



RESEARCH

INFORMATION

How microbes acquired in early life relate to infant health and respiratory infections



AIMS

The microbiome is the community of microorganisms, including bacteria, that live in and on our bodies. It develops from birth and may help shape the immune system. We aimed to understand how early experiences influence this development and its links with infant health, particularly respiratory infections, to guide future ways of preventing illness and longer-term inflammatory problems.



KEY FINDINGS

- Mothers are a major source of their babies' early microbial communities. In a study of about 120 mother–baby pairs, around 60% of the infant microbiome could be traced back to the mother.
- Respiratory microbial communities develop more slowly in premature babies. Encouragingly, their development appeared to catch up after they were discharged home.
- In premature babies, gut microbial patterns are linked to brain development. These links do not by themselves establish cause and effect.
- Microbial communities in healthy newborn babies are linked to subsequent respiratory health and immune responses to vaccination.
- Birth by caesarean section, feeding and antibiotic exposure can be linked to differences in microbiome development.
- In a trial comparing three antibiotic regimens in newborn babies, one caused less disruption to the gut microbiome than the other two. Above findings can help researchers explore how to support babies with different early-life experiences.
- The bacteria present in the airways of young children with an acute respiratory infection are linked to how severe respiratory infections became. We identified potentially beneficial bacteria repeatedly across studies, providing candidates for further research into protection against infection.





WHAT DID THE STUDY INVOLVE?

We brought together studies following babies over time in Scotland, the Netherlands and The Gambia, alongside other collaborating studies. These included babies born prematurely and at full term, studies of respiratory infection and vaccination, and a trial in which newborn babies were randomly assigned to different antibiotic regimens.

We analysed samples to identify the microorganisms present and compare how their communities changed. We also measured immune responses and chemical marks on DNA involved in controlling gene activity. We examined how these measurements related to birth circumstances, feeding, treatment and health outcomes.

The Scottish studies were embedded within the Theirworld Edinburgh Birth Cohort. TEBC actively engages participating families through a dedicated Parent Advisory Group, regular family newsletters, and questionnaires. Guided by the Jennifer Brown Research Laboratory, this robust involvement framework ensures that participant voices directly shape the ongoing research design and clinical translation. Likewise, the studies abroad have actively involved parent/patient representatives (Netherlands) and communities (Gambia) in their design.



WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

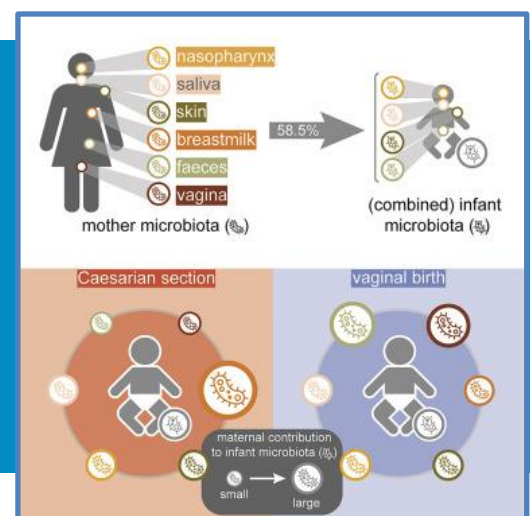
How babies acquire their first microbes

In about 120 mother–baby pairs, we estimated that around 60% of the babies' microbial communities across the sampled body sites came from communities found in their mothers. Transfer occurred from several maternal body sites. Babies born by caesarean section received fewer microbes from their mothers' gut communities, but transfer from other maternal sites may partly compensate. The portion not attributed to the mother was not fully explained by this analysis. Delivery, feeding and antibiotics were linked to different patterns of microbial development. This is more complex than simply having more or fewer microbes: the types present and their balance also matter. The findings help explain why babies can follow different developmental paths; they do not mean that an individual child will become unwell.

Figure 1

"Mothers are a major source of babies' first microbial communities. In about 120 mother–baby pairs, around 60% of the infant microbiome across the sampled body sites could be attributed to communities sampled from the mother. Transfer occurred from several sites; the remaining portion was not fully explained by this analysis."

Reference: [/doi.org/10.1016/j.chom.2023.01.018](https://doi.org/10.1016/j.chom.2023.01.018)



Effects of antibiotic treatment

The newborn antibiotic trial showed that three commonly used regimens changed the gut microbiome and the genes that can make bacteria resistant to antibiotics. One regimen caused less disruption than the others. Although some changes diminished over time, differences remained detectable at 12 months. This supports further work on choosing effective treatment while limiting disruption to the developing microbiome.



WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

Immune responses and respiratory infection

Microbial communities in early life were linked to the strength or type of measured immune response after vaccination. This raises questions about whether the microbiome helps explain differences in vaccine responses between children. Further research is needed to establish whether changing these communities could improve protection.

During respiratory infections, including bronchiolitis and pneumonia, the bacteria present in the airways were linked to illness severity and inflammation. This included infections involving respiratory syncytial virus, or RSV, a common cause of respiratory illness in young children. Similar potentially beneficial bacteria were identified across studies, giving us candidates to investigate as possible ways to reduce infection risk or severity.

Microbiome development and later health

In babies born at full term, viral infections in the first weeks of life were linked to altered development of respiratory microbial communities and inflammation in the lining of the nose. These patterns were, in turn, linked to a higher risk of subsequent respiratory infections.

In the Scottish cohort, premature babies' respiratory microbial communities initially developed more slowly than those of babies born at full term. Their developmental patterns appeared to catch up after the expected date of birth. Gestational age, hospitalisation and treatments were linked to this development, but these findings cannot establish how much each factor contributed. Microbial patterns in these children were also linked to changes in regulation of mucosal genes involved.

Premature born infants also had differences in gut microbial patterns, that in turn were linked to brain development. These results suggest relationships worth investigating further; they do not show that microbiome differences caused developmental problems.

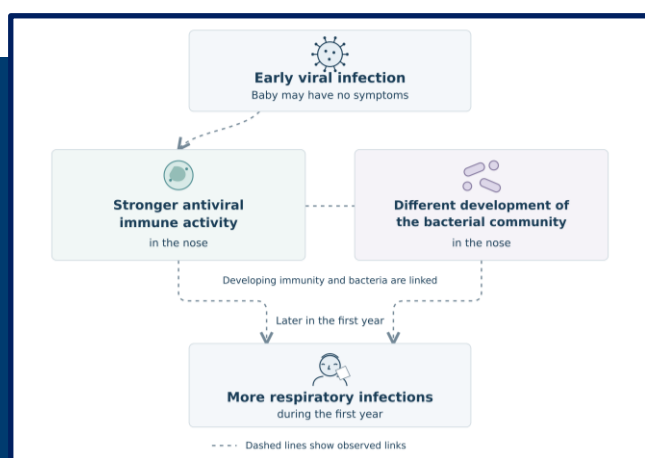


Figure 2.

“In a study following 114 babies from birth to one year, early viral infections—often without symptoms—were linked to stronger antiviral immune activity and different development of bacterial communities in the nose. These patterns were associated with more respiratory infections during the first year”.

Further research is needed to establish cause and effect of this phenomenon.

Reference: doi:10.1038/s41564-021-01043-2



WHAT IMPACT COULD THE FINDINGS HAVE?

- For babies and families, including those in Scotland: the findings provide a foundation for investigating ways to support healthy microbial development in early life, especially after premature birth or antibiotic treatment.
- For clinical practice: differences between antibiotic regimens could inform future research and neonatal prescribing guidance, alongside studies to restore disrupted microbiome development.
- For prevention and treatment: the beneficial bacteria that we repeatedly identified offer candidates for testing new approaches, such as probiotic preparations containing selected live bacteria. The studies reported here have not yet established this.
- For vaccination: understanding links between microbial communities and immune responses help researchers to investigate why responses vary and how they can be improved.



HOW WILL THE OUTCOMES BE DISSEMINATED?

By the time of the original report, our wider research programme had produced approximately 60 articles in international peer-reviewed journals on these subjects. We presented findings to national and international audiences working in child health, respiratory medicine, infection and microbiome research. Several publications were accompanied by press releases and coverage through social media, radio, newspapers, television and magazines. See example 1: <https://edinburgh-infectious-diseases.ed.ac.uk/news-and-events/news-archive/2022-news/antibiotics-after-birth-affects-gut-microbes-of-babies-study>, and example 2: <https://inflammation-research.ed.ac.uk/whether-born-naturally-or-cesarean-section-babies-receive-essential-microbes-their-mothers>. Also, one PhD student graduated on this work in March 2024.

The next research step is to establish whether the potentially beneficial bacteria identified in these studies actively protect against infection, and whether supporting microbial development can improve health. For this, we applied for further funding with among others the National Institute for Health Research, Wellcome Trust, Medical Research Council, the Chief Science Office, the Horizon programme of the European union, and the Dutch science organisation.



CONCLUSION

Early-life microbial communities are linked to infant health and are shaped by birth circumstances, feeding, illness and treatment. Their development can also change and recover, as illustrated by the apparent catch-up in premature babies. These findings provide a foundation for testing ways to support healthy microbial development and improve care for children. The central next step is to determine which of the observed links can be translated into effective prevention or treatment.



RESEARCH TEAM & CONTACT

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Project completed: October 2023
Report updated: October 2026
Funding received: £300K

