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Research Profile

Digital health, wearable sensing, and interpretable AI applied to gait and daily physical activity, to assess frailty, mobility decline, fall risk, and chronic low back pain, with a focus on healthy aging.

Education

University of Groningen / University Medical Center Groningen, The Netherlands

Ph.D., Human Movement Sciences

Nov 2019 – Apr 2024

- Thesis: *Explainable Artificial Intelligence in Movement Sciences: Focusing on Gait Analysis in Healthy Older Adults and Patients with Back Pain*
- Doctoral research conducted within a university medical center, in collaboration with rehabilitation medicine and pain medicine
- Supervisors: Prof. Dr. Claudine Lamothe, Prof. Dr. Michiel Reneman, and Prof. Dr. Bert Otten

China University of Geosciences, Wuhan, China

M.Sc., Software Engineering

Sep 2016 – Jun 2019

- Thesis: *Path Distance-Based Map Matching Method for Indoor Wi-Fi Fingerprint Localization*
- Supervisor: Prof. Dr. Jianga Shang

China University of Geosciences, Wuhan, China

B.Sc., Information Engineering

Sep 2012 – Jun 2016

- Thesis: *IFNavi: A Smartphone Inertial Sensor-Based Navigation System for Pedestrians*
- Supervisor: Prof. Dr. Jianga Shang

Academic Appointments

Department of Sports Science and Physical Education, The Chinese University of Hong Kong

- Postdoctoral Fellow Jun 2025 – Present
- Research Assistant / Associate Dec 2023 – May 2025
- Supervisor: Prof. Dr. Yijian Yang

Competitive Grants and Funding

Awarded Grant

- Postdoctoral Fellowship Scheme 2024–25 Award, The Chinese University of Hong Kong 2025 – 2029
- Research Fellowship Scheme 2024–25 Award, Faculty of Education, The Chinese University of Hong Kong 2025 – 2026
- Guarding the Silver Years: AI-Assisted Mobile Health Intervention for Preventing Elderly Falls in the Community. NSFC/RGC Joint Research Scheme, Ref. N-CUHK4134/25, Co-I 2026 – 2030

Peer-reviewed Journal Publications

1. **Zheng, X.**, Zeng, Z., van Schooten, K., and Yang, Y. A Machine Learning Approach for Frailty Detection in Long-Term Care Using Accelerometer-Measured Gait and Daily Physical Activity: Model Development and Validation Study. *JMIR Aging*, 8 (2025): e77140.
2. **Zheng, X.**, Reneman, M., Otten, E., and Lamothe, C. Explaining Deep Learning Models for Age-Related Gait Classification Based on Time-Series Acceleration. *Computers in Biology and Medicine*, 184 (2025): 109338.
3. **Zheng, X.**, Wilhelm, E., Reneman, M., Otten, E., and Lamothe, C. Age-Related Gait Patterns Classification Using Deep Learning Based on Time-Series Data from One Accelerometer. *Biomedical Signal Processing and Control*, 104 (2025): 107406.
4. **Zheng, X.**, Lamothe, C., Timmerman, H., Otten, E., and Reneman, M. Establishing Central Sensitization Inventory Cut-Off Values in Patients with Chronic Low Back Pain by Unsupervised Machine Learning. *Computers in Biology and Medicine*, 178 (2024): 108739.
5. **Zheng, X.**, Reneman, M., Schiphorst Preuper, R., Otten, E., and Lamothe, C. Relationship Between Physical Activity and Central Sensitization in Chronic Low Back Pain: Insights from Machine Learning. *Computer Methods and Programs in Biomedicine*, 232 (2023): 107432.
6. **Zheng, X.**, Reneman, M., Echeita, J., Schiphorst Preuper, R., Kruitbosch, H., Otten, E., and Lamothe, C. Association Between Central Sensitization and Gait in Chronic Low Back Pain: Insights from a Machine Learning Approach. *Computers in Biology and Medicine*, 144 (2022): 105329.
7. Zeng, Z., **Zheng, X.**, Sit, C., Wong, S., Sum, R., and Yang, Y. Effects of Pickleball on Pre-Frailty, Physical Fitness, 24-Hour Movement Behaviors, and Quality of Life in Older Adults: A Randomized Controlled Trial. *International Journal of Nursing Studies*, 180 (2026): 105549.
8. Zhang, X., **Zheng, X.**, Hobbelen, H., van Munster, B., Qian, T., Yu, T., Feng, L., and Lamothe, C. Factors Contributing to Differences in Physical Activity Levels in (Pre-)Frail Older Adults Living in Rural Areas of China. *PLOS ONE*, 20(11) (2025): e0335607.
9. Chen, P., **Zheng, X.**, Gu, F., and Shang, J. Path Distance-Based Map Matching for Wi-Fi Fingerprinting Positioning. *Future Generation Computer Systems*, 107 (2020): 82–94.
10. Wu, Y., Chen, P., Gu, F., **Zheng, X.**, and Shang, J. HTrack: An efficient heading-aided map matching for indoor localization and tracking. *IEEE Sensors Journal*, 19(8) (2019): 3100–3110.

Manuscripts Under Review / In Preparation

1. **Zheng, X.**, Zeng, Z., Ho, C., Zhou, Z., and Yang, Y. Effects of a Customized Multicomponent Physical Activity Program on Gait Pattern Transitions in Long-Term Care Older Adults: A Cluster Randomized Controlled Trial Using Wearable Sensors and Explainable Machine Learning. Under major revision, *JMIR mHealth and uHealth*.
2. **Zheng, X.**, Zhou, Z., Pang, M., and Yang, Y. Sustained and regained robustness are not equivalent: four-year risk of frailty or death in older people. Ready to submit.
3. **Zheng, X.**, Zhou, Z., van Schooten, K., and Yang, Y. Accelerometer-Derived Sedentary-Bout Accumulation Patterns and Frailty Severity Among Long-Term Care Residents. Ready to submit.
4. **Zheng, X.**, Ho, C., Beesley, D., Yu, S., Cheung, L., Sum, R., and Yang, Y. Are Better Game Statistics Equivalent to Key Technical-Tactical Indicators? A SHAP-Based Explanation of Collegiate and Youth 3×3 Basketball Game Outcomes. In preparation.
5. Yang, Y., **Zheng, X.**, Song, X., Pang, M., Kim, Y., Chan, K., and Fung, C. Effect of Customized 3D-Printed Hip Protectors on User Compliance in Older Adults in Care Homes: Protocol for a Cluster Randomized Controlled Trial. Submitted.
6. Zhang, X., **Zheng, X.**, Yang, Y., Hobbelen, H., van Munster, B., Feng, L., and Lamothe, C. Differences in Accelerometer-Measured Daily Physical Activity Patterns Between Pre-Frail and Non-Frail Older Adults. Submitted.

7. Shen, J., Pan, J., **Zheng, X.**, Sit, H., and Yang, Y. Effects of Visual Tasks on Kinematic Characteristics during Obstacle Crossing in Older Adults. Submitted.
8. Zhang, H., **Zheng, X.**, and Yang, Y. Safety Without Compromise: Assessing if Wearing Hip Protectors Alters Mobility and Balance in Older Adults Living in Care Homes. Under review.

Conference Publications

1. **Zheng, X.**, Zeng, Z., van Schooten, K., and Yang, Y. AI-Driven Frailty Detection in Long-Term Care Using Accelerometer-Measured Gait and Daily Physical Activity. *Innovation in Aging* (2025). Presented at the Gerontological Society of America Annual Scientific Meeting 2025, Boston, United States (Oral).
2. **Zheng, X.**, Chen, P., and Shang, J. Reference Points Density Invariant Map Matching for Wi-Fi Fingerprinting Positioning. *2018 26th International Conference on Geoinformatics*, IEEE (2018).

Conference Presentations

1. **Zheng, X.**, Zeng, Z., Ho, C. Y., Zhou, J., and Yang, Y. Explainable Machine Learning Identifies Mechanisms of Gait Improvement After a Multicomponent Exercise Program in Long-Term Care. *World Congress of Biomechanics 2026*, Vancouver, Canada (Poster)
2. **Zheng, X.**, et al. Physical Inactivity in Pre-Frail Older Adults: Insights from Objective Monitoring. *World Congress on Sports Science and Technology 2025*, Hong Kong (Oral; Session Chair)
3. **Zheng, X.**, et al. Explainable AI Reveals How Deep Learning Classifies Age-Related Gait Patterns. *International Society of Posture and Gait World Congress 2025*, Maastricht, The Netherlands (Poster)
4. **Zheng, X.**, et al. Computer-Assisted Customized Exercise Program for Frail Older Adults in Care Homes. *International Symposium of Asian Society for Adapted Physical Education and Exercise 2024*, Hokkaido, Japan (Oral)
5. **Zheng, X.**, et al. Explaining Deep Learning Models for Age-Related Gait Classification Based on Time-Series Acceleration. *Congress of the International Society of Biomechanics 2023*, Fukuoka, Japan (Oral)
6. **Zheng, X.**, et al. Deep Learning for Age-Related Gait Patterns Classification Based on Raw Accelerometer Signals from 3 Minutes of Walking. *International Society of Posture and Gait World Congress 2023*, Brisbane, Australia (Oral)
7. **Zheng, X.**, et al. Physical Activity Patterns of Patients with Chronic Low Back Pain and Central Sensitization: Insights from a Machine Learning Method. *Dutch Conference for Biomedical Engineering 2023*, Egmond aan Zee, The Netherlands (Oral)
8. **Zheng, X.**, et al. Effects of the Level of Central Sensitization on Physical Activity Patterns in Chronic Low Back Pain: Insights from a Machine Learning Approach. *International Society of Posture and Gait World Congress 2022*, Online (Oral)
9. **Zheng, X.**, et al. Exploring the Effects of Central Sensitization on Gait in Chronic Low Back Pain Using a Machine Learning Approach. *International Conference on Ambulatory Monitoring of Physical Activity and Movement 2022*, Online (Oral)
10. **Zheng, X.**, et al. Classification of Patients with Chronic Low Back Pain and High or Low Central Sensitization by Gait Outcomes Using Machine Learning Methods. *Dutch Conference for Biomedical Engineering 2021*, Online (Oral)
11. **Zheng, X.**, et al. Establishing Central Sensitization Inventory Cutoff Scores in a Chronic Low Back Pain Population by Deep Learning. *Pijn Alliantie in Nederland Congress 2021*, Online (Oral)
12. **Zheng, X.**, et al. Exploring the Effects of Central Sensitization on Gait in Chronic Low Back Pain by Machine Learning. *Pijn Alliantie in Nederland Congress 2021*, Online (Oral)

13. **Zheng, X.**, et al. Physical Activity Levels of Patients with Chronic Low Back Pain and Central Sensitization: Insights from a Machine Learning Method. *International Conference on Ambulatory Monitoring of Physical Activity and Movement 2021*, Online (Oral)
14. **Zheng, X.**, et al. Reference Points Density Invariant Map Matching for Wi-Fi Fingerprinting Positioning. *International Conference on Geoinformatics 2018*, Kunming, China (Oral)

Invited Talks

1. A Machine Learning Approach for Frailty Detection in Long-Term Care Based on a Single Accelerometer. *2025 Academic Conference of the Injury Prevention and Control Branch, Chinese Preventive Medicine Association*, Changsha, China
2. Application of AI in Gait and Frailty Assessment Among Older Adults. *Geriatric Medicine and Health Forum 2025*, Shenzhen, China
3. Association Between Central Sensitization, Gait Patterns, and Physical Activity Intensity Patterns in Chronic Low Back Pain: Insights from Machine Learning. *Pain Rehabilitation Meeting 2022*, Utrecht, The Netherlands
4. Explainable AI for Deep Learning Models of Gait: Methods and Lessons. *Machine Learning Lab Community (DASH) 2023*, UMCg, The Netherlands (invited methods seminar)

Teaching and Student Engagement

Co-Instructor, SPED4640 Human Kinematics and Kinetics, undergraduate elective, Department of Sports Science and Physical Education, The Chinese University of Hong Kong Sep 2026 – Present

- Co-instructor of record for an undergraduate course covering foundational concepts in human kinematics and kinetics, movement analysis, and applications to sport, exercise, and health.

Guest Lecturer, Department of Sports Science and Physical Education, CUHK 2024 – 2025

- *SSPA6308 Information Technology in Sports Science and Physical Activity*: IMU and AI Technologies for Sports and Health Analysis
- *SSPA6205 Structural Biomechanics and Sports Injury*: Relationship Between Gait Patterns, Physical Activity Intensity, and Central Sensitization in Chronic Low Back Pain
- *SPED4640 Human Kinematics and Kinetics*: Applications of Gait Analysis in Health: A Case Study

Teaching Assistant, *Introduction to Exercise Biomechanics (SPED2610)*, CUHK Spring 2026

- Supported undergraduate teaching in exercise biomechanics.

Teaching Areas

- Machine learning and interpretable modelling for movement and health data
- Wearable sensing, biomedical signal analysis, and digital health
- Human movement analysis and biomechanics
- Research methods, quantitative analysis, and student project supervision

Student Mentorship and Research Project Support

Ongoing since Ph.D.

- Mentored undergraduate and postgraduate students in research design, health and movement data analysis, academic writing, and project development, including six undergraduate final-year projects across the 2024–25 and 2025–26 cohorts.
- Provided guidance on wearable device data collection, data processing, quantitative analysis, and academic communication.

Research Themes and Project Experience

Healthy aging, physical activity, and mobility in older adults

Dec 2023 – Present

- Conduct ongoing research on mobility decline, frailty, fall risk, gait, and physical activity in older adults in long-term care and community settings.
- Developed and validated machine learning models that identify frailty from a single body-worn accelerometer, using free-living gait and daily physical activity data. Model interpretation showed that dynamic gait outcomes (stride length variability, sample entropy, gait symmetry) discriminate frailty more sensitively than conventional spatial-temporal measures such as gait speed (*JMIR Aging*, 2025).
- Integrate wearable IMU data, daily physical activity monitoring, and clinical assessments to support early identification of abnormal movement patterns and mobility decline.
- Develop interpretable machine learning approaches, including model interpretation with SHAP, so that model output can be examined and used rather than taken on trust.
- Extend this work from cross-sectional detection toward longitudinal risk prediction, including four-year risk of frailty or death in older people.
- Led the wearable-sensor and explainable machine learning analysis within a cluster randomized controlled trial of a customized multicomponent physical activity programme in long-term care; first author on the resulting manuscript.
- Contribute to projects on fall prevention, customized exercise programs, and protective technologies for older adults.

Sport and exercise for healthy aging

2024 – Present

- Contribute to randomized controlled trials evaluating sport- and exercise-based programs for older adults, including a pickleball trial on pre-frailty, physical fitness, 24-hour movement behaviors, and quality of life.
- Apply wearable sensing and objective movement monitoring to evaluate intervention response and movement behavior change.

Explainable machine learning in analyzing human movement characteristics

Nov 2019 – Apr 2024

- Ph.D. research project, conducted within a university medical center with rehabilitation medicine and pain medicine collaborators.
- Implemented Random Forest for the classification of gait patterns in patients with chronic low back pain and central sensitization, using gait features derived from accelerometer data. Employed SHAP to interpret the classifier, revealing alterations in motor control.
- Utilized a Hidden Semi-Markov Model to investigate varying physical activity intensity patterns in patients with chronic low back pain and central sensitization based on acceleration signals.
- Applied a range of clustering methods to determine optimal cut-off scores for the Central Sensitization Inventory in a chronic low back pain population using questionnaire data.
- Evaluated the performance of conventional machine learning techniques (based on gait features) and deep learning methods (based on acceleration signals) for classifying age-related gait patterns.
- Interpreted deep learning models using SHAP in the classification of age-related gait patterns, providing insights into the information processed by deep learning.

Explainable analytics for technical-tactical performance in 3×3 basketball

2025 – Present

- Investigate whether conventional game statistics adequately capture the key technical-tactical indicators associated with game outcomes in collegiate and youth 3×3 basketball.
- Apply interpretable machine learning and SHAP to identify the relative importance of performance indicators associated with winning and losing.

Indoor intelligent positioning and sensor-based tracking

Jul 2016 – Jul 2019

- Contributed to a China National Key R&D Program project on intelligent positioning in large and complex environments.
- Served as one of the main researchers on indoor localization and tracking, responsible for algorithm design and software implementation.
- Explored Hidden Markov Models, Bayesian-network-based methods, and map-matching techniques for Wi-Fi fingerprint localization.

Knowledge Transfer, Community Engagement, and Academic Service

Instructor, Smart Silver Enriched ICT Training Programme for the Elderly, The Chinese University of Hong Kong Sep 2026

- Deliver four courses for older adults on generative AI, cloud computing and file storage, digital storytelling and multimedia editing, and blockchain and digital payments.
- This work supports digital literacy, lifelong learning, and university-community engagement among elderly learners.

Community- and care-based health research in Hong Kong

- Current research is closely connected to long-term care and community settings, with a focus on mobility, physical activity, fall prevention, and healthy aging in older adults.

Conference and scholarly service

- Session Chair, World Congress on Sports Science and Technology 2025, Hong Kong.
- Ad hoc reviewer for *JAMDA*, *JMIR Aging*, *JMIR mHealth and uHealth*, and *Gait & Posture*.

Awards and Recognition

- BioSci Student Travel Stipend, Gerontological Society of America 2025
- Gold Medal, International Inventions Exhibition Geneva, for mass customization of lightweight and breathable hip protectors for older adults via automated reverse design and 3D printing 2025
- Gold Medal, Asia Exhibition of Innovation and Inventions Hong Kong, for mass customization of lightweight and breathable hip protectors for older adults via automated reverse design and 3D printing 2025
- Ph.D. Scholarship, China Scholarship Council–University of Groningen Scholarship 2019 – 2023
- First Prize, Indoor Localization Competition, hosted by the National Remote Sensing Centre of China and Beijing Municipal Science & Technology Commission 2018

Patent and Innovation Output

- Shang, J., Wu, F., Gu, F., Pan, C., and **Zheng, X.** A Map Matching Method for Indoor Localization. China Patent (Application No. 201910481496.1; application date: June 4, 2019).

Methods, Technical Competencies, and Languages

Movement / Health Methods: gait analysis, physical activity assessment, mobility evaluation, frailty assessment, wearable sensing

Quantitative Methods: statistics, measurement, time-series analysis, classification, clustering, model interpretation

Machine Learning: Hidden (Semi-)Markov Models, Decision Trees, Naive Bayes, Random Forest, XGBoost, LightGBM, SVM, KNN, ANN, Autoencoders, CNN, GRU, LSTM, BiLSTM, Convolutional LSTM

Signal Processing: digital filtering, Fourier transform, wavelet transform

Programming: Python, MATLAB, Java, C++, HTML, LaTeX

Languages: English (Fluent), Cantonese (Fluent), Mandarin (Native), Teochew (Native)