

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Dr. Nigro has extensive expertise across a wide range of biomechanical disciplines, from the design of orthopedic assistive devices for human locomotion to the analysis of complex, high-performance sports movements. His background spans both academic research and private industry, enabling him to provide comprehensive support in biomechanical experimental design, data analysis, and product performance evaluation. He has led many human subject studies utilizing advanced technologies such as optical marker-based and markerless 3D motion capture systems, inertial measurement units (IMUs), and indirect calorimetry. His collaborative work with engineers, physical therapists, and prosthetists/orthotists in both research and clinical environments underscores his multidisciplinary approach.

Dr. Nigro earned his Ph.D. in Mechanical Engineering from the University of Delaware, where he was awarded the National Science Foundation Graduate Research Fellowship. His doctoral research focused on the development of an innovative ankle-foot orthosis featuring stepwise bending stiffness to more accurately replicate the dynamic rotational stiffness of the human ankle during walking, pushing the state-of-the-art of ankle-foot orthoses forward. Following his Ph.D., Dr. Nigro completed a postdoctoral fellowship at the University of Colorado Boulder, where he leveraged low-cost IMUs to develop empirically driven alignment protocols for prosthetists and clinicians working with lower-limb amputees.

In the private sector, Dr. Nigro has applied his expertise to sports biomechanics, ranging from pitching and batting in baseball to optimize performance to shoe and insole fitting for elite runners to reduce injury risk.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, University of Delaware, 2022

B.S., Mechanical Engineering, Pennsylvania State University, 2017

National Science Foundation Graduate Research Fellowship

Prior Experience

Technical Operations Engineer, KinaTrax, Inc., 2023-2024

Clinical Scientist, ActiVie, LLC., 2023-2024

Post-Doctoral Researcher, University of Colorado Boulder, 2022-2023

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Professional Affiliations

Member, American Society of Biomechanics

Publications

Skigen J, Koller C, **Nigro L**, Reisman DS, McKee Z, Pinhey S, Henderson A, Wilken J, Arch ES. Customized passive-dynamic ankle-foot orthoses can improve walking economy and speed for many individuals post-stroke. Journal of Neuroengineering and Rehabilitation 2024; 21(1):126. DOI: 10.1186/s12984-024-01425-7., PMID: 39069629, PMCID: PMC11285468.

Nigro L, Arch ES. Design and mechanical testing of a novel dual-stiffness ankle-foot orthosis. Journal of Medical Devices 2023; 17(3):034501. DOI: 10.1115/1.4062864.

Nigro L, Arch ES. Comparison of existing methods for characterizing bi-linear natural ankle quasi-stiffness. Journal of Biomechanical Engineering 2022; 144(11):114502. DOI: 10.1115/1.4054798, PMID: 35698872.

Nigro L, Arch ES. Metatarsophalangeal joint dynamic stiffness increases with walking speed and changes throughout terminal stance. Journal of Applied Biomechanics 2022; 38(5):320-327. DOI: 10.1123/jab.2021-0385, PMID: 36096476.

Nigro L, Koller C, Glutting J, Higginson JS, Arch ES. Nonlinear net ankle quasi-stiffness reduces error and changes with speed but not load carried. Gait & Posture 2021; 84:58-65. DOI: 10.1016/j.gaitpost.2020.11.023, ISSN: 0966-6362.

Presentations

Nigro L, Zhang-Lea J, Grabowski AM. Use of inertial measurement units for lower limb prosthesis alignment during walking. Poster presentation, 2023 American Society of Biomechanics Rocky Mountain Regional Meeting, 7-8 April 2023.

Nigro L, Arch ES. Ankle mechanics of typical individuals walking with a bi-linear stiffness ankle-foot orthosis. Podium presentation, 2022 North American Congress on Biomechanics, Ottawa, ON, CA, 21-25 August 2022.

Nigro L, Arch ES. Bi-linear natural ankle quasi-stiffness during walking: characterization & implications for orthosis design. Thematic poster, 2021 America Society of Biomechanics annual meeting, Virtual Conference, 10-13 August 2021.

Nigro L, Arch ES. Bi-linear natural ankle quasi-stiffness during walking: characterization & implications for orthosis design. Podium presentation, 2021 International Society of Biomechanics meeting, Virtual Conference, 25-29 July 2021.

Nigro L, Arch ES. Metatarsophalangeal dynamic joint stiffness during toe rocker. Podium presentation, 2021 Gait and Clinical Movement Analysis Society annual meeting, Virtual Conference, 8-11 June 2021.

Nigro L, Wagner N, Higginson JS, Arch ES. Providing rate-responsive bending stiffness to a passive-dynamic ankle-foot orthosis with shear-thickening fluid elements. 3-Min Video, 2020 American Society of Biomechanics East Coast Conference, Virtual Conference, 4-10 October 2020.

Nigro L, Wagner N, Higginson JS, Arch ES. Providing rate-responsive bending stiffness to a passive-dynamic ankle-foot orthosis with shear-thickening fluid elements. Poster presentation, 2020 American Society of Biomechanics Annual Conference, Virtual Conference, 4-7 August 2020.

Nigro L, Higginson JS, Arch ES. Modelling nonlinear natural ankle quasi-stiffness across multiple walking

& running speeds. Poster presentation, 2019 International Society of Biomechanics/American Society of Biomechanics Annual Conference, Calgary, AB, Canada, 31 July – 4 August 2019.

Nigro L, Higginson JS, Arch ES. Modelling nonlinear natural ankle quasi-stiffness across multiple walking & running speeds. Poster presentation, Center for Biomechanical Engineering Research (CBER) Symposium, Newark, DE, USA, 17 April 2019.

Nigro L, Higginson JS, Arch ES. Modelling nonlinear natural ankle quasi-stiffness across multiple walking & running speeds. Podium presentation, American Society of Biomechanics East Coast Conference, Reading, PA, USA, 13 April 2019.

Nigro L, Higginson JS, Arch ES. Modelling nonlinear natural ankle quasi-stiffness across multiple walking & running speeds. Poster presentation, College of Health Sciences Research Day, Newark, DE, USA, 1 February 2019.

Nigro L, Challis JH. Wavelet coherence of joint moments during running. Presentation, Pennsylvania State University College of Engineering Research Initiative symposium, State College, PA, USA, August 2015.

Project Experience

Prior work in graduate school Dr. Nigro worked closely with biomechanics researchers, clinicians, and custom carbon fiber manufacturers to design, build, and test a novel ankle-foot orthosis (AFO). This AFO employed a dual leaf-spring design to exhibit bending stiffness properties that closer mimicked natural ankle rotational stiffness during human walking than prior AFO designs.