

BIOGRAPHICAL SKETCH

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NAME: Swanson, Christine M.

eRA COMMONS USER NAME (credential, e.g., agency login): SWANSCHR

POSITION TITLE: Associate Professor

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of Colorado, Boulder, CO	BS	05/2005	Finance
Tulane University SOM, New Orleans, LA	MD	05/2009	Medicine
Mayo Clinic Arizona, Phoenix, AZ	Internship/ Residency	06/2012	Internal Medicine
Oregon Health & Science University, Portland, OR	Fellowship	06/2015	Endocrinology
International Society for Clinical Densitometry	CCD	05/2016	Certified Clinical Densitometrist
University of Colorado, Aurora, CO	Fellowship	06/2016	Endocrine Research
Oregon Health & Science University, Portland, OR	Masters	05/2017	Clinical Research (MCR)

A. Personal Statement

My goal is to positively impact patient care through scientific discoveries that allow us to better understand if and how lifestyle (e.g., exercise, sleep and circadian disruption, cannabis use, etc.) affects the skeleton. My intellectual curiosity and desire to understand the pathophysiology of disease have driven me to investigate clinically relevant, novel hypotheses in this understudied area because it has the potential to positively impact patient care by improving the prevention, evaluation, and treatment of osteoporosis. My clinical endocrinology training, Masters of Clinical Research (**MCR**), mentored patient-oriented research career development award (K23, NIAMS), R03 (NIAMS), R01 (NHLBI), and academic productivity to date have prepared me for a successful, collaborative career in clinical research. *As an ISCD-certified clinical densitometrist (CCD), the medical director of the High-Resolution peripheral Quantitative Computed Tomography (HR-pQCT) bone imaging device at the University of Colorado Anschutz Medical Campus (CU-AMC), and a board-certified physician scientist with continuous NIH funding for clinical research since 2016, I am qualified to serve as the Assistant Director, and eventually Associate Director, of the NORC Energy Balance Assessment Core (EBAC) to oversee all clinical services in conjunction with Dr. Seth Creasy.*

My research primarily investigates if and how sleep and circadian disruptions affect bone metabolism to determine if these disturbances are novel, modifiable risk factors for bone loss, osteoporosis, and increased fracture risk. Nutrition and obesity are necessary to incorporate and consider in this line of research because 1) they are often impacted by sleep and circadian disruptions and 2) they are critically important determinants of bone health. I rely on the NORC EBAC for the nutrition services (e.g., diets controlled for macro- and micronutrient composition), bone mineral density (**BMD**) testing with dual-energy x-ray absorptiometry (**DXA**), and assessment of volumetric BMD and bone quality utilizing HR-pQCT. The NORC EBAC and its excellent bone imaging instrumentation and services are critical to my current and future research. As a Certified Clinical Densitometrist interpreting clinical DXA scans at the University of Colorado Hospital (**UCH**) and a physician scientist with a metabolic bone clinic, I understand the importance of rigorously performed, high-quality BMD testing for clinical and research purposes. The EBAC's subsidized DXA scans made it feasible to perform a clinical study on my career development award and are critical to growing the bone metabolism research

community at CU-AMC. *The NORC has helped me achieve my goal of becoming a successful, independent clinician scientist and leader in the field of sleep-bone research to positively impact patient care and I look forward to working with Drs. Creasy, MacLean, Kohrt and Melanson to ensure this resource is available to help others with their research.*

Ongoing and Completed Research Projects From the Past Three Years:

R01 HL151332 (NHLBI) Swanson (PI) 07/01/2021-06/30-2026

“Fractured Schedules: Skeletal Effects of Acute and Chronic Night Shift Work”

Goals: Determine the effects of night shift work on bone metabolism, density, microarchitecture and strength, and investigate a plausible underlying mechanism (e.g., increased sympathetic tone) by which night shift work impairs bone metabolism.

R01 AG074979 (NIA) Beavers (PI)/Wherry (CU-AMC PI) 09/01/2022-08/31/2027

“Exercise and Bisphosphonate Use to Minimize Weight Loss Associated Bone Loss Among Older Adults”

Goals: Compare the independent and combined effects of exercise and bisphosphonate use on dietary weightloss-associated bone loss in older adults.

P30 DK048520 (NIDDK) MacLean (PI) 05/01/2024 – Current

“Nutrition Obesity Research Center (NORC)”

Goals: The mission of the Colorado NORC is to advance the science of nutrition and obesity by facilitating interdisciplinary, collaborative, translational research and by fostering the development of the next generation of scientists in the Rocky Mountain region. The NORC is in its 29th year of continuous funding. I have served as the Assistant Director for the Energy Balance Assessment Core within the NORC since May 2024.

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2022- Associate Professor, University of Colorado, Aurora, CO
2016-22 Assistant Professor, University of Colorado, Aurora, CO
2015-16 T32 Endocrinology Research Fellow, University of Colorado, Aurora, CO
2013-15 T32 Endocrinology Research Fellow, OHSU, Portland, OR
2012-13 Endocrinology Clinical Fellow, Oregon Health & Science University, Portland, OR
2009-12 Internal Medicine Intern and Resident, Mayo Clinic Arizona, Scottsdale, AZ

Scientific Appointments:

2024- Associate Director, Energy Balance Assessment Core (NORC), University of Colorado
2020- Medical Director, HR-pQCT Imaging Core, University of Colorado
2019-22 Women in Bone and Mineral Research Committee (ASBMR)
2019- CU Subspecialty (Endocrinology) Internal Medicine Research Liaison
2016- Member, International Society for Clinical Densitometry
2016- Certified Clinical Densitometrist (CCD), International Society for Clinical Densitometry
2014- ABIM Certification in Endocrinology, Diabetes & Metabolism
2013- Member, American Society for Bone & Mineral Research (ASBMR)
2013- Member, Endocrine Society
2012-2022 ABIM Certification in Internal Medicine

Honors

2021 Univ of Colorado Department of Medicine Outstanding Early Career Scholar Award
2021 Article Features in JCEM's Thematic Issue on Biological Rhythms
2018 Article Featured in JCEM's Thematic Issue on Bone Health
2018 ENDO 2018 Presidential Poster Competition Winner - Endocrine Society National Meeting
2017 Research Summary Book and highlight in Endocrine Daily News Briefing for research presented at the annual Endocrine Society National Meeting April 2017 in Orlando, FL
2016-23 NIH Loan Repayment Program Recipient through June 2023
2016 Endocrine Society 2016 Early Investigators Award, Boston, MA

- 2016 Highest Impact Paper by an MD Trainee, CU, Division of Endocrinology
- 2015 Participant in the NIA-AGS 8th Annual Bedside to Bench Conference, "Sleep, Circadian Rhythms, and Aging: New Avenues for Improving Brain Health, Physical Health and Functioning."
- 2014 ASBMR Young Investigator Annual Meeting Travel Grant, Houston, TX
- 2014 Participant in the EFF Preceptorship in Metabolic Bone Diseases at Columbia
- 2012 The Spirit of Mayo Clinic Award, Mayo Clinic Arizona, Phoenix, AZ
- 2012 Patient Advocate Award, Mayo Clinic Arizona, Phoenix, AZ
- 2012 Dave R. Sanderson Award, Mayo Clinic Arizona, Phoenix, AZ
- 2012 1st Place for Clinical Vignettes Poster Presentation "An Unusual Case of Milk Alkali Syndrome", Arizona Medical Education Consortium, Phoenix, AZ
- 2011 Poster Presentation at annual Endocrine Society National Meeting highlighted in Research Summary Book as one of forty newsworthy abstracts, Boston, MA
- 2010 1st Runner-up for Oral Presentation: "Pre-transplant Predictors of New Onset Diabetes After Kidney Transplant" Research, Arizona Medical Education Consortium, Phoenix, AZ
- 2009 Gold Humanism in Medicine Award, Tulane SOM, New Orleans, LA
- 2009 The Department of Medicine Chairman's Award, Tulane University, New Orleans, LA
- 2008- Alpha Omega Alpha Honor Medical Society
- 2001-05 Dean's List and graduation with High Distinction (equivalent to Summa Cum Laude), University of Colorado at Boulder, Boulder, CO

C. Contributions to Science

1. Controlled investigations of the skeletal effects of sleep and circadian disruption in humans:

Sleep disturbance and low bone mass are prevalent conditions that cause significant morbidity, mortality and economic implications for society. My 2014 grant through the Medical Research Foundation of Oregon characterized the relationship among nocturnal hypoxia, sleep restriction, and circadian misalignment and biomarkers of bone metabolism to better understand how sleep and circadian disturbance affect the skeleton on a cellular level. This research was the first to demonstrate that ~3-weeks of cumulative sleep restriction and concurrent circadian misalignment impairs bone formation in healthy men despite no change in bone resorption. In a subsequent publication we described similar changes in bone turnover in women in response to the same sleep restriction and concurrent circadian disruption. Similar to men, young women had a larger magnitude of impairment in bone formation than older women. However, unlike the men, young women also had an increase in bone resorption. This uncoupling of bone turnover where resorption exceeds formation could have deleterious effects on long-term skeletal health by increasing the risk for bone loss, osteoporosis, and fracture.

- a. **Swanson CM**, Shea SA, Wolfe P, Cain SW, Munch M, Vujovic N, Czeisler CA, Buxton OM, Orwoll ES. *Bone Turnover Markers After Sleep Restriction and Circadian Disruption: A Mechanism for Sleep-Related Bone Loss in Humans*. JCEM. Vol 102. October 2017. 3722-3730. (Peer Reviewed Article)
- b. **Swanson CM**, Shea SA, Kohrt WM, Wright KP, Cain SW, Munch M, Vujovic N, Orwoll ES, Buxton OM. *Sleep Restriction with Circadian Disruption Negatively Alter Bone Turnover Markers in Women*. JCEM. 105(7). July 2020. p2456-2463. (Peer Reviewed Article)
- c. Depner CM, Rice JD, Tussey EJ, Eckel RH, Bergman BC, Higgins JA, Melanson EL, Kohrt WM, Wright KP, **Swanson CM**. *Bone Turnover Marker Responses to Sleep Restriction and Weekend Recovery Sleep*. Bone. Vol 152. November 2021. (Peer Reviewed Article)
- d. **Swanson CM**, Shanbhag P, Tussey EJ, Rynders CA, Wright KP, Kohrt WM. *Bone Turnover Markers After Six Nights of Insufficient Sleep and Subsequent Recovery Sleep in Healthy Men*. Calcified Tissue International. Vol 110 (6). p712-722. June 2022. (Peer Reviewed Article)

2. **Epidemiological investigations and reviews of the sleep-bone relationship:** I utilized the sleep studies embedded in large epidemiological cohort studies (SOF, MrOS, SWAN) to investigate the relationships between sleep and bone health. As a result of my work in this area, I published four invited first- or sole-author review articles on the relationship between sleep and bone in high impact journals. These reviews summarized the limited and often conflicting literature to date and proposed areas in need of future investigation. I was invited to speak on this topic at the inaugural sleep and musculoskeletal system symposium at the internationally attended ASBMR meeting in September 2017, the International Society for Clinical

Densitometry (ISCD) meeting in April 2020 (canceled due to COVID-19), and the Plenary Symposium at the European Calcified Tissue Society meeting in May 2022 (virtual due to COVID-19). I was also asked to write the inaugural chapter on sleep and osteoporosis in the premier textbook in the bone field, "Osteoporosis" (also known as "Big Red"). This work has helped to establish me as the leading expert in this novel field of investigation.

- a. **Swanson CM**, Shea SA, Stone KL, Cauley JA, Rosen CJ, Redline S, Karsenty G, Orwoll ES. *Obstructive Sleep Apnea and Metabolic Bone Disease: Insights in to the Relationship Between Bone and Sleep*. JBMR. Vol 30, No 2. February 2015. p199-211. (Peer-Reviewed Perspective)
- b. **Swanson CM**, Kohrt WM, Buxton OM, Everson CA, Wright KP, Orwoll ES, Shea SA. *The Importance of the Circadian System and Sleep for Bone Health*. Metabolism. Vol 84. July 2018. p28-43. (Peer Reviewed Perspective)
- c. **Swanson CM**. *Sleep Disruptions and Bone Health: What do we know so far?* Current Opinion in Endocrinology, Diabetes and Obesity. 28(4). August 2021. (Invited Review)
- d. **Swanson CM**. *Sleep Disruption and Bone Health*. Current Osteoporosis Reports. Vol 20. p202-212. June 2022. (Invited Review)

3. **Effect of exercise on calcium and bone metabolism:** Exercise has traditionally been thought to exert positive effects on bone health. However, some data suggest acute changes in calcium homeostasis with exercise could drive bone resorption. This research aims to understand how exercise affects calcium homeostasis and bone turnover.

- a. Kohrt, WM, Wherry SJ, Wolfe P, Sherk V, Wellington T, **Swanson CM**, Weaver CM, Boxer RS. *Maintenance of Serum Ionized Calcium During Exercise Attenuates Parathyroid Hormone and Bone Resorption Responses*. JBMR. Vol 33 No 7. July 2018. p1326-1334. (Peer-Reviewed Article)
- b. Wherry SJ, **Swanson CM**, Wolfe P, Wellington T, Boxer RS, Schwartz RS, Kohrt WM. *Bone Biomarker Response to Walking Under Different Thermal Conditions in Older Adults*. MSSE. Vol 51 No 8. Aug 2019. p1599-1605. (Peer-Reviewed Article)
- c. Kohrt WM, Wolfe P, Sherk V, Wherry SJ, Wellington T, Melanson E, **Swanson CM**, Weaver CM, Boxer RS. *Dermal calcium loss is not the primary determinant of PTH secretion during exercise*. MSSE. 51(10). Oct 2019. 2117-2124. (Peer-Reviewed Article)
- d. Armento A, Heronemus M, Truong D, **Swanson CM**. *Bone Health in Young Athletes: A Narrative Review of Recent Literature*. Current Osteoporosis Reports. 21(4). August 2023. (Peer-Reviewed Perspective)

4. **Vitamin D – metabolite relationships and outcomes of total and free fractions:** Vitamin D is critically important for optimal bone health. Using the MrOS cohort, we established an inverse relationship between the D₂ and D₃ forms of vitamin D that provided insight into vitamin D metabolism and may have implications for vitamin D supplementation. We examined and compared the associations of 25-hydroxyvitamin D and 1,25-dihydroxyvitamin D with major skeletal outcomes to understand which metabolite is more strongly associated with clinically relevant skeletal outcomes. We also investigated the "free" fraction of vitamin D. Similar to other hormones, the concept of a "free" or biologically active fraction of vitamin D may have important implications for clinical targets and various health outcomes. Our NEJM and JCEM publications highlighted the analytical barriers to widespread investigation of free vitamin D and identified racial and geographic differences in free vitamin D that are similar to those of total 25OHD.

- a. **Swanson CM**, Nielson CM, Shrestha S, Lee CG, Barrett-Connor E, Jans I, Cauley JA, Boonen S, Bouillon R, Vanderschueren D, Orwoll ES. *Higher 25(OH)D₂ is associated with lower 25(OH)D₃ and 1,25(OH)₂D₃*. JCEM. 2014 Aug;99(8): 2736-44. (Peer-Reviewed Article)
- b. **Swanson CM**, Srikanth PS, Lee CG, Cummings SR, Jans I, Cauley JA, Bouillon R, Vanderschueren D, Orwoll ES, Nielson CM. *Associations of 25-hydroxyvitamin D and 1,25-Dihydroxyvitamin D with Bone Mineral Density, Bone Mineral Density Change and Incident Non-Vertebral Fracture*. JBMR. Vol 30, No 8. August 2015. P1403-1413. (Peer-Reviewed Article)
- c. Nielson CM, Jones KS, Chun RF, Jacobs JM, Wang Y, Hewison M, Adams JS, **Swanson CM**, Lee CG, Vanderschueren D, Prentice A, Smith RD, Zmuda JM, Lapidus J, Cauley JA, Bouillon R, Schoenmakers I, Orwoll ES. *Letter to the Editor: Role of Assay Type in Determining Free 25-Hydroxyvitamin D Levels in Diverse Populations*. NEJM. 374(17). April 28 2016. 1695-6. (Peer-Reviewed Article)

- d. Nielson CM, Jones KS, Chun RF, Jacobs JM, Wang Y, Hewison M, Adams JS, **Swanson CM**, Lee CG, Vanderschueren D, Pauwels S, Prentice A, Smith RD, Shi T, Geo Y, Schepmoes AA, Zmuda JM, Lapidus J, Cauley JA, Bouillon R, Schoenmakers I, Orwoll ES. *Free 25-hydroxyvitamin D: impact of vitamin D binding protein assays on racial-genotypic associations*. JCEM. Vol 101. May 2016. 2226-2234. (Peer-Reviewed Article)

5. **Diabetes:** The diabetes epidemic has significant economic and personal health implications. Inpatient glycemic control and the prevention of diabetes are important issues in managing this health crisis. I completed this work during my Internal Medicine residency while working with my mentor, Dr. Curtiss B. Cook.

- a. **Swanson CM**, Potter DJ, Kongable GL, McMahon DM, Cook CB. *Inpatient Glycemic Control: An Update from 576 U.S. Hospitals*. Endocrine Society Annual Meeting, Boston, MA. June 2011. (Abstract/Poster Presentation)
- b. Chakkera HA, Weil EJ, **Swanson CM**, Dueck AC, Heilman RL, Reddy KS, Hamawi K, Khamesh H, Moss AA, Mulligan DC, Katariya N, Knowler WC. *Pre-Transplant Risk Score of New Onset Diabetes Mellitus after Kidney Transplantation*. Diabetes Care 34(10); 2141-5. October 2011. (Peer-Reviewed Article)
- c. **Swanson CM**, Potter DJ, Kongable GL, Cook CB. *Update on Inpatient Glycemic Control in Hospitals in the United States*. Endocrine Practice. Vol 17, No 6. November/December 2011; p853-861. (Peer-Reviewed Article)
- d. **Swanson CM**, Bersoux S, Larson MH, Aponte-Furlow RT, Flatten SS, Olsen CL, LaRosa C, Verona PM, Jameson KA, Cook CB. *An Outpatient-Based Clinical Program for Diabetes Prevention: An Update*. Endocrine Practice. Vol 18, No 2. March/April 2012. p200-208. (Peer-Reviewed Article)

Bibliography is available at:

<https://www.ncbi.nlm.nih.gov/sites/myncbi/1xOarUAwoftk8/bibliography/51902760/public/?sort=date&direction=descending>