New research on the strength of children's bones could help in the design of safer car seats

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Credit: University of Sheffield

Researchers at the University of Sheffield have successfully used computer simulated models and medical imaging to test the strength of young children's bones, producing results which could help car seat

manufacturers design safer car seats for young children.

The study, the first on infant bone strength in relation to age/weight using models developed from modern medical images, is published today in the *Journal of Biomechanics and Modeling in Mechanobiology*.

The research used CT scans—x-rays to take detailed pictures of the bones from different angles—and subsequent computer models to set up scenarios looking at how a different amount of force affects the bones, bending and twisting the bones to detect the breaking point.

These non-invasive techniques created 3-D models of the femur (thigh bone) in the study of children's bones in the newborn to three-year-old age range.

This is the age range that has had the least research conducted previously but also the ages where children can't talk or communicate effectively about how their injury occurred. There is also a period of rapid growth between these ages and the researchers were able to determine how bones developed during this time and how bone strength changed.

Protection has improved significantly since the introduction of car seats but car accidents are still a leading cause of life threatening injury in children. Computer aided engineering is an essential part of vehicle development and safety assessments are increasingly relying on simulations. Therefore, it is vital that the correct simulations, using accurate models, are used to ensure optimum safety.

Current testing for car seats in simulated crash tests often use scaled down models of adults to simulate a child in a given situation. However, anatomically, a toddler has a very different bone structure to an adult—the bones are not fully formed and still growing.

Dr. Xinshan Li, from the Insigneo Institute for in silico Medicine and the Department of Mechanical Engineering at the University of Sheffield, said: "There is currently very little research looking into the bone strength of young children. Our data can be applied to help car seat manufacturers, pram manufacturers, toy manufacturers and any other companies designing children's products, to design and make safer products and use our modelling of bone strength in testing their products before bringing them to market.

"We will be continuing our research in this area and hope to work in partnership with these industries to demonstrate the impact our work could have in helping to prevent and minimise the impact of potential accidents. This will give parents peace of mind that their child is as safe as possible and that the products they are using have been tested using the very latest and accurate techniques."

Dr. Amaka Offiah, Reader in Paediatric Musculoskeletal Imaging in the Department of Oncology and Metabolism at the University of Sheffield, and Honorary Consultant Paediatric Radiologist at Sheffield Children's Hospital, said: "Bone fractures are common in childhood and have been estimated to account for 25 per cent of all paediatric injuries. They can broadly be categorised into accidental or inflicted injuries.

"Currently, distinguishing between these can often be extremely difficult. Due to the difficulties in obtaining paediatric bone samples there has been a lack of research to provide evidence-based information on bone strength in young children.

"In addition to the child safety industry-based applications, the findings from our study can be used in future to aid clinical diagnosis. If we can provide a table which shows bone strength by age range for different bones in the body, we can then calculate the force required to break that particular bone. This would help clinicians to use evidence-based

information to decide whether an injury is accidental or inflicted, particularly for younger children who aren't able to articulate how the injury occurred. We are grateful to The Children's Hospital Charity, who funded the initial work in this area."

The Insigneo Institute for in silico Medicine is a collaborative initiative between the University of Sheffield, Sheffield Teaching Hospitals NHS Foundation Trust and Sheffield Children's NHS Foundation Trust (in silico medicine is also known as computational medicine). It is a multidisciplinary collaboration between over 140 academics and clinicians to develop computer simulations of the human body and its disease processes that can be used directly in clinical practice to improve diagnosis and treatment. MultiSim is an Engineering and Physical Sciences Research Council (EPSRC) funded programme which is based in Insigneo.

Professor Damien Lacroix, Director of MultiSim, said: "The MultiSim project provided resources for this research, as the research team were able to use the same modelling techniques and software we created to look into musculoskeletal diseases and apply this to modelling for children's bones to test their strength.

"The potential applications of this research are far-reaching and demonstrate how computer simulations can potentially save time and provide a more reliable diagnosis for clinicians."

The research team is continuing their work in this area and will be building on the current research to assess other long bones, such as the tibia, expand their database to ensure a good representation of children in each age range, and look at more complex injury scenarios.

More information: Investigating the mechanical response of paediatric bone under bending and torsion using finite element analysis.

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Provided by University of Sheffield

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