

**The Faculty of Medicine of Harvard University  
Curriculum Vitae**

**Date Prepared:** December 02, 2023  
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**Education:**

9/05-7/09	BS	Biomedical Engineering	Shandong University, Jinan, Shandong Province, China
7/06-7/09	BBA	Business Administration	Shandong University
9/09-6/14	PhD	Biomedical Engineering (Changchun Liu)	Shandong University

**Postdoctoral Training:**

6/14-12/15	Postdoctoral Fellow	Nonlinear Dynamics for Cardiovascular Physiology (Mengsun Yu)	Shandong University
12/15-12/18	Research Fellow	Sleep and Circadian Disorders and Neurophysiology (Kun Hu)	Brigham and Women's Hospital (BWH), Harvard Medical School (HMS)

**Faculty Academic Appointments:**

1/19-6/21	Instructor	Medicine	HMS
7/21-11/23	Assistant Professor	Medicine	HMS
11/23-	Assistant Professor	Anesthesia	HMS

**Appointments at Hospitals/Affiliated Institutions:**

1/19-6/21	Investigator (Associate Physiologist)	Sleep and Circadian Disorders	BWH
7/21-11/23	Lead Investigator (Physiologist)	Sleep and Circadian Disorders	BWH
11/23-	Assistant Investigator	Anesthesia, Critical Care and Pain Medicine	Massachusetts General Hospital (MGH)

**Faculty Membership in Harvard Initiatives, Programs, Centers, and Institutes:**

2021-	Associate Member	The Broad Institute of MIT and Harvard
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**Other Professional Positions:**

2010-2012	R&D Researcher	Jinan Huiyironggong Technology Corporation Ltd., Jinan, China
2013-2014	Research Assistant	Institute of Biomedical Engineering, School of Control Science and Engineering, Shandong University
2014-2015	Consultant	Jinan Huiyironggong Technology Corporation Ltd., Jinan, China

**Major Administrative Leadership Positions:**

**Local**

2019-	Research Director, Medical Biodynamics Program,	Division of Sleep and Circadian Disorders, BWH
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**Committee Service:**

**Local**

2022-	Diversity, Equity, and Inclusion Steering Committee	Harvard University Center for AIDS Research
2022-		Member
2023	2023 DOM Mentoring Award Selection Committee	Brigham and Women’s Hospital, Department of Medicine
	December 2023	Member

**Professional Societies:**

2014-2019	Chinese Society of Biomedical Engineering	Member
2015-	IEEE Engineering in Medicine and Biology Society	
2015-2021		Member
2022-		Senior Member
2016-	Society for Research on Biological Rhythms	
2016		Postdoc member
2020		Member

2017-	American Heart Association	
	2017	Postdoc member
	2021	Member
2017-	Sleep Research Society	
	2017-2018	Postdoc member
	2019-	Member
2017-	American Academy of Sleep Medicine	
	2017-2018	Postdoc member
	2019-	Member
2017-	The Alzheimer's Association International Society to Advance Alzheimer Research and Treatment (ISTAART)	
	2017-2017	Postdoc member
	2020-	Member
2018-2022	Beijing Society for Cognitive Neuroscience	Member
2018-	Society for Neuroscience	Member

#### **Grant Review Activities:**

2020	Scientific Review Committee	National Natural Science Foundation, China
	June 11-30	Ad hoc reviewer, Young Scientists Fund Ad hoc reviewer, Regional Program

#### **Editorial Activities:**

- **Ad hoc Reviewer**

*Advanced Biology*

*Aging Cell*

*AIDS Research and Human Retroviruses*

*Alzheimer's & Dementia: The Journal of the Alzheimer's Association*

*Alzheimer's & Dementia: Translational Research & Clinical Interventions*

*Applied Acoustics*

*Artificial Intelligence in Medicine*

*Biocybernetics and Biomedical Engineering*

*Biomedical Research International*

*Biomedical Signal Processing and Control*

*British Medical Journal (BMJ)*

*BMJ Public Health*  
*Cancer Management and Research*  
*Circulation*  
*Complexity*  
*Computational and Mathematical Methods in Medicine*  
*Computers in Biology and Medicine*  
*Current Alzheimer Research*  
*Ecological Indicators*  
*Entropy*  
*Frontiers in Endocrinology*  
*Frontiers in Physiology*  
*Frontiers in Neurology*  
*Frontiers in Neuroscience*  
*Healthcare Technology Letters*  
*Hypertension*  
*IEEE Access*  
*IEEE Journal of Biomedical and Health Informatics*  
*IEEE Sensors*  
*IEEE Signal Processing Letters*  
*IEEE Transactions on Biomedical Engineering*  
*Innovation and Research in BioMedical Engineering*  
*Journal of Alzheimer's Disease*  
*Journal of Biological Rhythms*  
*Journal of Cardiovascular Development and Disease*  
*Journal of Medical and Biological Engineering*  
*Journal of Medical Imaging and Health Informatics*  
*Journal of Neural Engineering*  
*Journal of Neurology, Neurosurgery and Psychiatry*  
*Journal of the American Geriatrics Society*  
*Journal of The American Heart Association*  
*Life*  
*Medical & Biological Engineering & Computing*  
*Medical Science Monitor*  
*Nature and Science of Sleep*  
*Nonlinear Dynamics*

*Nutrition, Metabolism and Cardiovascular Diseases*

*Physiological Measurement*

*Plos One*

*Plos Medicine*

*Psychiatry and Clinical Neurosciences*

*Scientific Reports*

*Sleep*

*Sleep Medicine Reviewers*

• **Other Editorial Roles**

2015-2022	Associate Editor	<i>Journal of Medical Imaging and Health Informatics</i>
2017-2018	Guest Editor	<i>Computational and Mathematical Methods in Medicine</i>
2018	Guest Associate Editor	<i>Frontiers in Physiology</i>
2020	Special Issue Guest Editor	<i>Entropy</i>
2020-2023	Academic Editor	<i>Computational and Mathematical Methods in Medicine</i>
2020	Special Issue Guest Editor	<i>Journal of Healthcare Engineering</i>
2021-	Associate Editor	<i>Frontiers in Physiology</i>
2021-	Review Editor	<i>Frontiers in Network Physiology</i>
2021-	Review Editor	<i>Frontiers in Neurology</i>
2021-	Review Editor	<i>Frontiers in Endocrinology</i>
2021-	Special Issue Editor	<i>Entropy</i>
2022-2023	Guest Editor	<i>Advanced Biology</i>
2023-	Topic Editor	<i>Frontiers in Network Physiology</i>

**Honors and Prizes:**

2008	First Prize (Provincial Level)	Shandong Provincial Education Department	Undergraduate Electronic Design Contest
2009	Excellent Bachelor's Thesis	Shandong University	
2010	Second Prize (National Level)	Organizing Committee of Mathematical Contest in Modeling	Graduate Mathematical Contest in Modeling
2012	National Scholarship	Ministry of Education, China	Excellent doctoral research

2014	Outstanding PhD Student (Provincial Level)	Shandong Provincial Education Department	Excellent doctoral research
2014	International Travel Award	Shandong University	
2015	International Travel Award	China Postdoctoral Council	
2017	2016 Provincial Award for Science and Technology Innovations	Shandong Provincial Government, China	Key techniques and applications of the early diagnosis of cardiovascular diseases (No. FM2016-2-7-R04)
2017	2016 Innovation Discovery	Partners Healthcare	Stability and Fragmentation of Daily Activity Rhythm
2018	Trainee Professional Development Award	Society for Neuroscience	
2019	Microgrant	Brigham and Women's Hospital Research Institute	Advanced research training in deep learning
2020	Travel Award to attend the International Workshop on HIV & Aging 2020 (award received but converted to registration fee waiver due to Covid-19 travel/meeting ban)	Harvard University Center for AIDS Research (HU CFAR)	
2021	Young Investigators Research Forum Award	American Academy of Sleep Medicine	
2022	Early Career Mentoring Award	Department of Medicine, BWH	

### **Report of Funded and Unfunded Projects**

#### **Past:**

2012-2013	Quality assessment of ambulatory ECG recordings Shandong University, Graduate Research Award yzc12082 PI The goal of this project was to establish an easier-to-implement algorithm for assessing the quality of ambulatory ECG recordings. This grant is awarded to well-qualified PhD students with rigorous peer-review.
2014-2015	The evaluation of the nonlinear properties of cardiac dynamics through short-term heartbeat interval data China Postdoctoral Council 2014M561933 PI

- The major goal of this project was to develop a robust entropy method for evaluating the complexity of short-term heartbeat interval data.
- 2015 Distribution entropy method and its application in the complexity analysis of cardiac dynamics  
Shandong Provincial Natural Science Foundation ZR2015FQ016  
PI  
The goal of this project was to examine the performance of the distribution entropy method PI developed in cardiac dynamics in term of accurately detecting heart failure patients from healthy control group through short-term ECG measurement.
- 2015 Distribution entropy analysis to the cardiac electrical and mechanical activities' interval time-series in patients with coronary heart disease  
National Natural Science Foundation of China 61471223  
Co-Investigator (PI: Changchun Liu)  
The major goal of this project was to explore the potential of a new developed distribution entropy method in characterizing the complexity of neurological cardiovascular control of patients with coronary heart disease through the cardiac electrical and mechanical activities' interval time-series, e.g., heartbeat interval, diastolic time.
- 2016 Entropy measures-based study on the effects of circadian disorders on the complexity of cardiac dynamics  
China Postdoctoral Council, Research Fellowship 20150042  
PI  
This goal of this project was to study the effects of circadian misalignment on physiological complexity. The Postdoctoral fellowship fully covered my first-year salary at the Brigham and Women's Hospital.
- 2018-2023 Fractal motor activity regulation and the risk for Alzheimer's disease in middle-to-old aged adults  
National Institutes of Health (NIH)/National Institute on Aging (NIA) RF1AG059867  
Co-Investigator (PI: Kun Hu)  
The goal of this grant is to test whether fractal activity regulation, a recently revealed novel dynamic control in motor activity fluctuations, can be used as a cost-efficient, reliable tool to predict the risk of Alzheimer's disease in middle-to-old aged adults.
- 2021-2022 Circadian disturbances and cognitive impairment in people living with HIV  
Harvard University Center for AIDS Research (HU CFAR), Developmental Award (subcontract to NIH 5P30AI060354-17)  
PI (\$79,714)  
The goal of this project is to determine the role of circadian regulation in HIV-associated cognitive impairment.
- 2021-2022 Association between rest activity circadian rhythm and cognition in PLWH  
University of Alabama, Birmingham, HIV and Aging Research Consortium HIV/Aging Pilot Program (subcontract to NIH R33AG067069-01)  
PI (\$60,000, including \$10,000 internal matching fund from the HU CFAR)  
The goal of this project is to characterize the circadian patterns in PLWH using a novel data adaptive tool for analyzing rest activity data, examine the association between circadian variations and cognition in PLWH, and explore the potential mechanisms.
- 2020-2022 Circadian multiscale activity regulation and the risk for delirium in elderly hospitalized patients  
NIH/NIA R03AG067985  
Co-Investigator (PI: Lei Gao)

The goal of this project is to determine the long-term relationship between earlier-life circadian/sleep regulation and delirium, in the context of cognition and normal aging.

- 2020-2023      Circadian regulation, autonomic function and Alzheimer's disease  
BrightFocus Foundation, Standard Award A2020886S  
PI (\$285,000)  
The goal of this project is to determine the roles of circadian dysregulation and autonomic dysfunction in the development/progression of AD utilizing novel circadian and autonomic measures derived from nonlinear analyses.

**Current:**

- 2019-2024      Integrated motor activity biomarker for the risk of Alzheimer's dementia  
NIH/NIA RF1AG064312  
Co-Investigator (PI: Kun Hu)  
The goal of this project is to develop an integrated, non-invasive biomarker for the risk of Alzheimer's dementia using motor activity recordings.
- 2023-2024      Circadian rest-activity rhythms and links with cognitive function in women aging with HIV  
Brigham Research Institute (BRI) Fund to Sustain Research Excellence (FSRE)  
PI (\$50,000)  
The BRI Fund to Sustain Research Excellence (FSRE) will provide support to allow the team to prepare more compelling preliminary results to boost the success of a resubmission of an R01 application that will evaluate circadian rest-activity rhythms (CRAR), the influence of menopause on CRAR, and the association of CRAR with cognition in women living with HIV (WLH) and HIV seronegative women.
- 2023-2025      Li Lab start-up fund  
Department of Anesthesia, Critical Care and Pain Medicine  
PI (\$300,000)  
This start-up package is established for the PI to successfully initiate his independent research program at MGH. The funding serves to facilitate the expeditious start-up of the research lab, including the support of reasonable expenses such as effort and the PI and other personnel as well as materials and supplies.
- 2023-2028      Circadian disturbance and dementia in Latin America  
NIH, R01 (to be started)  
Co-Investigator (PI: Hu)  
The goal of this project is to determine the effects of age, sex, and socioeconomic status on circadian function in Latin America countries, and the involvement of circadian disturbance in the development/progression of Alzheimer's disease and frontotemporal dementia in Latin America.

**Projects Submitted for Funding:**

**Training Grants and Mentored Trainee Grants:**

- 2022-2025      Timing and irregularity of daytime napping and Alzheimer's disease  
Alzheimer's Association Research Fellowship to Promote Diversity Program  
Primary Mentor  
The proposed study will address two aims: (1) To investigate the relationship of timing



and irregularity of daytime naps with longitudinal cognitive decline, and AD; and (2) To determine whether timing and irregularity of daytime naps interact with genetic risks of AD to influence the trajectory of cognitive change and incident Alzheimer's dementia.

- 2023 Daytime napping and Alzheimer's disease in middle-to-older aged adults: Timing, irregularity, and interaction with genetic risks  
American Academy of Sleep Medicine, Focused Projects for Junior Investigators  
Primary Mentor  
We will address two aims: (1) To investigate the relationship of timing and irregularity of daytime naps with cross-sectional and longitudinal cognitive decline, and AD; and (2) To determine whether timing and irregularity of daytime naps interact with genetic risks of AD to influence the trajectory of cognitive change and incident AD

### **Unfunded Current Projects:**

- 2023-2025 Influence of sleep and circadian disturbances on mental health in transgender and gender diverse people  
America Academy of Sleep Medicine, Strategic Research Grant (to be resubmitted as new)  
PI  
This project will evaluate the feasibility and acceptability of performing at-home monitoring of sleep and circadian daily rhythms in TGD individuals. We will also examine relationships across age, biological sex assigned at birth, gender identity, SCH, psychosocial stress, and depressive symptoms among TGD individuals.
- 2024-2025 Expert-level epoch-by-epoch sleep scoring from ambulatory motion data  
National Academy of Medicine, Healthy Longevity Catalyst Awards (to be resubmitted)  
PI  
We propose to provide a solution to the challenge in remote sleep medicine to achieve an expert-level epoch-by-epoch recognition of sleep/wake status from motion data and ultimately sleep staging from multiple physiological outputs collected from wearables by applying novel data analytical tools and leveraging the power of machine learning.
- 2023-2028 Circadian rest activity rhythms and links with cognitive function in women aging with HIV  
NIH, R01 (scored missing payline; to be re-submitted)  
PI  
This project will evaluate circadian rest-activity rhythms (CRAR), the influence of menopause on CRAR, and the association of CRAR with cognition in WLH and HIV seronegative women.
- 2024-2026 Extracting biological age of circadian function from actigraphy  
NIH, R21 (scored missing payline; to be resubmitted)  
PI  
The goal of this project is to define and evaluate a proxy for the biological age of circadian function (circadian age: CircAge) by integrating multiple features from actigraphy for rest-activity rhythms (RARs) and/or deep learning the graphical representation of actigraphy—actogram—that sketches rest-activity patterns over the course of a day.
- 2024-2029 Sleep, Circadian Rhythms, and Aging with HIV: A Botswana-Boston Collaborative Project  
NIH, R01 (ND; to be re-submitted)  
MPI/ Contact PI  
We propose to initiate a comparative cohort of PLWH and HIV-uninfected controls in

Boston (US, North America) and Gaborone (Botswana, Africa), i.e., the Botswana-Boston Collaborative (BBC), to study disparities in SCH in PLWH that synergize with SDoH representing varied life exposures to biological and social stressors to drive dysregulation of inflammatory-bioenergetic homeostasis (IBH), and over time resulting in reduced cognitive and physical reserves.

- 2024-2029 Cardiovascular health and cognitive decline in older adults with dementia in Latin America  
NIH, R01 (ND; to be resubmitted)  
MPI, contact PI  
This project will examine the cardiovascular function in people with Alzheimer's disease, frontotemporal lobe dementia, as well as cognitively normal adults living in Latin American countries. The results will help understand the link between the heart and the brain in Latinos and determine whether cardiovascular health contributes to brain or cognitive outcomes in these older adults. The project will also provide insights into the change of cardiovascular health in Latinos with dementia and its role in the progression of dementia.
- 2024-2029 Circadian Rest-Activity Rhythms and Dementia: Understanding Causal Associations and Pathways  
NIH, R01 (scored missing payline; to be resubmitted)  
PI  
This project is designed to strengthen the understanding of the causal relationship between disrupted circadian rhythms and risk for ADRD and the underlying mechanisms. Achieving the aims will provide new modifiable targets for designing treatments to lower individual's risk of ADRD and/or slow or even halt the progression.

### **Report of Local Teaching and Training**

#### **Other Mentored Trainees and Faculty:**

- 2014-2017 Lizhen Ji, PhD / Instructor, Shandong Normal University, Jinan, Shandong, China  
Career stage: doctoral student; Mentoring role: research co-advisor; Accomplishments: Co-author on 4 published papers.
- 2014-2019 Chang Yan, PhD / Postdoctoral fellow, Southeast University, Nanjing, China  
Career stage: doctoral student; Mentoring role: research co-advisor; Accomplishments: Co-author on 4 published papers.
- 2015-2019 Yang Li / Postdoctoral fellow, Shanghai Jiao Tong University, Shanghai, China  
Career stage: doctoral student; Mentoring role: research co-advisor; Accomplishments: Co-author on 3 published papers.
- 2015-2020 Lianke Yao / PhD student, Shandong University, Jinan, Shandong, China  
Career stage: doctoral student; Mentoring role: research co-advisor; Accomplishments: Co-author on 1 published paper and 2 under review.
- 2016-2017 Melissa Patxot, BS / Program Manager at RIP ROAD, Inc., New York, NY  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: 1 local poster presentation.
- 2016-2018 Tommy To, BS / Medical student at Virginia Tech Medical School, Roanoke, VA  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: 4

- poster presentations in local and national conferences, and successfully enrolled in an MD program.
- 2017-2019 Chelsea Hu, BS / Postgraduate student at Loyola University, Chicago, IL  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: 2 poster presentations in local and national conferences.
- 2018-2019 Lei Gao, MBBS / Assistant Professor in Anesthesia, Massachusetts General Hospital, Boston, MA  
Career stage: T-32 fellow; Mentoring role: research co-mentor; Accomplishments: 2 published journal article, 1 manuscript submitted, and 3 conference oral presentations. He was promoted to Assistant Professor in April 2020.
- 2019-2020 Longchang Cui, MS / Co-Founder, Lead Unity Developer at Hyper Artisan Inc., Boston, MA  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: co-author on 2 manuscripts under review, 1 poster presentation.
- 2019-2020 Arlen Gaba, BS / MD student at Wake Forest School of Medicine, Winston-Salem, NC  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: co-author on 3 manuscripts, 1 poster presentation.
- 2020-2022 Hui-Wen Yang, PhD / Postdoctoral Fellow, BWH  
Career stage: postdoctoral fellow; Mentoring role: research co-mentor; Accomplishments: one first-author paper, and one first-author manuscript in preparation
- 2020-2022 Ma Cherrysse Ulsa, MS / Research Assistant, BWH  
Career stage: research assistant; Mentoring role: research co-mentor; Accomplishments: submitted 1 first-author abstract to a scientific meeting; obtained Trainee Merit-based Award from SLEEP 2021
- 2020- Xi Zheng, MS / Research Assistant, BWH  
Career stage: research assistant; Mentoring role: research mentor; Accomplishments: submitted 2 first-author abstracts to scientific meetings; obtained Trainee Merit-based Award from SLEEP 2021
- 2021- Chenlu Gao, PhD / Postdoctoral Fellow, BWH  
Career stage: postdoctoral fellow; Mentoring role: mentor; Accomplishments: Honorable Mention in Div. Sleep Medicine, Sleep Benefit Dinner Poster Session 2021 and Presentation Award in Sleep Benefit Dinner Poster Session 2022; published a first-author paper in 2022; >5 first-authored conference abstracts; received a fellowship grant from Alzheimer's Association in 2022; received a Focused Grant for Junior Investigators from American Academy of Sleep Medicine in 2023
- 2021- Max Wagner / Research Trainee, BWH  
Career stage: high-school research trainee; Mentoring role: mentor; Accomplishments: one first-author abstract submitted to SLEEP 2022; Honorable Mention in HMS Div. Sleep, Sleep Benefit Dinner Abstract Session 2022
- 2022- Ruixue Cai / Visiting PhD Student, BWH  
Career stage: graduate student; Mentoring role: mentor; Accomplishments: multiple presentations in academic conferences including SLEEP, SRBR, etc. Received a Trainee Merit Award from SLEEP 2023. One manuscript accepted for publication in Nature Communications in 2023.

### **Local Invited Presentations:**

*No presentations below were sponsored by 3<sup>rd</sup> parties/outside entities*

*Those presentations below sponsored by outside entities are so noted and the sponsor(s) is (are) identified.*

- 2013 Entropy measures with application to the complexity analysis of cardiac dynamics /  
Keynote speaker  
'Haiyou' doctoral academic forum, School of Control Science and Engineering, Shandong  
University, Jinan, Shandong, China
- 2016 Night shift work disrupts fractal activity regulation / Invited presentation  
Boston mini symposium on Circadian Rhythms, Metabolism, and Beyond  
Division of Sleep and Circadian Disorders, BWH
- 2018 Fractal regulation and Alzheimer's disease / Invited talk  
Clinical Data Animation Center, Massachusetts General Hospital, Boston, MA
- 2018 Alzheimer's disease: Prevalence, diagnosis, and pathogenesis / Invited lecture at the  
MBP/MCP mini course series  
Division of Sleep and Circadian Disorders, BWH
- 2020 Physiological complexity, brain health, and well-being / Invited talk  
Alzheimer's Clinical and Translational Research Unit, Massachusetts General Hospital,  
Boston, MA
- 2020 Physiological complexity, brain health, and well-being / Invited talk delivered to visitors  
from Stanford  
Division of Sleep and Circadian Disorders, BWH
- 2020 Physiological complexity, brain health, and well-being / Invited talk at the Scientific Staff  
Meeting  
Division of Sleep and Circadian Disorders, BWH
- 2023 Circadian rest-activity rhythms and cognitive performance in people living with HIV /  
Invited talk at the "HIV Research in Progress" series  
Harvard University Center for AIDS Research

### **Report of Regional, National and International Invited Teaching and Presentations**

*No presentations below were sponsored by 3<sup>rd</sup> parties/outside entities*

*Those presentations below sponsored by outside entities are so noted and the sponsor(s) is (are) identified.*

#### **Regional:**

- 2017 Physiological consequences of altered fractal regulation / Invited presentation  
Massachusetts Life Sciences Innovation Day 2017, Massachusetts Technology Transfer  
Center, Boston, MA

#### **National:**

- 2016 Aging effect on multiscale activity control / Invited talk  
7th Religious Orders Study/Memory and Aging Project (ROS/MAP) investigators meeting, Rush Alzheimer's Disease Center, Chicago, IL
- 2017 Physiological consequences of altered fractal regulation / Invited talk  
8th ROS/MAP investigators meeting, Rush Alzheimer's Disease Center, Chicago, IL
- 2018 Fractal regulation and dementia-related pathologies / Invited talk  
9th ROS/MAP investigators meeting, Rush Alzheimer's Disease Center, Chicago, IL
- 2019 Fractal motor regulation and adverse health consequences / Invited talk  
10th ROS/MAP investigators meeting, Rush Alzheimer's Disease Center, Chicago, IL
- 2020 Daytime napping in community-based elderly adults / Invited talk  
11th ROS/MAP investigators meeting (Virtual)
- 2022 Multidimensional actigraphy features: Link between circadian rest activity rhythms and Alzheimer's disease / Symposium talk  
SLEEP 2022, Charlotte, NC

**International:**

- 2020 O4-12 Biomarkers (non-neuroimaging): Alzheimer's Disease Incidence, Risk Factors and Biomarkers / Session Chair  
Alzheimer's Association International Conference, Amsterdam, the Netherlands (Virtual)
- 2020 Physiological complexity, brain health, and well-being / invited lecture  
the 2020 cross-disciplinary research forum on mathematics, artificial intelligence, and chronic diseases, Taiyuan, China (on-site and online)
- 2021 Resting heart rate complexity and all-cause and cardiorespiratory mortality in a middle-to-older aged, population cohort / Invited talk  
Mini-symposia 12 "The control of cardiovascular system in health and disease" in the Society for Mathematical Biology Annual Meeting 2021, Online and at the University of California Riverside, USA
- 2021 Predicting patterns in daily activities / Invited talk  
the 2021 Taishan Scientific Forum, Jinan, China (on-site and online)
- 2022 Circadian rhythms: analytical approaches and novel insights into cognitive health in older adults / Invited talk  
Departmental Seminar, Department of Psychology, The University of Hong Kong, Online Zoom and On-site in Hong Kong
- 2023 Cardiovascular autonomic function and cognitive aging in older adults / Invited talk  
Centre for Intelligence Healthcare, Coventry University, UK (delivered through Zoom)
- 2023 Analytical approaches for circadian rest-activity rhythms and new insights into cognitive aging / Invited speaker  
The 12<sup>th</sup> International Conference on Biomedical Engineering and Biotechnology, hybrid (in person at Macao and online through online meeting platform)
- 2023 Rest-activity rhythms, cardiovascular dynamics, and dementia: Towards digital biomarkers for brain health / Invited lecturer  
Public Lecture, National Science and Technology Council, Taiwan (delivered through Google meet)

## Report of Scholarship

### Peer-Reviewed Scholarship in print or other media:

#### Research Investigations

(#: contributed equally; \*\*: mentee)

1. Liu C, Li L, Zhao L, Zheng D, **Li P**, Liu C. A combination method of improved impulse rejection filter and template matching for identification of anomalous intervals in RR sequences. *J Med Biol Eng.* 2012;32:245–50.
2. Liu C, Zheng D, Zhao L, **Li P**, Li B, Murray A, Liu C. Elastic properties of peripheral arteries in heart failure patients in comparison with normal subjects. *J Physiol Sci.* 2013;63:195–201. PMID: 23519698
3. **Li P**, Liu C, Wang X, Li L, Yang L, Chen Y, Liu C. Testing pattern synchronization in coupled systems through different entropy-based measures. *Med Biol Eng Comput.* 2013;51:581–91. PMID: 23337958
4. **Li P**, Liu C, Wang X, Zheng D, Li Y, Liu C. A low-complexity data-adaptive approach for premature ventricular contraction recognition. *Signal Image Video Process.* 2014;8:111–20.
5. Liu C, **Li P**, Di Maria C, Zhao L, Zhang H, Chen Z. A multi-step method with signal quality assessment and fine-tuning procedure to locate maternal and fetal QRS complexes from abdominal ECGcg recordings. *Physiol Meas.* 2014;35:1665–83. PMID: 25069817
6. Sun X, Li K, Ren H, **Li P**, Wang X, Liu C. Influence of timing algorithm on brachial-ankle pulse wave velocity measurement. *Bio-Med Mater Eng.* 2014;24:255–61. PMID: 24211905
7. Ji L \*\*, **Li P**, Li K, Wang X, Liu C. Analysis of short-term heart rate and diastolic period variability using a refined fuzzy entropy method. *Biomed Eng Online.* 2015;14:64. PMID: 26126807. PMCID: PMC4487860
8. Ji L \*\*, Liu C, **Li P**, Wang X, Yan C, Liu C. Comparison of heart rate variability between resting state and external-cuff-inflation-and-deflation state: a pilot study. *Physiol Meas.* 2015;36(10):2135–46. PMID: 26333766
9. **Li P**, Liu C, Li K, Zheng D, Liu C, Hou Y. Assessing the complexity of short-term heartbeat interval series by distribution entropy. *Med Biol Eng Comput.* 2015;53:77–87. PMID: 25351477
10. Hu K, Riemersma-van der Lek RF, Patxot M, **Li P**, Shea SA, Scheer FA, Van Someren EJ. Progression of dementia assessed by temporal correlations of physical activity: results from a 3.5-year, longitudinal randomized controlled trial. *Sci Rep.* 2016;6:27742. PMID: 27292543. PMCID: PMC4904193
11. Ji L \*\*, **Li P**, Liu C, Wang X, Yang J, Liu C. Measuring electromechanical coupling in patients with coronary artery disease and healthy subjects. *Entropy.* 2016;18:153.
12. **Li P**, Karmakar C, Yan C, Palaniswami M, Liu C. Classification of five-second epileptic EEG recordings using distribution entropy and sample entropy. *Front Physiol.* 2016;7:136. PMID: 27148074. PMCID: PMC4830849
13. **Li P**, Li K, Liu C, Zheng D, Li Z-M, Liu C. Detection of coupling in short physiological series by a joint distribution entropy method. *IEEE Trans Biomed Eng.* 2016;63(11):2231–42. PMID: 26760967
14. Shi B, Zhang Y, Yuan C, Wang S, **Li P**. Entropy analysis of short-term heartbeat interval time series during regular walking. *Entropy.* 2017;19:568.
15. Karmakar C, Udhayakumar RK, **Li P**, Venkatesh S, Palaniswami M. Stability, consistency and performance of distribution entropy in analysing short length heart rate variability (HRV) signal. *Front Physiol.* 2017;8:720. PMID: 28979215. PMCID: PMC5611446

16. **Li P**, Morris CJ, Patxot M, Yugay T, Mistretta J, Purvis TE, Scheer FAJL, Hu K. Reduced tolerance to night shift in chronic shift workers: insight from fractal regulation. *Sleep*. 2017;40(7):zsx092. PMID: 28838129. PMCID: PMC6317507
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14. Cai R<sup>\*\*</sup>, Zheng X, Gao L, Hu K, **Li P**. Current shift work and frailty: findings from the uk biobank. Associated Professional Sleep Societies 2023 Annual Meeting; Indianapolis, IN. Abstract: 246  
*Trainee Ruixue Cai received a Trainee Merit Award*
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## **Narrative Report**

I am a biomedical engineer and computational physiologist at the interface of medicine and engineering. I am a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE). I have published over 70 scientific research articles with an H-index of 26 (based on Google Scholar). My research has been focused on evaluating cardiovascular and cognitive aging and assessing the risk for developing cardiovascular diseases and dementia by noninvasive and cost-effective approaches.

My prior contributions to science and/or technology are three-fold:

1. *Assessing sub-clinical cardiovascular function/risk by designing novel signal processing tools.*

One of the intriguing findings in physiology is the robust complexity of physiological outputs, such as heartbeat dynamics. I have contributed significantly to this field with my most important early work (8+ years ago). I developed a new algorithm, distribution entropy, and several variants to assess physiological complexity based on short-length signals. Prior to this work, a reliable assessment of complexity requires long data. In contrast, physiological recordings collected in standard clinical settings (e.g., routine screening ECGs at rest) are short and, thus, unsuitable for complexity analysis. This has been the main barrier to utilizing complexity for functional assessment and outcome prediction in real-world practice. The new algorithm was designed to fundamentally address this major limitation by considering a more integrated feature in the fluctuation patterns of the signal, allowing a reliable assessment of complexity from short recordings.

In addition to highly cited research publications (i.e., the distribution entropy paper has been cited 210 times since it was published in 2015), I led a software development team, collaborating with a hardware designing company in China to implement these novel approaches. Together, we developed a cardiovascular function assessment device that simultaneously evaluates autonomic balance, cardiac systolic function, and vascular function through 5-minute assessments of several body-surface physiological recordings, including ECG, pulse wave (oximetry and cuff sensor), and heart sounds. Many core techniques have been patented, and the device has been certified by the FDA in China and has now been used widely in many hospitals. (COI: none. I do not hold stocks of the company, nor do I hold any patent rights.)

2. *Understanding sleep and circadian health, cognitive aging, and dementia etiology.*

Disruptions in sleep and circadian rhythms—the internal biological cycles that help prepare bodily responses for the daily environmental, light-dark changes—are commonly seen in people with Alzheimer’s disease and related dementias (ADRD) and may contribute to the pathogenesis of ADRD. My research in the recent 8 years has contributed to the understanding of sleep and circadian disturbances as early-stage manifestations or risk factors of AD. Specifically, my work has shown that lower strength of the rest-activity rhythms, increased fragmentation, perturbed fractal structures, as well as longer/ more frequent daytime sleep/resting period, predicted elevated risk for developing AD in older adults many years before any clinical sign of AD (*Research Investigation*<sup>5-7</sup>) and related physical health outcomes (*Research Investigation*<sup>8,9</sup>). Such relationships were independent of previously known risk factors for AD. Moreover, my research has helped advance our understanding of simultaneous degradations in cognition and sleep/circadian rhythms with advanced age and clarified the bidirectional relationship between cognitive decline and circadian degradation in human participants. Specifically, by following and examining the cognitive performance and rest-activity rhythms longitudinally in older adults, I discovered that cognitive decline and many of the manifestations of sleep and circadian disturbances occurred in parallel and that the two processes drove each other’s changes in a bidirectional manner (*Research Investigation*<sup>6,10</sup>). One highlight of my recent discoveries in this field is the link between altered daytime napping and risk for AD (*Research Investigation*<sup>11</sup>), which opens a new research avenue to understand behavioral rhythms or sleep behaviors in dementia etiology and to design potential interventional strategies through consolidating sleep behaviors or sleep hygiene for cognitive benefits. Following this research, under my direct supervision, Dr. Chenlu Gao received a 3-year postdoctoral fellowship from the Alzheimer’s Association to further investigate the relationship of timing and regularity of daytime napping with cognition, AD pathology, and genetic AD risks. Besides, under my direct mentorship, Dr. Chenlu Gao also received a focused projects award for junior investigators from the American Academy of Sleep Medicine for studying daytime napping characteristics in middle- to older-aged adults and risk of AD.

I also leveraged my biomedical engineering expertise to promote such applications in clinical practice, population-based research, and even trials. I developed a user-friendly software application, ezActi, to implement multiple analytical procedures on actigraphy/rest-activity data (*Review*<sup>1</sup>). It has already been used in ongoing collaborative work with the ALFASleep cohort (Barcelona, Spain) on studying circadian rhythms and cognitive resilience as well as evaluating rest-activity rhythms in the Harvard Aging cohort, the clinical trial led by a collaborator, Dr. Hassan Dashti, in the Department of Anesthesia, Critical Care and Pain Medicine (DACCPC), and the postoperative delirium work led by the DACCPC colleague Dr. Lei Gao.

### *3. Addressing disparities in physical and cognitive resilience in diverse populations by understanding/enhancing sleep and circadian health.*

My research in the last 3 years has also been expanded to the study of physical and cognitive resilience in the context of sex/gender and racial minorities as well as people living with chronic conditions such as HIV infection, who show a disproportionately higher burden of age-related comorbidities. This new line of research will be essential for promoting healthy aging in diverse settings. While I have just started my research journey in this new field, I have obtained exciting findings for me to further explore this direction. For example, my research study in middle-aged population showed that, while sleep behaviors were not associated with cognitive performance in HIV-uninfected people, they were associated in people living with HIV (*Research Investigation*<sup>12</sup>), underscoring a need to understand HIV-associated accelerated or accentuated aging in the context of sleep health. Besides, my most recent pilot study collaborated with a group in Sub-Saharan Africa found that sleep disturbances were linked to physical frailty in people living with HIV in an African setting (*Conference Abstract*<sup>1</sup>), implying a need to further understand how social/structural determinants of health contribute to sleep and circadian function, leading to varied health anticipations.

#### *Teaching and mentorship.*

During my appointment as an assistant professor of medicine, I spend on average five hours/week co-directing the Medical Biodynamics Program (MBP) as the Research Director, with responsibilities

including administration and coordination, conceiving research ideas, implementation of analytical tools, design of the training program, and mentoring of research trainees.

I currently supervise one postdoctoral research fellow and one PhD student as the primary mentor. I also supervise two research trainees and one postdoctoral research fellow as the co-mentor. In total, I have co-mentored 11 trainees within the MBP and four outside the HMS community. I give weekly 1-hour tutorials to these trainees on topics including physiological complexity, nonlinear dynamical analysis, applied statistics, software application, and machine learning.