UNIVERSITY of WISCONSIN

A CROSSE

La Crosse Institute For Movement Science (LIMS) Thomas Kernozek, PhD, FACSM, Director

The Institute was created in 2005 at the University of Wisconsin-La Crosse in the Department of Health Professions, Physical Therapy Program. LIMS brings together scientists and clinicians from various disciplines seeking applied knowledge related to human movement, factors related to injury, and in the foundations of therapeutic exercise used in the treatment and rehabilitation of injury.

Each year over 40 students from graduate and undergraduate programs from the UW-L campus are involved in laboratory research including Physical Therapy, Physics, Exercise and Sport Science, and Biology. High-technology funding from the State of Wisconsin supports 8 Physics Biomedical student internships in the laboratory.

Due to the many publications from the clinical biomechanics laboratory, LIMS has developed a national/international reputation.

Dr. Almonroeder's research with UWL ROTC

Military personnel routinely march while carrying 40+ pounds of equipment and supplies in a rucksack on their back ('ruck marching'), which increases loading of the lower body joints. Not surprisingly, ruck marching appears to contribute to the high rates of lower body overuse injuries among military personnel. While the effects of load carriage on marching mechanics has been studied extensively, previous studies have typically compared loaded vs. completely unloaded marching. Our research team was interested in examining how more subtle changes in rucksack load influence marching mechanics. In collaboration with UWL's Army Reserve Officer Training Corps (ROTC) program, we examined the lower body mechanics of 18 cadets as they marched on an instrumented treadmill within our motion analysis lab. During marching, cadets carried relatively light (35 lbs), moderate (45 lbs), and heavy (55 lbs) loads in their rucksack. Interestingly, hip, knee, and ankle loading all decreased as rucksack load was reduced. Our findings indicate that even relatively subtle reductions in rucksack load lessen hip, knee, and ankle loading during marching. As result, it appears that efforts should be made to reduce rucksack loads, even slightly, in order minimize the risk of lower body injury among military personnel. Rucksack loads could potentially be reduced by limiting the need to carry nonessential equipment or by making equipment lighter. We shared our findings with the cadre and cadets in UWL's ROTC program and have prepared a manuscript for publication. In the future, we plan to examine ways to train cadets to prepare for the demands of ruck marching. In addition, we will investigate different potential approaches for limiting the effects of load carriage on lower body joint loading, such as reconfiguring rucksack load distribution or re-training cadets to march with different technique.

Health Science Center Celebrates 20 Year Anniversary

The Health Science Center is home to the La

by other researchers over the past 7 years.

CONSORTIUM

Crosse Medical Health Consortium, a unique partnership between Gundersen Health System, Mayo Clinic Healthcare La Crosse, Western Technical College and Viterbo University. The building serves as the core of many community partnerships/programming, educational programs and research activities. LIMS has grown along with the HSC into one of central research hubs. Faculty and student research that involve some HSC Consortium partners have resulted in over 100 publications related to movement science and biomechanics since the formation of LIMS. This research is prominent at the national and international level where it has been highly cited by other resarchers. The figure below shows how often LIMS research has been cited



LIMS Scientists

Thomas "Gus" Almonroeder, DPT, PhD Motor Control/Biomechanics (Health Professions).

Chris Durall, DPT, ATC, MSPT Clinical Researcher, (UW-La Crosse Health Center),

John Greany, PT, PhD, Exercise Physiologist, (Health Professions),

Thomas Greiner, PhD, Biological Anthropologist, (Health Professions),

Naghmeh Gheidi, PhD, Biomechanist, (Assistant Professor, Exercise & Sport Science),

Becky Heinert, MSPT, SCS, (Gundersen Sports Medicine),

Tom Kernozek, PhD, FACSM, Biomechanist, (Health Professions).

Patrick Grabowski, PT, PhD, OCS, CSCS, Motor Control/ Biomechanics, (Health Professions),

Drew Rutherford, MS, Laboratory Manager/Engineer (Health Professions),

Nate Vannatta, DPT, SCS, (Gundersen Sports Medicine),

Robert Ragan, PhD, Computational Physicist (Physics),

Kanikkai "Steni" Sakiriyas, PT, DSc, Clinical Biomechanics (Health Professions)





Movement Science



Physical Therapy





LIMS

Gundersen/UWL Sports Medicine Residency Research

C.N. Vannatta, DPT, SCS

It has been an active year for Gundersen Sports Medicine residents despite changes due to the COVID pandemic implemented Spring 2020. Between physical therapy and family medicine residents, Gundersen clinicians and LIMS scientists have worked together that have resulted in presentions at local and national levels. Sports Medicine Resident Vien Vu, DPT presented a platform presentation at the 2020 AP-TA Combined Sections Meeting in Denver, CO investigating coincidence anticipation timing in athletes with and without ankle sprains. Family Medicine Resident Laura Jacobson, MD, has submitted a manuscript to The Knee describing sex differences in patellofemoral joint stress.

The 2019/20 Sports Physical Therapy residents have contributed to project investigating jump landing strategies in those recovering from ACL injury and also assisted in community programs for feedback training to help prevent ACL injury. With LIMS faculty and student efforts have submitted an abstract to the 2021 Combined Sections Meeting of the American Physical Therapy Association.

Gundersen's Sports Physical Therapy residency continues to collaborate with LIMS in an ongoing prospective trial with the UW-L Men's and Women's Cross Country Teams. Preliminary data has allowed for two publications examining the sex differences in lower extremity muscle forces and relationships between hip strength, running kinematics, and muscle forces.



Interested in being a participant or working with LIMS?

Contact Drew Rutherford, MS, <u>drutherford@uwlax.edu</u> or Tom Kernozek, PhD <u>tkernozek@uwlax.edu</u> for details



La Crosse Institute for

Movement Science LIMS UWLACROSSE

Physical Therapy

Motion capture of runner on our instrumented treadmill. Stick figure to the right is used to provide a 3-D representation of runner motion. Red line represents the location and magnitude of impact forces from force plates embedding in treadmill belt. This treadmill can be used to analyze walking or running forces.

Published Manuscripts from Gundersen/LIMS Collaboration:

Rodriguez M, Menhennett S, Vannatta CN, Kernozek TW, & Rutherford D. Relationship Between Maximum Hip Isometric Strength, Peak Gluteal Muscle Force Values and Hip Kinematics During Running. PT in Sport. July 2020.

Vannatta CN, Almonroeder TG, Kernozek TW, Meardon S. Muscle Force Characteristics of Male and Female Collegiate Cross-Country Runners During Overground Running. Journal of Sports Sciences. January 2020.

Vannatta CN, Heinert BL, Kernozek TW. Biomechanical risk factors for running-related injury differ by sample population: A systematic review and meta -analysis. Clinical Biomechanics. March 2020.

Abstracts/Presentations from Gundersen/LIMS Collaboration:

Vu V, Kovacs A, Wughalter E, Vannatta CN, Kernozek T. Effects of Ankle Sprains and Single versus Dual Task Paradigms on Coincidence Anticipation Performance in Female High School Basketball Players. Findings presented as a platform presentation at the 2020 APTA Combined Sections Meeting, Denver, CO.

Wenzlaff S, Hoppa L, Heinert BL, Rutherford D, Vannatta CN, Dietrich S, Anderson E, Dade R, Kernozek TW. The Effect of Post-Trial Visual Feedback Training on Landing Mechanics in High School and Collegiate Female Basketball Players. Findings presented at the WPTA West Central District Meeting. Abstract is submitted for a platform presentation at the 2021 APTA Combined Sections Meeting, Orlando, FL.

LIMS

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ACL Injury Prevention Programming and Runner's Clinic Partnership

Becky Heinert, MSPT, PT, SCS Gundersen Health

LIMS and Gundersen Health Sports Medicine: Community Partnership

Runners' Clinic and LIMS PACER Lab

Approximately 70% of runners will experience some type of overuse lower extremity injury. LIMS and Gundersen Health Sports Medicine launched a pilot Runner's Clinic to screen Winona high school cross country runners in the new PACER lab. Athletes received a custom report generated from the instrumented treadmill and 3D motion system along with a 2D qualitative assessment of their running biomechanics.

ACL Injury Prevention

Females are 2-8 times more likely to

suffer an injury to the ACL with the vast majority resulting from a non-contact mechanism like an awkward landing. LIMS innovative portable force plate system has been used with over 270 high school and collegiate athletes to help identify and teach proper landing patterns that may reduce the risk of ACL injury. Last year UWL and LIMS partnered with Gundersen Health Sports Medicine to provide 4 weeks of force plate and video based feedback training to promote changes in landing performance over time. The results of our work may help to provide clinicians with recommendations for injury prevention training programs and insight as to how motor strategies are integrated into the pre-programmed motor patterns. Our recently accepted paper in the International Journal of Sports Physical Therapy shows that this type of training is guite effective in improving landing performance. Further work is ongoing. Grants from UWL and Gundersen Medical Foundation have supported for these initiatives.

Winona High School athlete running on

the instrumented treadmill that measures ground impact. Reflective markers placed on the runners body to measure motion with high speed cameras. Data can be projected to monitor in front of the runner for performance based feed-back of movement performance Data can be projected to monitor in front of the runner for performance based feedback of movement performance.

Recently presented papers from community based collaboration:

Kernozek. T., Anderson, E, Dietrich, S., Dade, R., Heinert, B., Rutherford, D. Post-Trial Feedback May Alter Single and Dual Task Landing Performance in Female Collegiate Athletes, American College of Sports Medicine Meeting, San Francisco, CA, Medicine and Science in Sports and Exercise, July 2020, 52(7): 141. Presented virtually because of COVID pandemic.

Kernozek, T.W., McCutchin, B., Lee, M., Cleerman, J., Onsager, J., Schiedermayer, J., Heinert, B., Rutherford, D. (2019, May). Post-trial feedback alters single and dual task landing Performance in healthy and ACL reconstructed athletes. American College of Sports Medicine, Orlando, FL.

Lee, M., Onsager, J., Schiedermayer, J., Heinert, B., Rutherford, D., Kernozek, T. (2019, May). Post-trial feedback may alter single and dual task landing performance in female collegiate athletes. American College of Sports Medicine, Orlando, FL.

Kernozek, T.W., McCutchin, B., Lee, M., Cleerman, J., Onsager, J., Schiedermayer, J., Heinert, B., Rutherford, D. (2019, May). Post-trial feedback alters single and dual task landing Performance in healthy and ACL reconstructed athletes. American College of Sports Medicine, Orlando, FL



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Recently Published or In Press Research (2019-2020)

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Effects of Relative Drop Heights of Drop Jump Biomechanics in Male Volleyball Players. Peng HT, Song CY, Wallace BJ, Kernozek TW, Wang MH, Wang YH.Int J Sports Med. 2019 Dec;40(13):863-870. doi: 10.1055/a -0969-8623.

The effects of both jump/land phases and direction on Achilles tendon loading. Gheidi N, Kernozek TW.J Sports Med Phys Fitness. 2019 Oct;59 (10):1684-1690. doi: 10.23736/S0022-4707.19.09428-3.PMID: 31694362

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Biomechanical risk factors for running-related injury differ by sample population: A systematic review and meta-analysis. Vannatta CN, Heinert BL, Kernozek TW.Clin Biomech (Bristol, Avon). 2020 May;75:104991. doi: 10.1016/j.clinbiomech.2020.104991.

Patellofemoral Joint Loading During Single-Leg Hopping Exercises. Ristow A, Besch M, Rutherford D, Kernozek TW.J Sport Rehabil. 2019 Dec 22:1-6. doi: 10.1123/jsr.2019-0135.

Patellofemoral Joint Stress during Running with Added Load in Females. Kujawa M, Goerlitz A, Rutherford D, Kernozek TW.Int J Sports Med. 2020 Jun;41(6):412-418. doi: 10.1055/a-1088-5467.

Impact kinetics associated with four common bilateral plyometric exercises. Stewart E, Kernozek T, Peng HT, Wallace B.J Sports Med Phys Fitness. 2019 Apr;59(4):575-580. doi: 10.23736/S0022-4707.18.08359-7.

<u>Divided attention during cutting influences lower extremity mechanics in</u> <u>female athletes.</u> Almonroeder TG, Kernozek T, Cobb S, Slavens B, Wang J, Huddleston W.Sports Biomech. 2019 Jun;18(3):264-276. doi: 10.1080/14763141.2017.1391327.

<u>Muscle force characteristics of male and female collegiate cross-country</u> <u>runners during overground running.</u> Vannatta CN, Almonroeder TG, Kernozek TW, Meardon S.J Sports Sci. 2020 Mar;38(5):542-551. doi: 10.1080/02640414.2020.1713689.

Incorporating a dual-task assessment protocol with functional hop testing. Ness BM, Zimney K, Kernozek T, Schweinle WE, Schweinle A.Int J Sports Phys Ther. 2020 May;15(3):407-420.

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Two-dimensional versus three-dimensional measurement of infant cervical active motion. Castle KB, Kernozek TW, Warren E.Physiother Theory Pract. 2020 Jul 6:1-13. doi: 0.1080/09593985.2020.1790069.

Annual Report/News 2019-2020

We measure movement performance!

Our laboratories have sophisticated equipment that measure motion, impact forces, pressures on the feet or in seating, muscle activation, energy cost and heart rate, or for the imaging of tendons or soft tissue.

These data can be used to determine the loading on joints and muscles to give insight to how and why injuries may occur or for the improvement of performance to keep you active.

Musculoskeletal models are used to determine loading on bone, joints, ligaments, and tendons.



Pressure distribution measures show us the pressure points in seating or on your foot during walking or running.





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