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Developmental and behavioural outcomes at 2 years in babies born during the COVID-19 pandemic: communication concerns in a pandemic birth cohort

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ABSTRACT

Introduction The CORAL (Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown) study reported a reduction in social communication milestones in 12-month-old infants born into the COVID-19 pandemic.

Aims To look at 24-month developmental and behavioural outcomes in the CORAL cohort.

Design The CORAL study is a longitudinal prospective observational study of Irish infants born in the first 3 months of the pandemic. At 24 months of age, the Ages and Stages Developmental Questionnaire (ASQ24) and the Child Behaviour Checklist (CBCL) were completed and compared with prepandemic BASELINE (Babies After SCOPE: Evaluating the Longitudinal Impact Using Neurological and Nutritional Impact) cohort.

Results 917 babies (312 CORAL infants and 605 BASELINE infants) were included. At 24 months of age, infants in the CORAL and BASELINE cohorts had similar developmental ASQ24 scores in fine motor, problem solving and personal and social domains but ASQ24 communication scores were significantly lower in the CORAL group compared with the BASELINE cohort (mean (SD) 49.5 (15.1) vs 53.7 (11.6), p<0.01). Infants from the CORAL cohort were more likely to score below standardised cut-offs for developmental concern in the communication domain (11.9% CORAL compared with 5.4% BASELINE, p<0.01). Unadjusted ASQ24 gross motor scores were lower for the pandemic cohort. Fewer CORAL infants fell under 2 SD cut-off in personal-social subdomain. For CBCL, there was no evidence of difference in scores between the cohorts on multivariable analysis.

Conclusion 24-month-old pandemic-born infants had largely similar developmental and behavioural scores compared with their prepandemic counterparts. Concerns have been raised in the communication developmental domain.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ We know that babies aged 12 months and younger born during the COVID-19 pandemic have some deficits in developmental outcomes. To date, there have been no reports solely regarding the outcome at 24 months of age in those babies born into the pandemic.

WHAT THIS STUDY ADDS

⇒ This study looks at parentally reported outcomes in babies aged 24 months who were born during the pandemic.
⇒ We demonstrate that communication deficits continue to be evident at 2 years of age.
⇒ Reassuringly, there are no differences between pandemic-born and prepandemic infants in most other developmental domains or behavioural outcomes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study highlights the need for continued national developmental screening programmes.
⇒ Additional resources will be required for developmental interventions for pandemic-born children who require them.

Linked

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INTRODUCTION

The world was very different for children during the COVID-19 pandemic. Exposure to people outside their immediate family group (parents and siblings) was curtailed from birth.[1] Lockdown led to limited or no input from family especially grandparents.[1] Additional childcare responsibilities, working from home and financial concerns added to parenting stressors,[2] with reports of loneliness and isolation,[1] and an increase in maternal depression.[3] School-age children were not able to go to in-person classes and most preschool-age children were unable to attend early years care/education, with those in attendance demonstrating better outcomes in language and executive function.[4] When children did meet others from outside the home it was likely (given local public health policies) that adults were wearing a mask, leading to questions about what impact this may have on language development.[5] A recent paper demonstrated that myelination of language-related white matter pathways at 2 years of age was positively associated with conversation.[6]

Studies of infants who have lived some portion of their life during the pandemic have demonstrated deficits in communication, motor and personal/social scores.[7–9] We have previously demonstrated that an Irish birth cohort born into the pandemic had reduced social communication skills relative to a historic Irish cohort at 12 months of age.[10] This has been confirmed in a recent systematic review

looking at developmental outcomes.[11] However, young children born prior to and living some of their life during the pandemic demonstrated no behavioural differences on total internalizing or externalizing scores at 3–4 years of age on the Child Behaviour Checklist (CBCL).[3]

Developmental screening is well established in many countries,[12–14] but lockdown presented significant challenges to screening programmes with some services suspended or severely curtailed[15 16] and a prioritisation-based approach adopted in some regions. The onus for recognising developmental delay shifted to parents, which may have been difficult, especially for first-time parents, without input from grandparents or comparisons with similarly aged children of their social group.[17]

There are many validated developmental and behavioural screening tools.[18] The Ages and Stages Questionnaire (ASQ) is a parentally reported validated developmental screening tool used in many screening programmes.[19] It has five domains (communication, gross motor, fine motor, problem solving, personal-social). The ASQ is available at two monthly intervals from 2 to 60 months of age. Cut-offs are determined by normative data (based on a US cohort) and are set at <1 SD (indicating a 'monitoring zone' where the child should be reassessed at an interval) and at <2 SD (indicating that the child should be referred for further developmental assessment). The CBCL is a validated parentally reported 99-question behavioural problem scale and it includes a subscale for issues that may be associated with autism.[20]

The CORAL (Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown) study is a longitudinal prospective observational study of allergy, immune function and neurodevelopment in singleton term Irish infants born during the first 3 months of the COVID-19 pandemic.[1 21 22] In the 13 months that followed the start of lockdown in Ireland, 87% of that time was spent in the strictest level (national level 5) of lockdown[1] (level 5: no home visitors, stay at home except for essential purposes, exercise within 2–5 km of home, essential retail only, work from home unless essential worker). The BASELINE (Babies After SCOPE: Evaluating the Longitudinal Impact Using Neurological and Nutritional Impact) study recruited babies born in Ireland between 2008 and 2011.[23]

In CORAL we hypothesised that there may be developmental and behavioural deficits compared with a prepandemic cohort. Our aim was to compare developmental and behavioural outcomes at 24 months of age between the CORAL and BASELINE birth cohorts using parentally reported questionnaires.

METHODS

Recruitment in CORAL study

A total of 3065 term infants born in the two participating major maternity hospitals in Dublin from March to May 2020 were invited to participate. Exclusion criteria were prebirth PCR-proven SARS-CoV-2 infection in a parent or codwelling person, intravenous antibiotics in the neonatal period, multiple births or major congenital anomaly. A total of 354 infants were recruited postnatally to the CORAL study. Babies were reviewed at 6, 12 and 24 months of age.

Recruitment in BASELINE study

The BASELINE study recruited babies born in Ireland between 2008 and 2011.[23] Detailed information was collected at birth and 12 and 24 months (early life environment, diet, growth, general health and development). Further details about recruitment, protocol and prior results of the BASELINE study have been published[23] and are available online (www.baselinestudy.net and www.birthcohorts.net →Babies After SCOPE: Evaluating the Longitudinal Impact Using Neurological and Nutritional Impact).

Assessments

At 24 months of age, parents for both birth cohorts were sent the ASQ (version 3) 24-month[19] questionnaire (for completion between 23 months 0 day and 25 months 15 days) and the CBCL 1.5–5 years questionnaire.[20] Comparisons were made between term infants from the CORAL and BASELINE cohorts who completed the questionnaires. The ASQ24 has total score (out of 300), five domain scores (each out of 60) and standardised 2 cut-off points (1 SD and 2 SD).[24] On the ASQ, higher scores are associated with a normal developmental profile. CBCL has total, internalizing and externalizing scores and 1 cut-off point (above T score; previously determined by standardised testing); in addition, there are domain scores.[20] On the CBCL, lower raw scores are associated with a normal behavioural profile.

Demographic details were collected on both cohorts. Parents of the CORAL cohort were asked if they had developmental concerns and, if so, in which domain(s). Details on PCR, antigen or antibody-confirmed COVID-19 infection in the first 2 years of life were available for participants in the CORAL study.

Statistical analysis

Appropriate descriptive statistics were used to describe the two cohorts and appropriate tests were used to explore potential differences between the cohorts (ie, T-tests or Mann-Whitney U test for continuous data and χ^2/Fisher's exact test for categorical data). It is commonplace in the literature to report both ASQ and CBCL by mean score values (although not normally distributed), so for both questionnaire outcomes we reported mean and SD in addition to median and IQR. To explore potential differences between the two cohorts, multivariable logistic or linear regression was carried out, adjusted for age at questionnaire completion (in months and days), gender, presence of siblings, maternal educational attainment and COVID-19 infection. Beta coefficients (β) or ORs and 95% CIs for the CORAL cohort relative to the BASELINE cohort are reported where appropriate. Analysis was complete case analysis. Where a subdomain score from ASQ or CBCL was missing this case was not included in subgroup analysis. As this was an exploratory observational study significance was set at 0.05 and there was no adjustment for multiple comparisons. Stata (SE V.17.1, StataCorp, Texas, USA) was used for all analyses.

RESULTS

Demographics

Parents of 312 CORAL and 605 BASELINE term babies completed the 24-month assessments and were included in the analysis. Mean age at assessment was 24.1 months in the CORAL cohort and 24.8 months in the BASELINE cohort ($p<0.01$). CORAL had 55% male participants compared with 49.6% in BASELINE ($p=0.13$). Maternal education to tertiary level was higher in the CORAL compared with the BASELINE cohort (95% vs 88%, $p<0.01$). CORAL babies were more likely to have siblings than those in the BASELINE cohort (62.8% vs 37.2%, $p<0.01$). Forty per cent of the CORAL cohort of infants had COVID-19 infection during the 2-year study period (online supplemental table 1).

ASQ results in CORAL compared with BASELINE

Participants completing the ASQ24 between 23 months 0 day and 25 months 15 days were included (n=917; CORAL

Table 1 ASQ total and subset scores in CORAL versus BASELINE infants

	CORAL (n=312)	BASELINE (n=605)	Unadjusted comparison† P value	Adjusted regression models‡ β or OR (95% CI) P value
ASQ total score				
Median score; IQR	255; 230–275	263.5; 240–280	<0.01*	
Mean; SD	248.7; 36.7	255.6; 34.4	<0.01*	β −3.5 (−10.4 to 3.5) 0.33
Communication				
Median score; IQR	55; 45–60	60; 55–60	<0.01*	
Mean; SD	49.5; 15.1	53.7; 11.6	<0.01*	
Yes under 1 SD; % (n)	18.9 (59/312)	9.9 (60/605)	<0.01*	**OR 2.1 (1.2 to 6.7) 0.012**
Yes under 2 SD; % (n)	11.9 (37/312)	5.3 (32/605)	<0.01*	**OR 2.1 (1.1 to 4.2) 0.035**
Gross motor				
Median score; IQR	55; 50–60	60; 50–60	<0.01*	
Mean; SD	52.6; 9.3	55.1; 7.6	<0.01*	
Yes under 1 SD; % (n)	18.3 (57/312)	10.9 (66/605)	0.01*	OR 1.3 (0.7 to 2.2) 0.38
Yes under 2 SD; % (n)	6.7 (21/312)	3.5 (21/605)	0.025*	OR 1.3 (0.6 to 3.0) 0.52
Fine motor				
Median score; IQR	50; 45–55	50; 48–60	0.38	
Mean; SD	50.9; 7.5	51.3; 7.7	0.48	
Yes under 1 SD; % (n)	11.9 (37/312)	11.9 (72/603)	0.97	OR 0.8 (0.5 to 1.5) 0.51
Yes under 2 SD; % (n)	5.8 (18/312)	4.5 (27/604)	0.45	OR 0.6 (0.2 to 1.4) 0.23
Problem solving				
Median score; IQR	45; 40–55	50; 40–55	0.77	
Mean; SD	46.6; 9.8	46.3; 10.6	0.82	
Yes under 1 SD; % (n)	18 (56/312)	17.5 (105/600)	0.87	OR 0.8 (0.5 to 1.4) 0.42
Yes under 2 SD; % (n)	3.5 (11/312)	5.8 (35/600)	0.13	OR 0.4 (0.1 to 1.2) 0.11
Personal-social				
Median score; IQR	50; 45–60	50; 45–57.5	0.56	
Mean; SD	49.2; 9.2	49.3; 10.0	0.90	
Yes under 1 SD; % (n)	22.8 (71/312)	22.8 (138/605)	0.99	OR 0.9 (0.5 to 1.4) 0.51
Yes under 2 SD; % (n)	4.2 (13/312)	5.8 (35/605)	0.30	**OR 0.3 (0.1 to 0.8) 0.022**

Results highlighted in bold show evidence of a statistically significant difference between groups using adjusted analysis. Cases with missing data were not included in subgroup analysis which is why not all numbers add to 312 for CORAL and 605 for BASELINE.
*Results that reached significance in unadjusted analysis.
†Unadjusted comparisons made using Mann-Whitney U test, T-test and χ^2 test where appropriate.
‡All regression models were adjusted for sex, age at questionnaire completion, maternal education, COVID-19 infection and presence of siblings. Linear regression model results reported as beta coefficients (β) with 95% CI and p value. Logistic regression models reported as OR with 95% CI and p value.
ASQ, Ages and Stages Questionnaire; BASELINE, Babies After SCOPE: Evaluating the Longitudinal Impact Using Neurological and Nutritional Impact; CORAL, Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown.

n=312 and BASELINE n=605). There was a significant difference in two ASQ domains (communication and gross motor) in CORAL compared with BASELINE, as well as ASQ total score (see table 1). Multivariable logistic regression demonstrated a statistical difference in the communication domain with 18.9% of CORAL participants below 1 SD compared with 9.9% of BASELINE participants (OR 2.1, 95% CI 1.2 to 6.7), and 11.9% of CORAL babies below 2 SD compared with 5.3% of BASELINE participants (OR 2.1, 95% CI 1.1 to 4.2). There were no differences seen between personal-social subscores, although slightly fewer of the CORAL babies fell below 2 SD (4.1% compared to 5.8%; OR 0.3, 95% CI 0.1 to 0.8).

13.5% (40/305) of parents from the CORAL cohort expressed developmental concerns, mostly related to language (31/305); however, most of these children did not fall below the developmental assessment referral cut-off (2 SD) for the communication domain. Sixty-eight children from the CORAL cohort had at least one ASQ score under the 2 SD cut-off (in any domain), of whom 20 families had expressed developmental concerns.

Table 2 CBCL total and subset scores in CORAL versus BASELINE infants

	CORAL (n=303)	BASELINE (n=596)	Unadjusted† P value	Adjusted regression models‡ OR (95% CI) P value
Total scores				
Median; IQR	18; 10–29	20; 11–31	0.05	β –0.66 (–3.6 to 2.3) 0.66
Mean; SD	20.8; 15.8	22.3; 14.3	0.15	
T score (% over threshold)	3.3% (10/303)	3.2% (19/596)	0.93	OR 1.1 (0.3 to 3.5) 0.91
Internalizing scores				
Median; IQR	3; 1–6	4; 2–7	<0.01*	β –0.4 (–1.3 to 0.5) 0.34
Mean; SD	4.2; 4.7	5.0; 4.3	0.019*	
T score (% over threshold)	3.3% (10/303)	4.9% (29/596)	0.28	OR 0.9 (0.3 to 2.7) 0.79
Externalizing scores				
Median; IQR	7; 3–13	8; 4–13	0.10	β –0.1 (–1.4 to 1.2) 0.88
Mean; SD	8.6; 6.7	9.1; 6.2	0.27	
T score (% over threshold)	5.6% (17/303)	4.9% (29/595)	0.63	OR 1.3 (0.6 to 3.2) 0.54

*Indicates value <0.05.
†Unadjusted comparisons made with Mann-Whitney U test and χ^2 test.
‡All regression models were adjusted for sex, age at questionnaire completion, maternal education, COVID-19 infection and presence of siblings. Linear regression model results reported as beta coefficients (β) with 95% CI and p value. Logistic regression models reported as OR with 95% CI and p value.
BASELINE, Babies After SCOPE: Evaluating the Longitudinal Impact Using Neurological and Nutritional Impact; CBCL, Child Behaviour Checklist; CORAL, Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown.

CBCL results

Three-hundred and three CORAL and 596 BASELINE CBCL questionnaires were completed. There was no evidence of any statistically significant differences in the total and external scores (table 2). There was evidence of a marginally lower internal score in CORAL babies, but this was not significant on multivariable analysis. There was no evidence of any difference in the proportion of children scoring above the threshold for concern (for total, external and internal scores).

For CBCL subscores, there were marginally lower scores in the following domains: emotionally reactive, somatic complaints, withdrawn, autism spectrum problems and oppositional defiant, indicating that these issues were slightly less prominent in the COVID-19 cohort of children; however, multivariable regression modelling showed no evidence of any differences (online supplemental table 2).

DISCUSSION

We report developmental and behavioural outcomes at 24 months of age in a cohort of infants born during the first 3 months of the COVID-19 pandemic, who have lived their whole lives in and after the pandemic. The main developmental finding is that the pandemic-born babies showed deficits in communication not seen in a comparable prepandemic birth cohort. There were some differences in gross motor development in unadjusted analysis but not on adjusted analysis. Reassuringly, we report no differences in most developmental or behavioural domains of standardised tests.

Communication is the developmental domain that many professionals speculated would be at risk in young children during the pandemic due to lockdown factors including but not limited to smaller social circles and adult mask wearing.[5] In this study, we saw that babies born into the pandemic had lower scores on the ASQ24 communication domains and that more babies fell under the cut-off for 1 SD and 2 SD compared with a prepandemic cohort. Severely restricted social circles are likely to have led to babies hearing fewer words and conversations with those outside the family home, and if they did it was likely to be between masked adults. Twice as many children in the pandemic cohort fell below the cut-off for communication-related developmental referral compared with BASELINE. This has implications for the delivery of developmental services. Shuffrey and colleagues demonstrated that 255 6-month-old babies born during the pandemic had lower communication scores on the ASQ.[9] It has been reported in the popular press that infants born during the pandemic heard just 20–70 words per hour compared with between 100 and 140 words in babies sampled 3 years before the pandemic.[25] Further research is required to identify which factors impacted on the development of communication and to what extent. In addition, the pandemic-born babies had slightly lower gross motor domain scores on unadjusted comparison but not on adjusted analysis. Fewer CORAL infants fell below the 2 SD cut-off for personal-social subscore. Contrary to the subdomain heading, these 24-month questions refer to things that would happen at home rather than in society and so infants may have had more time to learn these 'domestic' or 'family' skills (eg, Does your child copy the activities that you do? When playing with either a stuffed animal or doll, does your child pretend to rock it, feed it, change its diapers, put it to bed and so forth?).

There were no marked behavioural differences between the pre- and pandemic- birth cohorts on CBCL. There was a minimal difference in unadjusted scores for CORAL infant scores for the internal domain and some subdomains. This would indicate fewer behaviour issues reported; however, on adjusted regression analysis there were no differences noted.

While parents had concerns about communication in general these did not always correlate with ASQ scores. Often developmental concerns come about when other family members (eg, grandparents) express concern, or parents see developmental progress in their children's peers, but these were largely unavailable to most parents whose babies were born early on in the pandemic.

This finding supports the role of universal national developmental screening instead of only carrying out assessments on children where there are parental concerns. It should be reinstated by public health programmes that had suspended it.

This study has some limitations. There was no possibility of a contemporaneous comparable cohort not in lockdown for the same time period as all of Ireland was in level 5 lockdown, as was most of the world. We used data from an Irish historic birth cohort and some differences were noted: assessment was done at 24.1 months in the CORAL cohort compared with 24.8 months in the BASELINE cohort; a higher proportion of babies in the overall BASELINE cohort had no siblings at 2-year assessment; and a higher proportion of mothers were educated to tertiary level in the CORAL cohort. These factors were adjusted for in all regression models. The CORAL pandemic birth cohort was recruited from a predominantly Caucasian and suburban population. The tests used for comparison were parentally reported screening tools and not in-depth psychological assessments required for a formal diagnosis of developmental delay. This was an exploratory observational study and we did not correct for multiple comparisons. It remains to be seen if these results are reproduced by children from different counties (with different public health policies) and different demographic backgrounds.

Children born during the pandemic had largely similar developmental and behavioural scores compared with their prepandemic counterparts, except in the communication developmental domain. Further work is required to understand what factors underpin differences in communication outcomes between pandemic-born children and their prepandemic and, in time, postpandemic counterparts, and what this may mean for these children when they reach school age.

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Contributors SB codesigned the developmental aspect of the CORAL study, collected the data, analysed the data and wrote the paper. HS collated the data and edited the paper. SHu and RF recruited the participants, collected the data and edited the paper. SHo collected the data and edited the paper. FB provided statistical input and edited the paper. NJ provided input on study design, contributed to data analysis and edited the paper. DMM is the PI of the BASELINE study. She provided input on CORAL developmental study design, contributed to data interpretation and edited the paper. JH is the PI of the CORAL study. He conceived and designed the CORAL study and the developmental substudy. He recruited the participants, collected the data, contributed to data interpretation and wrote the paper. He is the guarantor of the work.

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Competing interests JH is director of Clemens von Pirquet Foundation.

Patient consent for publication Consent obtained from parent(s)/guardian(s).

Ethics approval This study involves human participants and the National Covid Ethics Committee (20-NREC-COV-067) granted ethical permission for the CORAL study. Participants gave informed consent to participate in the study before taking part.

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