NORDIC WALKING TECHNIQUE ASSESSMENT USING INERTIAL SENSORS

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Background and Aims
Cardiovascular rehabilitation (CVR) is essential during recovery to prevent relapse or chronic conditions. While Nordic Walking (NW) is a recognised and efficient training technique for CVR, NW requires learning and continuous practice for effective and safe performance. For safety reasons patients perform NW typically under therapist supervision, however NW skills and mistakes are not systematically assessed outside laboratories. This work investigates the feasibility of a body-worn NW technique classification system to identify mistakes and patient's NW skills development.

Methods
Inertial motion sensors (Xsens MTx) were attached to hip, right pole, left tight, ankle, and shoe of eight healthy participants (four females; mean age=57.5±4.7years; body height=173±9.6cm, BMI=25.9±1.9). Participants followed regular NW training for 4±1.7years. For classification algorithm training, one participant performed regular NW (~20 minutes) and eight typical mistakes (~2 minutes) on a wide treadmill. For evaluation, all participants performed accustomed NW twice on an outdoor 150m gravel walkway. A NW expert performed mistake annotations.
Trunk, limb, and pole orientation angles were computed. Gait cycle (GC) segmentation was performed using the foot sensor sagittal angular velocity. Per GC, 16 NW parameters were derived and evaluated using a naïve Bayes classifier.

Results
A total of 1252 and 4764 GCs were recorded for training and evaluation datasets respectively. Average evaluation dataset timings were 1.05s (SD5.89ms) for toe off and 1.05s (SD9.78ms) for pole strike. Considering eight error types and correcting for class imbalances between training and evaluation, classification accuracy was 87.8%. Using sequential forward selection, 4 highest ranked NW parameters yielded peak classification accuracies: leg GC, pole angle at push off, knee angle at toe off, trunk angle at pole strike.

Conclusions
The NW technique can be automatically assessed outdoors using inertial sensors and could support therapists in patient CVR. Selecting more than 4 NW parameters did not further improve classification accuracy.