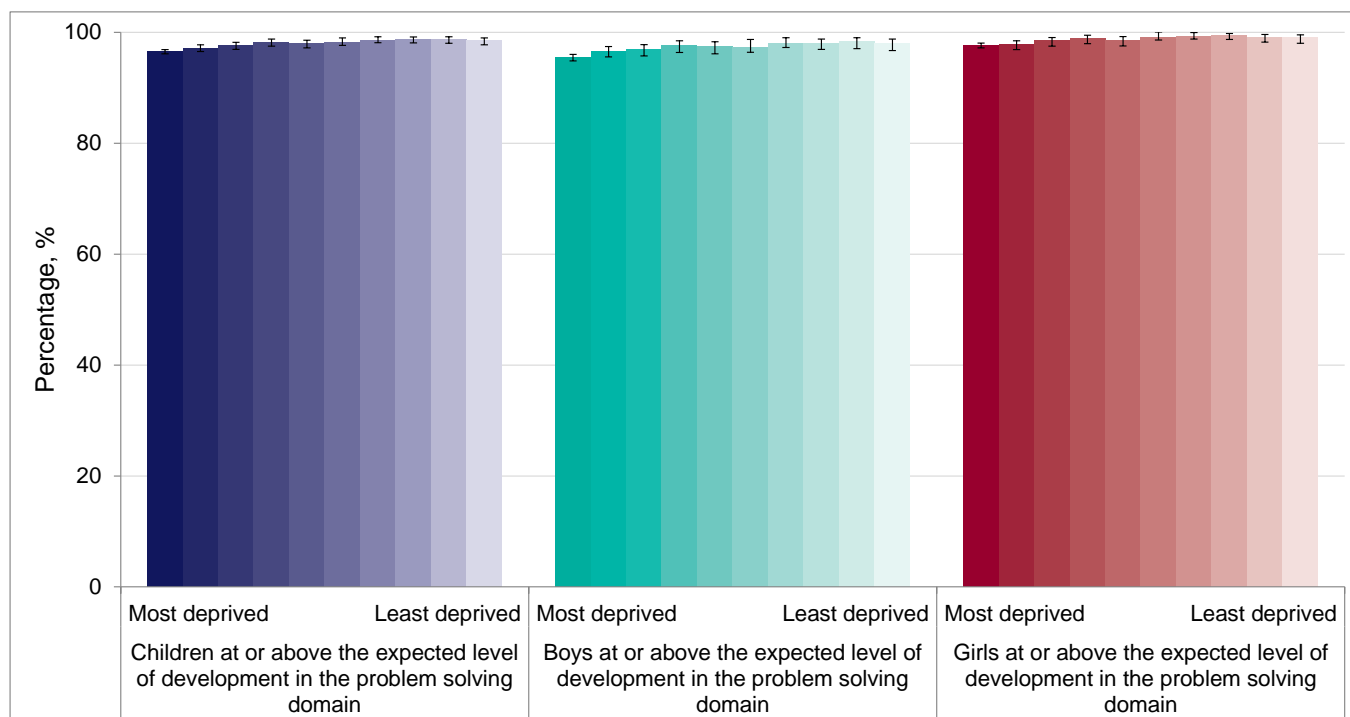

Table 2-2e – Percentage of boys and girls at or above the expected level of development in the problem solving domain, by decile of deprivation of residence

| | Most deprived | | | | | | | | | Least deprived |
	1	2	3	4	5	6	7	8	9	10
Children at or above the expected level of development in the problem solving domain	96.5% (96.1-96.9)	97.2% (96.5-97.8)	97.7% (96.9-98.2)	98.3% (97.5-98.8)	98.0% (97.2-98.6)	98.2% (97.4-98.7)	98.6% (97.9-99.0)	98.7% (98.1-99.2)	98.7% (98.0-99.2)	98.5% (97.7-99.0)
Boys at or above the expected level of development in the problem solving domain	95.5% (94.8-96.0)	96.6% (95.6-97.4)	96.9% (95.7-97.8)	97.6% (96.4-98.5)	97.4% (96.1-98.3)	97.3% (95.9-98.2)	98.0% (96.9-98.7)	98.1% (96.9-98.8)	98.3% (97.0-99.0)	98.0% (96.7-98.8)
Girls at or above the expected level of development in the problem solving domain	97.7% (97.2-98.1)	97.8% (96.9-98.5)	98.5% (97.5-99.1)	99.0% (98.0-99.5)	98.6% (97.6-99.2)	99.1% (98.1-99.6)	99.2% (98.4-99.6)	99.5% (98.7-99.8)	99.2% (98.2-99.6)	99.0% (98.0-99.5)

Figure 2-2f – Percentage of boys and girls at or above the expected level of development in the personal-social domain, by decile of deprivation of residence, most deprived decile on left of each chart, least deprived on right
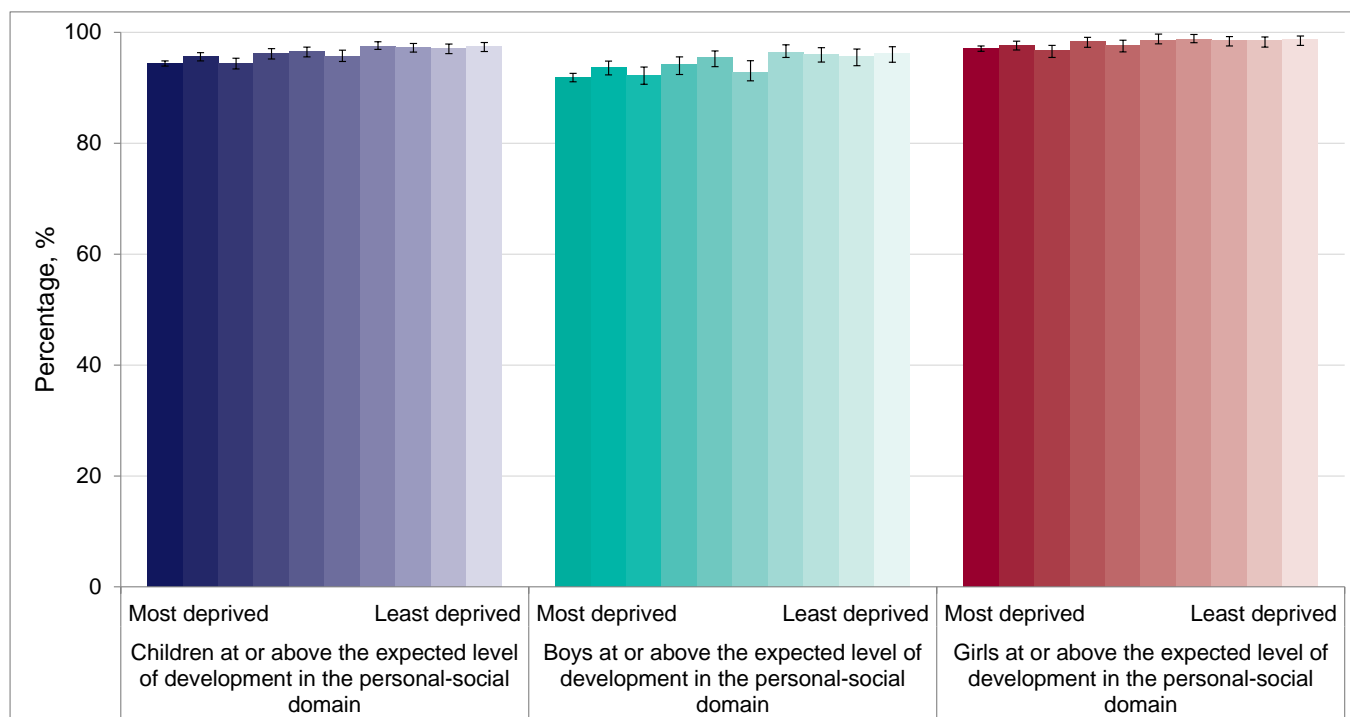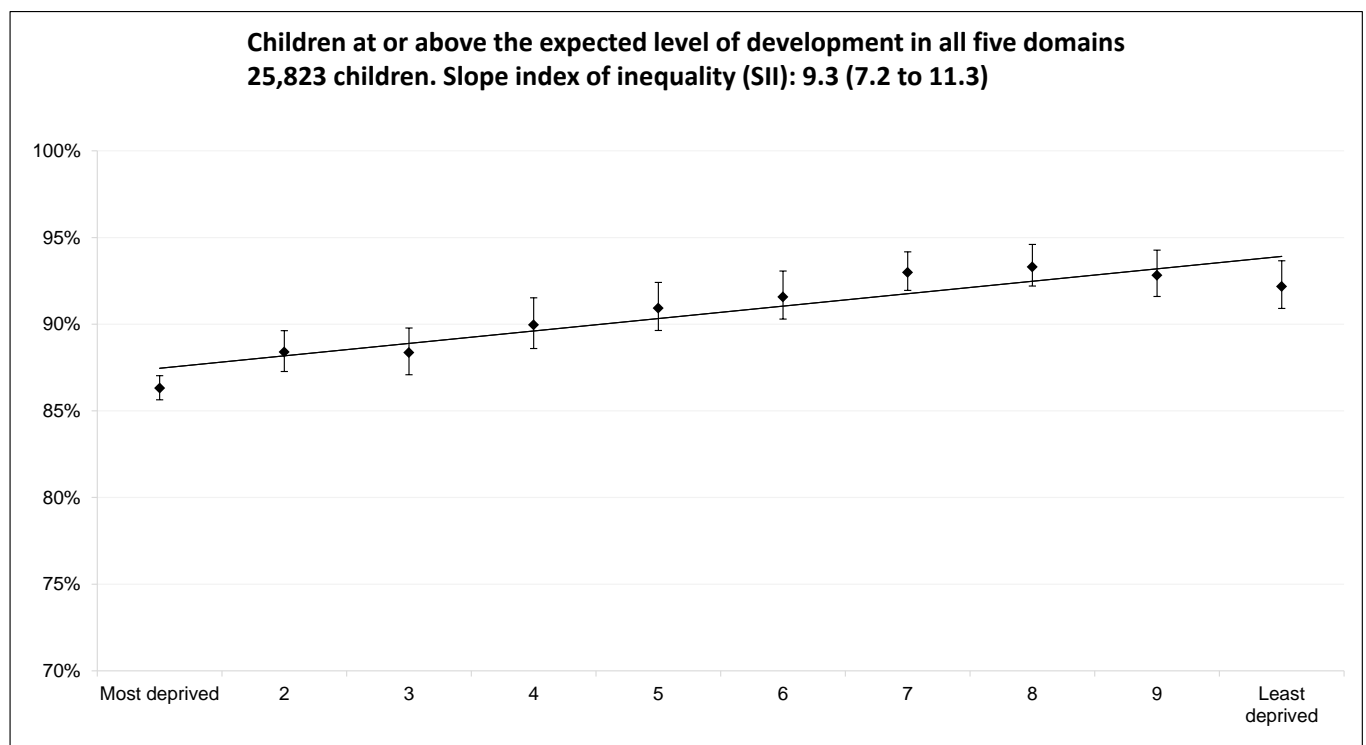

Table 2-2f – Percentage of boys and girls at or above the expected level of development in the personal-social domain, by decile of deprivation of residence

	Most deprived									Least deprived
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Children at or above the expected level of development in the personal-social domain	94.4% (93.9-94.8)	95.6% (94.8-96.3)	94.4% (93.4-95.3)	96.2% (95.2-97.0)	96.6% (95.6-97.3)	95.7% (94.5-96.6)	97.5% (96.8-98.1)	97.3% (96.4-98.0)	97.1% (96.1-97.9)	97.5% (96.6-98.2)
Boys at or above the expected level of development in the personal-social domain	91.9% (91.1-92.6)	93.7% (92.3-94.8)	92.3% (90.6-93.7)	94.2% (92.4-95.6)	95.4% (93.8-96.6)	92.8% (90.8-94.5)	96.4% (95.1-97.4)	96.1% (94.7-97.2)	95.7% (94.0-97.0)	96.2% (94.6-97.4)
Girls at or above the expected level of development in the personal-social domain	97.1% (96.6-97.5)	97.7% (96.8-98.4)	96.7% (95.5-97.7)	98.4% (97.3-99.1)	97.7% (96.5-98.6)	98.6% (97.4-99.2)	98.7% (97.8-99.2)	98.6% (97.5-99.2)	98.5% (97.3-99.2)	98.8% (97.7-99.3)

The slope index of inequality describes the extent to which deprivation (based on which national deprivation decile of the child's residence) impacts on the development outcome. Rather than just looking at the range between the values at the extreme ends, it takes into account the range for the entire population, and is also sensitive to the distribution of the population across the deciles.

Figure 2-2g – Slope index of inequality: all 5 domains of development (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in all five domains
25,823 children. Slope index of inequality (SII): 9.3 (7.2 to 11.3)

Figure 2-2h – Slope index of inequality: communication skills (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in the communication domain
25,823 children. Slope index of inequality (SII): 8.4 (6.8 to 9.9)
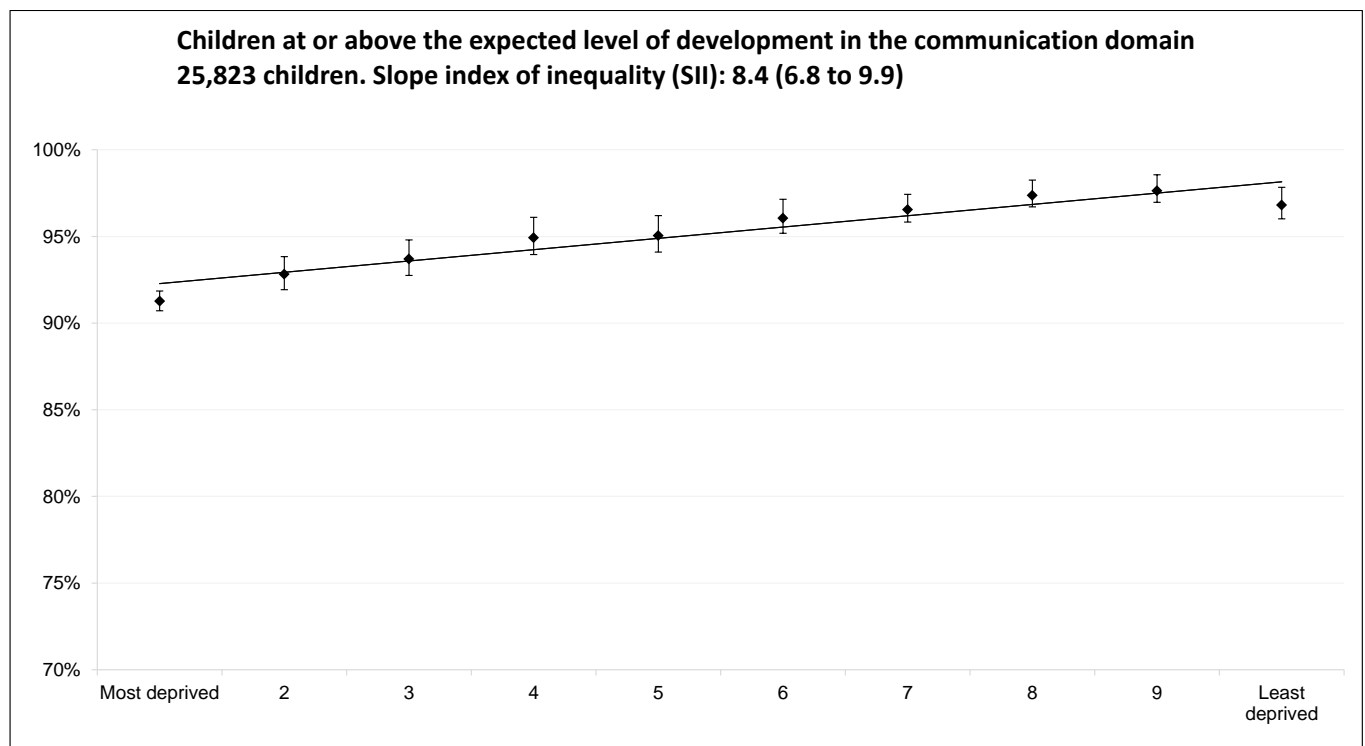
Figure 2-2i – Slope index of inequality: gross motor skills (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in the gross motor domain
25,823 children. Slope index of inequality (SII): 1.2 (0.2 to 2.3)
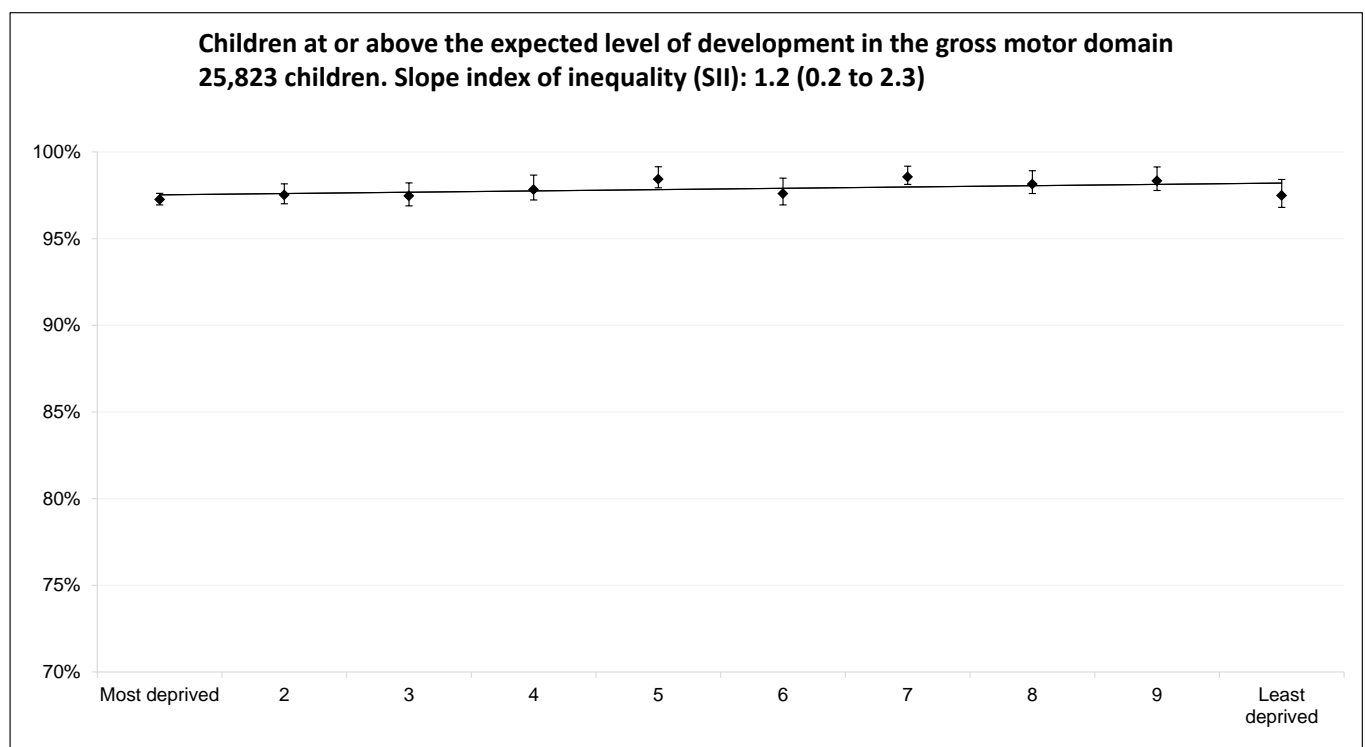
Figure 2-2j – Slope index of inequality: fine motor skills (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in the fine motor domain
25,823 children. Slope index of inequality (SII): 2.7 (1.8 to 3.8)
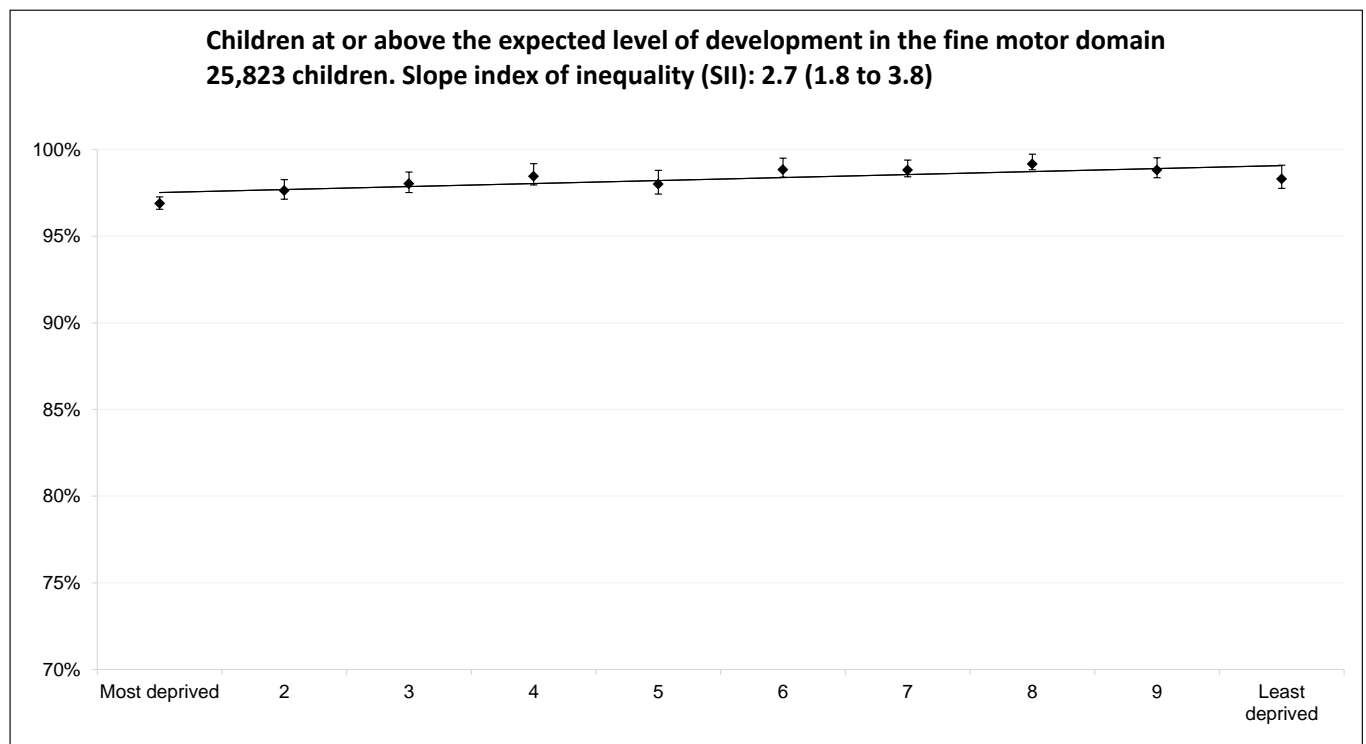
Figure 2-2k – Slope index of inequality: problem solving skills (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in the problem solving domain
25,823 children. Slope index of inequality (SII): 3.1 (2.0 to 4.1)

Figure 2-2l – Slope index of inequality: personal-social skills (confidence interval at 99.8% shown in brackets)

Children at or above the expected level of development in the personal-social domain
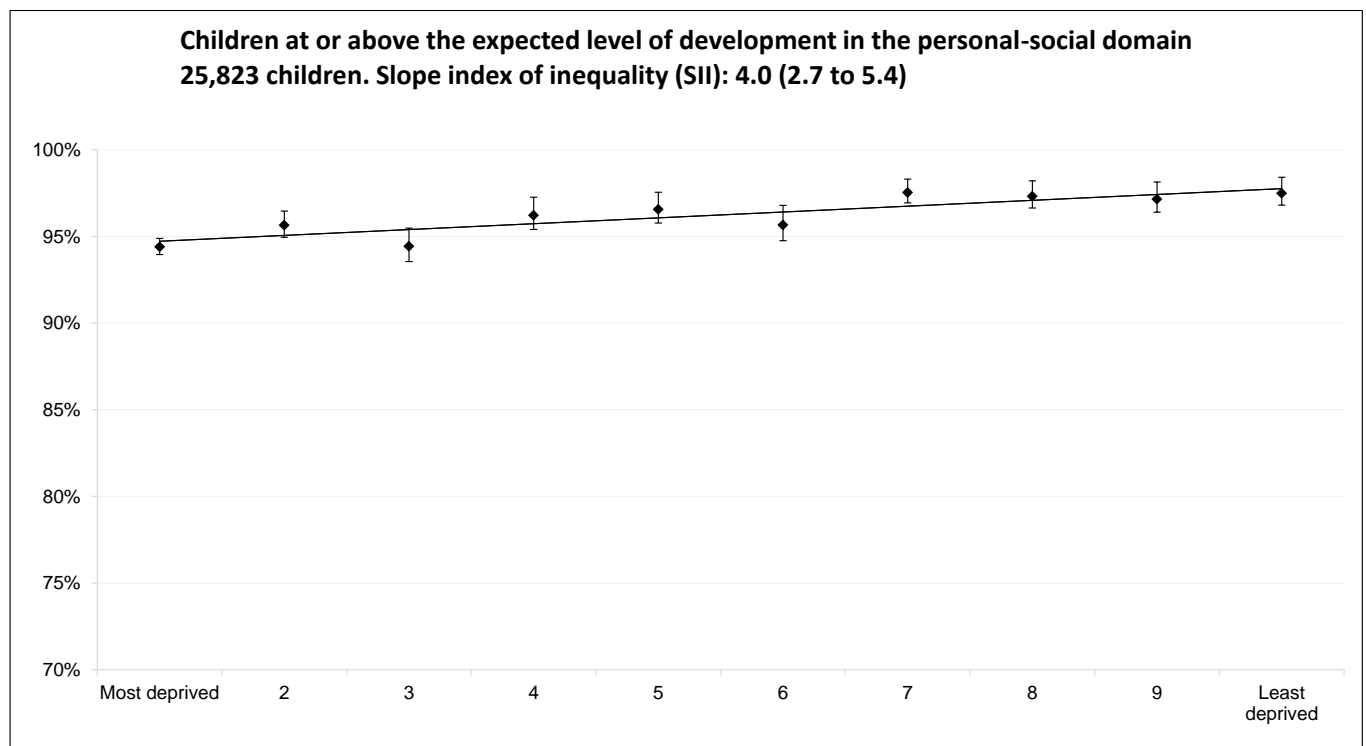25,823 children. Slope index of inequality (SII): 4.0 (2.7 to 5.4)

Table 2-2g – Summary of slope index of inequality for each domain of development Statistical significance was considered using the 99.8% confidence interval.

Dimension	Slope index of inequality (SII)	99.8% confidence interval of SII	Statistically significant at 99.8%*
All 5 domains	9.3	7.2 to 11.4	Yes
Communication skills	8.4	6.8 to 9.9	Yes
Gross motor skills	1.2	0.2 to 2.3	Yes
Fine motor skills	2.7	1.8 to 3.7	Yes
Problem solving skills	3.1	2.0 to 4.1	Yes
Personal-social skills	4.0	2.7 to 5.4	Yes

* considering whether the confidence interval spans zero: if it does the result is not considered significant

When considering all development domains together (overall development), figure 2.2g suggests that children living in the most deprived areas have somewhere between a 7.2 and 11.4 percentage points lower chance of achieving the expected level of development in all domains. At a population level, this indicates a significant inequality based on residence-based deprivation. Underlying this is a large inequality in communication skills (Figure 2.2h), with children living in the most deprived areas being at least 6.8 percentage points less likely to be at the expected level in this domain.

Smaller inequalities can be seen in personal-social skills (with children in the most deprived areas being at least 2.7 percentage points less likely to be at or above the expected level of development than those in the least deprived areas) and in problem solving skills (children in the most deprived areas being at least 2.0 percentage points less likely to be at or above the expected level of development than those in the least deprived areas). Gross motor skills shows a statistically significant inequality, however those in the least deprived areas are only about 1.2 percentage points more likely to reach the expected level in this domain, and therefore this will be of less interest at a population level. The inequality is slightly more marked for fine motor skills, where children in the most deprived areas are on average 2.7 percentage points less likely to be at or above the expected level than those in the least deprived areas.

Figure 2-2a shows the distribution with deprivation for all domains for both boys and girls separately and it is clear that growing up in deprivation poses a greater risk factor for boys than it does for girls. Again, this inequality is driven by the early development of communication skills, where there is a clear gradient for boys over the deprivation deciles.

Part 3: Comparison with NHS Digital and Ofsted publications

NHS Digital reports monthly on data from the Community Services Data Set, and this includes information that has been submitted about ASQ-3 outcomes at national and local authority levels. Monthly reports can be found here: http://content.digital.nhs.uk/maternityandchildren/CYPHSreports

As described in the introduction, coverage for the routine data still has some way to go and the data quality is not yet suitable for routine production of national indicators for the Public Health Outcomes Framework. However, the data that has been collected routinely is useful to compare and cross reference with the conclusions of this feasibility study.

In addition, in May 2017 a collaborative report between NHS Digital and Ofsted was published: http://digital.nhs.uk/catalogue/PUB30074. It investigated how sources of early years data can be used together to enrich analysis and insight into child development outcomes. This included analysis of the ASQ data between October 2016 and March 2017, and considered similar factors as those in this study, such as sex and deprivation.

The many different areas and time periods considered in this study mean there may be some overlap in the data shown so far in this study ('PHE data') and NHS Digital data (despite different reporting mechanisms, both were drawn from local information systems), and the findings cannot therefore be considered independent. However, comparison will help to provide some insight.

Table 3-1 – Percentage of children at or above the expected level of development in each development domain and overall (latest NHS Digital data, published October 2017)

Domain	Percentage of children at or above the overall expected level of development	
	PHE data (various points May 2015 to Sept 2017)	NHS Digital data (April to June 2017)
Communication	93.9%	93%
Gross Motor	97.7%	97%
Fine Motor	97.8%	97%
Problem solving	97.5%	97%
Personal-social	95.6%	97%
All 5	89.2%	89%

The values, while very slightly different, seem consistent. The proportion of children at the expected level of development in communication skills is lower than in the other domains.

Table 3-2 – Percentage of boys and girls at or above the expected level of development in each development domain and overall (NHS Digital from special report looking at detail of ASQ-3 data received, published September 2017)

Domain	Percentage of boys at or above the expected level of development		Percentage of girls at or above the expected level of development	
	PHE data (various points May 2015 to Sept 2017)	NHS Digital data (October 2016 to March 2017)	PHE data (various points May 2015 to Sept 2017)	NHS Digital data (October 2016 to March 2017)
Communication	91.9%	91%	95.9%	97%
Gross Motor	97.3%	97%	98.1%	98%
Fine Motor	97.3%	97%	98.4%	98%
Problem solving	96.7%	97%	98.4%	99%
Personal-social	93.6%	95%	97.7%	99%
All 5	86.1%	86%	92.6%	93%

The NHS Digital data also shows a large gap between boys and girls in the development of communication skills and a smaller yet notable gap in the development of personal-social skills, with other domains showing very small gaps which are less likely to be statistically significant.

As the methods used to assign children to deprivation deciles differed between the PHE data (which used IMD 2015) and the NHS Digital publication (which used IDACI), the figures are not shown in tables. However:

- a clear social gradient was noted overall development outcomes, and in the development of communication skills in the routine data reported by NHS Digital, with the 'gap' between those in the most and least deprived deciles at about 7 percentage points for communication skills, and 8 percentage points for overall development outcomes
- much smaller gaps were noted in the other domains
- this is consistent with the findings in this study, and supports the conclusion that children living in more deprived areas (despite methodological differences in

assigning this) are less likely to achieve the expected level of development in communication skills.

Conclusions

This feasibility study shows that the numerical results originating from the 5 domains of development, as assessed by using the Ages and Stages Questionnaire for individual children, are suitable for the production of population level indicators at national and local levels which are robust and statistically significant.

Once the Community Services Dataset is adequately populated with individual child health records updated on a monthly basis with the ASQ-3 data flowing from health visiting and/or early years services it will be possible to calculate indicators and prepare official statistics for child development outcomes aged 2 to 2 and a half years. It is proposed that these will be incorporated into the Public Health Outcomes Framework at England level and benchmarked by local authority of residence. Via this mechanism it will also be possible to track inequalities at an England level against various demographic and socio-economic factors and also for vulnerable groups as identified within the dataset.

Early results indicate that the development of communication skills is most heavily influenced by demographic and social factors, and is the one where the gap between boys and girls is the largest. Evidence is clear that poor communication skills can have long term consequences for social, educational, health and economic outcomes[1], and therefore the use of ASQ-3 and the publication of national statistics on child development outcomes provides an opportunity for early intervention to improve health and wellbeing outcomes for children and to reduce inequalities in those outcomes.

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[1] All Party Parliamentary Group on Speech and Language Difficulties, 2013
https://www.rcslt.org/about/parliamentary_work/appg_sld

Appendix A: Overview of study areas and their data submissions

Study area A is an urban area in the north of England. Over 20% of its Lower layer Super Output Areas (LSOAs) are classified as amongst the 10% nationally most deprived areas, and a higher than average proportion of children live in low income families. Compared to other upper-tier local authorities it has an average number of births per year. This area submitted 2,258 records covering 1 July 2016 to 30 April 2017. These have been scaled up to 12 months, and analysed as if representative of one full year's worth of data.

Study area B is a larger urban area, also in the north of England. Again over 20% of its LSOAs are classified as amongst the 10% nationally most deprived areas, and a higher than average proportion of children live in low income families. Compared to other upper-tier local authorities it has a very high number of births per year. This area submitted 13,782 records covering June 2015 to June 2017. This was by individual month. The first month has been discounted, and the subsequent 2 years analysed.

Study area C is another urban area in the north of England. Over 30% of its LSOAs are classified as amongst the 10% nationally most deprived areas, and a higher than average proportion of children live in low income families. Compared to other upper-tier local authorities it has a high number of births per year. It submitted 9,874 records covering the period May 2015 to September 2017. After looking at the number of records per month, the first 4 months and the very last month were discounted and the subsequent 2 years analysed (September 2015 to August 2017).

Appendix B: Cut off scores by questionnaire (extracted from ASQ-3 Information Summary sheets on 24, 27 and 30 month questionnaires)

24 month questionnaire

Area	Cutoff	Total Score	0	5	10	15	20	25	30	35	40	45	50	55	60
Communication	25.17														
Gross Motor	38.07														
Fine Motor	35.16														
Problem Solving	29.78														
Personal-Social	31.54														

27 month questionnaire

Area	Cutoff	Total Score	0	5	10	15	20	25	30	35	40	45	50	55	60
Communication	24.02														
Gross Motor	28.01														
Fine Motor	18.42														
Problem Solving	27.62														
Personal-Social	25.31														

30 month questionnaire

Area	Cutoff	Total Score	0	5	10	15	20	25	30	35	40	45	50	55	60
Communication	33.30														
Gross Motor	36.14														
Fine Motor	19.25														
Problem Solving	27.08														
Personal-Social	32.01														

The exact thresholds for each questionnaire are shown at the end of the shaded black section, with the grey sections showing the range of scores which professionals may want to follow up with individual children. The scores as applied are:

| Domain	24 month questionnaire threshold	27 month questionnaire threshold	30 month questionnaire threshold
Communication skills	25.17	24.02	33.3
Gross motor skills	38.07	28.01	36.14
Fine motor skills	35.16	18.42	19.25
Problem solving skills	29.78	27.62	27.08
Personal-social skills	31.54	25.31	32.01

Appendix C: Analytical methodology

Indices of Multiple Deprivation 2015

The English indices of deprivation 2015 (IMD 2015), were developed as official statistics by Department for Communities and Local Government. They measure relative levels of deprivation within small neighbourhoods (lower layer super output areas), in England. A number of domains are taken into account. More information:
www.gov.uk/government/statistics/english-indices-of-deprivation-2015

Slope Index of Inequality

The gradient of inequality for each outcome was described using the **slope index of inequality** (SII), calculated using the SII tool[2]. It calculates the 'line of best fit' for a standard bar chart, but then adjusts it to take into account the distribution of the indicator denominator within the 10 deciles. It is possible to do this because the underlying data source is at record level.
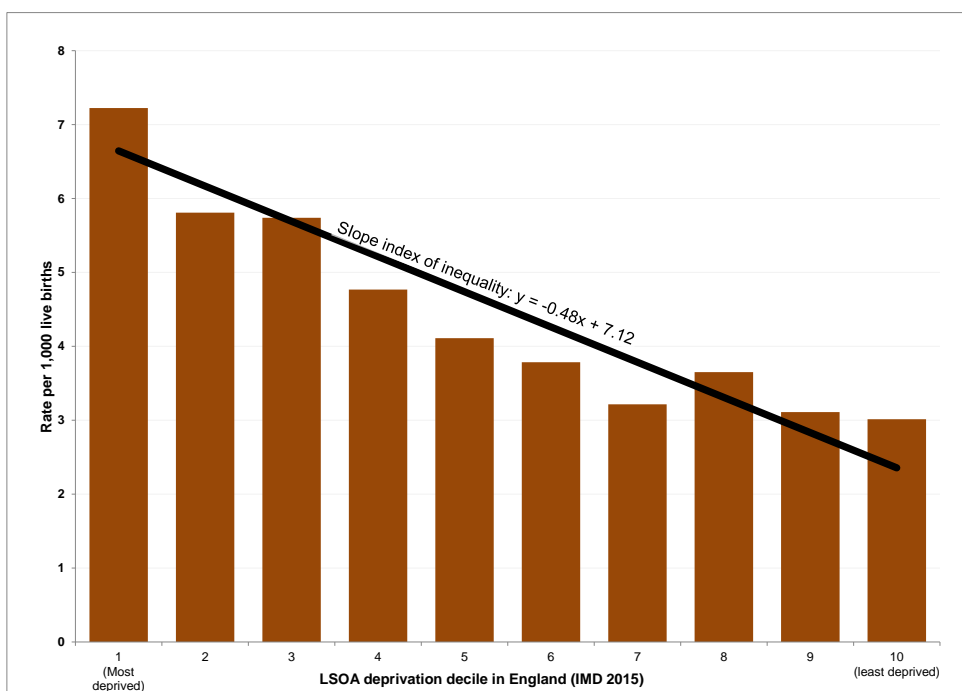
Example indicator of infant mortality rate in 2008, showing the slope index of inequality with gradient -0.48.

The confidence intervals for the slope index of inequality (SII) are calculated by simulation. Simulation is a method used to estimate the degree of uncertainty for measures where the statistical distributions underpinning the measure are too complex to analyse mathematically. For each decile, the value has been calculated along with its

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[2] The SII tool was developed by the Public Health England Knowledge and Intelligence Teams in the East Midlands and London. More information, including a link to a worked example in Excel can be found here:
www.apho.org.uk/resource/item.aspx?RID=132634

standard error (SE). These SEs give information about the degree of uncertainty around each of the values: essentially it describes a statistical distribution for each decile. Using a random number generating algorithm, a random value is taken from each decile value distribution and the SII recalculated. This is repeated many times (1,000,000), to build up a distribution of SII values based on random sampling from the decile value distributions. The 0.1% and 99.9% values from this distribution of SII values are then reported as the 99.8% confidence interval for the SII.

Confidence intervals on values

The Wilson Score method[1] gives very accurate approximate confidence intervals for proportions and odds based on the assumption of a Binomial distribution. It can be used with any data values, even when the denominator is very small and, unlike some methods, it does not fail to give an interval when the numerator count, and therefore the proportion, is zero. The Wilson Score method is the preferred method for calculating confidence intervals for proportions and odds, but it can also be used for rates, as long as the event rate is low (relatively rare events within the population) as the Binomial distribution is a very good approximation to the Poisson distribution when the event rate is low. The method is described in detail in APHO Technical Briefing 3: Commonly used public health statistics and their confidence intervals.[2]

[1] Wilson EB. Probable inference, the law of succession, and statistical inference. *J Am Stat Assoc* 1927;22:209-12.
[2] Eayres D. APHO Technical Briefing 3: Commonly used public health statistics and their confidence intervals York: APHO; 2008.