Arthritis Australia Scientific Project Report

Funded by:	Arthritis Australia, Gladys Irene Benjamin Estate
Recipient:	A/Prof Laura Diamond
Intended Department	Australian Centre for Precision Health and Technology (PRECISE), Griffith University
Project:	Feasibility of movement retraining in a natural environment for self-management of hip osteoarthritis

What were the main scientific objectives of the grant?

The initial objective of this project was to pilot the feasibility of movement retraining using smart wearable technology (Smarti-Shorts) in people with hip osteoarthritis (OA) at home/outdoors. However, as we engaged people with hip OA and trialed Smarti-Shorts in the laboratory, it because evident that measurement at home may be too onerous with the current design. While movement retraining at home remains the long-term vision, we moved to a proof-of-concept study which assessed the validity of Smarti-Shorts to measure hip biomechanics when walking using nine movement modifications.

To achieve our objectives, we used Smarti-Shorts in combination with a previously developed neural network to estimate hip biomechanics and compared its accuracy to gold-standard laboratory measurement and modelling methods. A female participant with hip OA attended two laboratory sessions where they walked on an instrumented treadmill wearing custom Smarti-Shorts. The shorts were equipped with textile electrodes embedded in the shorts' fabric and inertial measurement units on the pelvis and thighs. The participant walked using nine gait modifications while receiving real-time visual biofeedback of a personalised target to a monitor in front of the treadmill.

What were the main scientific achievements of the grant?

Suboptimal mechanical loading contributes to hip OA progression. Articular loading is necessary for cartilage remodelling, though abnormal loading (insufficient, excessive, or concentrated) can drive cartilage degeneration. We have previously proven that abnormal hip loading is a key marker of hip OA severity and can be improved with laboratory-based movement retraining. To make this intervention accessible outside the lab, we developed Smarti-Shorts. Smarti-Shorts is a wearable garment co-designed with consumers that monitors hip loading (and other important hip biomechanics variables) outside the lab.

In this study, we showed that Smarti-Shorts, in combination with our developed neural network, can estimate hip angles, moments, muscle and contact forces with low error across

nine gait modifications compared to gold standard laboratory measurement (Figure 1). Peak hip contact forces also showed excellent agreement between methods. The minimum detectable difference at 90% confidence was 0.33 body weights (~7.4% change from baseline peak). Overall, we showed that Smarti-Shorts can detect small changes in hip motion and loading that occur during gait retraining interventions which are highly relevant to cartilage health and adaption.

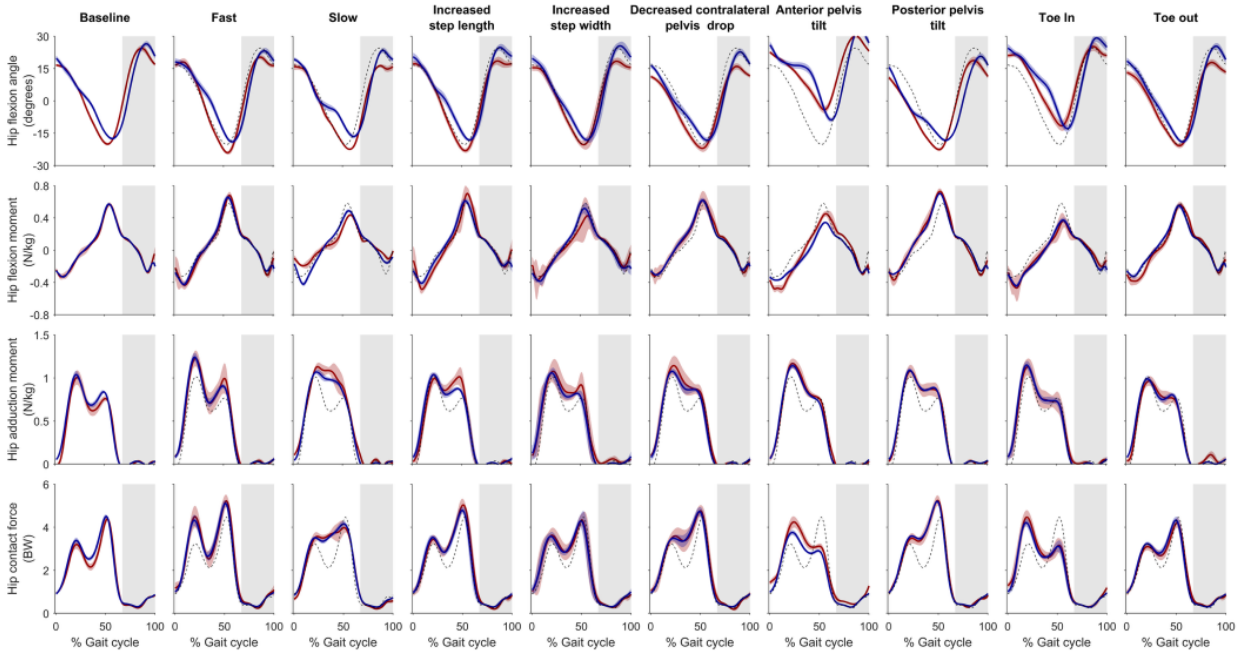

Figure 1. Comparison of NMS and PINN estimated hip biomechanics for nine gait modifications (columns). Ensemble average (±1 standard deviation) hip flexion angle (1st row), hip flexion moment (2nd row), hip abduction moment (3rd row), and hip contact force (4th row) across the gait cycle for NMS (red) and PINN (blue) estimates. The black-dashed line is the mean NMS estimate for the baseline condition (normal walking).

What problems, if any, did you encounter in achieving the project's objectives, and how did you address them?

We encountered two main challenges.

Resource constraints: While we now have a validated prototype which can measure hip loading outside the laboratory, additional funding is required to integrate sensor-embedded real-time feedback within the garment. To address this, we have submitted an Australian Economic Accelerator Ignite Grant and an NHMRC Ideas Grant, with funding decisions expected by the end of 2026.

Smarti-Shorts sizing/scalability: The current prototype requires Smarti-Shorts to be customised to each person's individual anatomy. This is time consuming and requires a trained researcher to perform the measurements. We are hopeful that this limitation can be mitigated by accessing a large sample of participants with a wide range of body types and applying machine learning methods. This work is underway and we anticipate soon requiring only a few simple measurements (e.g., waist circumference, thigh length), that users can measure themselves, to produce accurate and personalised sensor embedment at scale.

What is the plan for dissemination of findings?

We will be presenting preliminary results at the OARSI World Congress of Osteoarthritis (West Palm Beach, USA; April 23-26th, 2026) and the 10th World Congress of Biomechanics (Vancouver, Canada; July 11-15th, 2026). We intend to publish a paper detailing the validity and reliability of Smarti-Shorts in a larger cohort of participants with hip OA in late 2026. This data collection is ongoing.