Researchers create 'digital babies' to improve infant health care

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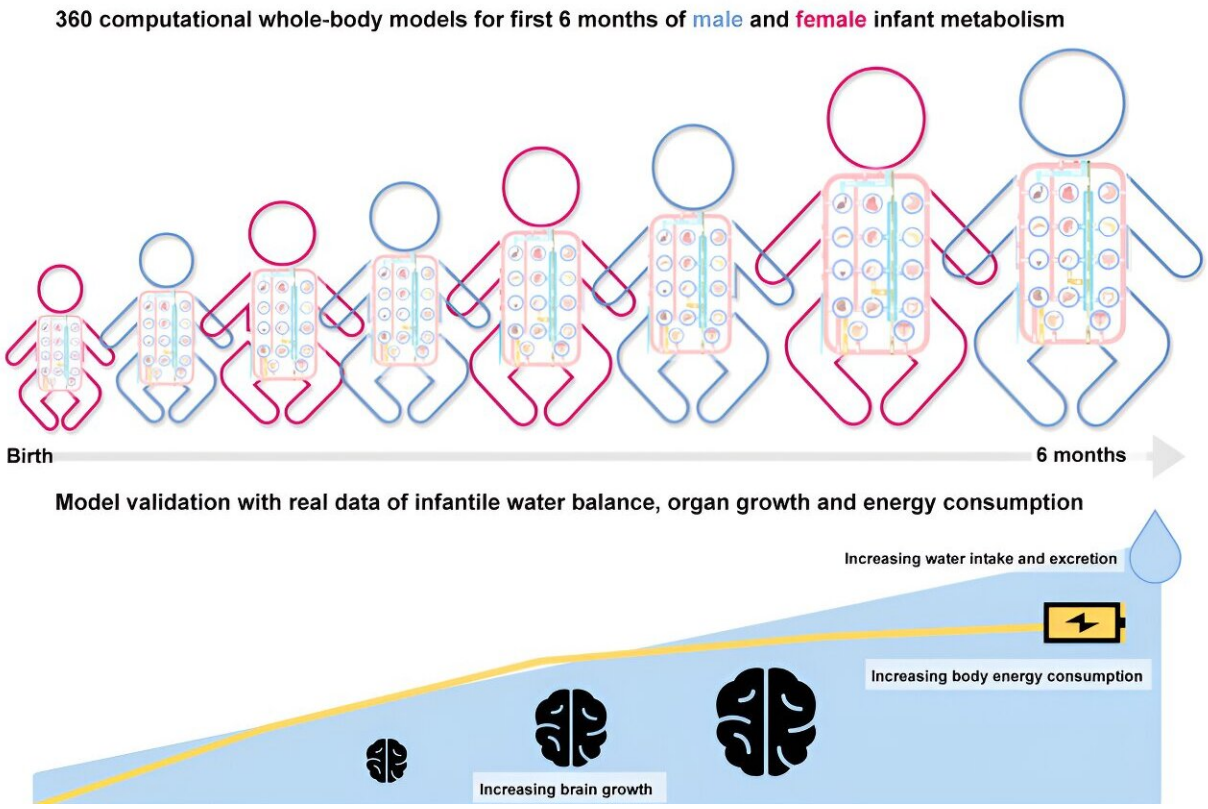

Graphical abstract. Credit: *Cell Metabolism* (2024). DOI: 10.1016/j.cmet.2024.05.006

Researchers at University of Galway have created digital babies to better understand infants' health in their critical first 180 days of life.

The team created 360 advanced computer models that simulate the unique metabolic processes of each baby. The digital babies are the first sex-specific computational whole-body models representing newborn and infant metabolism with 26 organs, six cell types, and more than 80,000 metabolic reactions.

Real-life data from 10,000 newborns, including sex, birth weight and metabolite concentrations, enabled the creation and validation of the models, which can be personalized—enabling scientists to investigate an individual infant's metabolism for precision medicine applications.

The work was conducted by a team of scientists at University of Galway's Digital Metabolic Twin Centre and Heidelberg University, led by APC Microbiome Ireland principal investigator Professor Ines Thiele.

The team's research aims to advance precision medicine using computational modeling. They describe the computational modeling of babies as seminal, as it enhances understanding of infant metabolism and creates opportunities to improve the diagnosis and treatment of medical conditions during the early days of a baby's life, such as inherited metabolic diseases.

Lead author Elaine Zaunseder, Heidelberg University, said, "Babies are not just small adults—they have unique metabolic features that allow them to develop and grow up healthy. For instance, babies need more energy for regulating body temperature due to, for example, their high surface-area-to-mass ratio, but they cannot shiver in the first six months of life, so metabolic processes must ensure the infant keeps warm.

"Therefore, an essential part of this research work was to identify these metabolic processes and translate them into mathematical concepts that could be applied in the computational model. We captured metabolism in an organ-specific manner, which offers the unique opportunity to

model organ-specific energy demands that are very different in infants compared to adults.

"As nutrition is the fuel for metabolism, we can use breast milk data from real newborns in our models to simulate the associated metabolism throughout the baby's entire body, including various organs. Based on their nutrition, we simulated the development of digital babies over six months and showed that they will grow at the same rate as real-world infants."

Professor Thiele, study lead on the project, said, "New-born screening programs are crucial for detecting metabolic diseases early on, enhancing infant survival rates and health outcomes. However, the variability observed in how these diseases manifest in babies underscores the urgent need for personalized approaches to disease management.

"Our models allow researchers to investigate the metabolism of healthy infants as well as infants suffering from inherited metabolic diseases, including those investigated in newborn screening. When simulating the metabolism of infants with a disease, the models showed we can predict known biomarkers for these diseases. Furthermore, the models accurately predicted metabolic responses to various treatment strategies, showcasing their potential in clinical settings."

Zaunseder added, "This work is a first step towards establishing digital metabolic twins for infants, providing a detailed view of their metabolic processes. Such digital twins have the potential to revolutionize pediatric health care by enabling tailored disease management for each infant's unique metabolic needs."

The research was published this week in *Cell Metabolism*.

This work was led by University of Galway and completed as part of a

collaboration with Heidelberg University, Heidelberg Institute for Theoretical Studies and Heidelberg University Hospital, Germany.

More information: Elaine Zaunseder et al, Personalized metabolic whole-body models for newborns and infants predict growth and biomarkers of inherited metabolic diseases, *Cell Metabolism* (2024). DOI: 10.1016/j.cmet.2024.05.006