How the engineering of bridges might help your knees

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The researchers have begun to model how cartilage cells repair damage, including extracellular matrix (ECM) production—molecular secretions that offer structural support to surrounding cells. Credit: Gill Poole

The structural engineering principles used to build safe bridges could help prevent osteoarthritis in the knee, research suggests.

Common and debilitating, osteoarthritis occurs when the joint's cartilage

wears away leading to increased friction between bones.

Currently there are no treatments aside from pain relief or replacing the affected joint such as the knee or hip.

However, an international team led by Murdoch University Professor Bruce Gardiner and UWA Professor David Smith is developing mathematical engineering models drawing on the structural reliability analysis which engineers apply to bridges.

They say this approach could advance our understanding of how osteoarthritis evolves and how a person might modify their lifestyle to prevent onset.

"Our basic idea is that biological systems are so complex we can't understand them through traditional clinical approaches, which involve mapping networks and linear relationships," Prof Gardiner says.

"There is too much going on and too much feedback into the system.

The only rationale way to access how these systems work is via the mathematical approach of physics or engineering.

This approach is informed by models such as fluid flow, chemical reactions and mass conservation and offer constraints on the ways a system can behave.

For example, the researchers have begun to model how cartilage cells repair damage, including extracellular matrix (ECM) production—molecular secretions that offer structural support to surrounding cells.

When put under cyclical loading, such as with walking, cartilage

produces ECM, but under a static load, like standing, it does not.

The researchers are keen to better understand the relationship between mechanics, the hormonal environment and the chemical environment.

"Cartilage acts like a sponge, so [when you stand] fluid squeezes out of it, the cells get compressed, the tissue is being strained, and it stops its production," Prof Gardiner says.

"If you go for a walk, you're squeezing fluid in and out, the cells are producing more ECM, they're getting flushed with growth factors and nutrients and they're getting rid of waste products—a much healthier situation.

"But if you go overboard, you start wearing your cartilage away."

Finding a balance for healthy cartilage is likely different for each person, which makes feeding more input into the models vital.

"We want to be able to say: this is how you walk, this is your joint size and BMI, we can get your genome and finally here's a prediction about the best strategy to keep your knees healthy," Prof Gardiner says.

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