



# Bone Health & Military Medical Readiness

## PROBLEM:

Stress fracture, an overuse injury to bone, is one of the most common and potentially debilitating overuse injuries seen in a military recruit population. Recent data indicate that over 9,000 service members were diagnosed with stress fracture in the U.S. Armed Forces last year. Although women are at greater risk for stress fracture, over 6,000 of these cases occurred in men. Approximately 40% of men and 60% of women who sustain a stress fracture do not complete basic training. This imposes high cost to the military in lost training time, medical care and, ultimately, military readiness. The recent increase in military recruitment has led to an upsurge in the total number of stress fracture cases reported.

An additional concern is the increased number of documented stress fracture injuries over the last two years in soldiers who have recently returned from lengthy deployments. Anecdotal reports from troop medical clinics indicate that these soldiers are sustaining stress fracture in unprecedented numbers.

It is critical that we continue to build on the promising results emanating from this research program. Recent findings have led to recommendations to reduce running and marching volume during recruit training, and support efforts to implement a new Army-wide physical training program. Studies are underway to determine the efficacy of this new program in reducing stress fracture and other overuse injuries in all soldiers.

## Key Investment Areas:

### Diet and Nutrition

- Determine proper dose of Vitamin D necessary to maintain healthy levels in all individuals, particularly in those who may be at risk for deficiency based on varying sunlight exposure (i.e. submariners and personnel who serve at great distances from the equator) and skin pigmentation
- Evaluate the influence of nutritional status on bone quality, and determine whether dietary supplements may be helpful in maintaining or improving bone quality, particularly in exercising individuals



### Genetics

- Investigate genetic factors that influence parameters of bone quality during normal remodeling and repair processes

### Pharmacology

- Assess the role of oral contraceptives, anti-inflammatory medications, anti-resorptive agents, alcohol, and other drugs that might influence normal bone remodeling through endocrine and other influences

### Mechanical Loading

- Determine how fluid flow and cell signaling mechanisms respond to mechanical loading, and how load-induced changes in these mechanisms affect bone remodeling
- Assess the influence of biomechanical factors inherent in impact loading on the bone adaptation response
- Evaluate the effect of resistance training, endurance training, and mechanical vibration interventions on parameters of bone quality



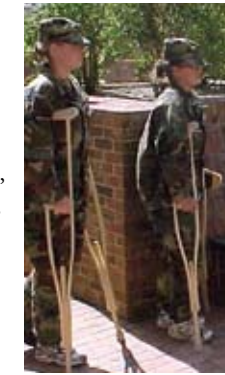
### Fracture Healing

- Assess the efficacy of innovative treatments, including electric field stimulation, pulsed ultrasound, and anti-inflammatory agents, on stress fracture recovery time



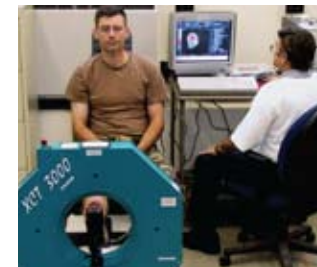
### Stress Fracture Predictors

- Examine the relationship between tissue fragility and parameters of bone quality, to include variations in mass, microarchitecture, geometry, and markers of bone turnover
- Conduct epidemiological studies to examine the association between stress fracture and potential risk factors for stress fracture, to include bone quality, physical training methods, menstrual patterns, and injury history



### Innovative Technology

- Develop and test new technologies, to include acoustic emission, positron emission tomography, and diffraction enhanced imaging, that might lead to innovations in non-invasive in vivo measures of bone quality



## MAJOR ACCOMPLISHMENTS:

### Mechanical Loading:

- Exercise history plays a key role in development of stress fracture, and is related to bone geometry. Animal studies revealed that short-term exercise training improves both material and structural properties of bone that increase fatigue resistance by 80-fold. *Studies are ongoing to determine if similar exercise programs improve bone quality in humans.*
- Extensive remodeling is triggered when fluid-flow pressure exceeds physiological intensity, suggesting that stress fracture may result from alterations in intramedullary pressure. *This challenges the current dogma that stress fractures are generated by material failure of bone in response to mechanical loading.*
- Low-level whole body vibrations applied for 15 minutes per day enhanced the quality of trabecular bone in the growing mouse. *These animal studies were the catalyst for current research focused on assessing the efficacy of whole-body vibration in improving bone quality in young adults.*

### Pharmacology:

- A COX-2 inhibitor was detrimental to stress fracture repair, as demonstrated by reduced bone formation in rats with experimentally induced stress fractures. *This suggests that non-steroidal anti-inflammatory medications may slow down stress fracture healing.*



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## MISSION

*To advance bone physiology research that may lead to strategies to improve bone health of young men and women, reducing stress fracture rates during physically intensive training, and reducing risk of osteoporosis later in life.*



## Special Congressional Appropriations



# Bone Health & Military Medical Readiness

Military Operational Medicine Research Program

## Congressional Special Interest Appropriations

Supported by:

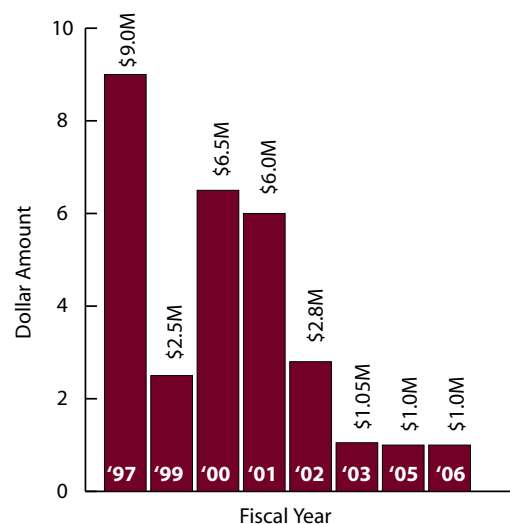
National Coalition for Osteoporosis and Related Bone Diseases

American Society for Bone & Mineral Research (ASBMR)

### How to Apply

For further information on how to apply for grants, watch for announcements on the Bone Health and Military Medical Readiness research program (BHMMR) at <http://www.momrp.org>

For more information on stress fracture research in the military, consult the Institute of Medicine review, "Reducing Stress Fracture in Physically Active Military Women", available from National Academy Press at <http://www.nap.edu/html/stress>.



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