2016 URC Faculty Fellowship Proposal Title Page

Vitamin D supplementation and bone turnover in NCAA D1 collegiate basketball players: a pilot study

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Abstract *(248 words)*

Background: Vitamin D supplementation is widely touted as an "ergogenic aid", improving both health and athletic performance. Research suggests that athletes with Vitamin D deficiency have smaller hearts, decreased muscle mass and are at greater risk of bone fractures when compared with athletes with higher Vitamin D levels. Our preliminary data suggests that male basketball players start the competitive season with Vitamin D insufficiency and finish with Vitamin D deficiency. Therefore, the primary aim of this study is to investigate the effects of Vitamin D plus calcium supplement on bone mass in male and female collegiate basketball players over five months of off-season training. **Methods**: All members of the 2017-2018 OU Men and Women's Basketball Team (N=30) will be invited to participate in this double-blind, randomized control trial. Consenting participants will be randomly split into two study groups: an intervention group and a control group. All members of the intervention group will receive a daily supplement containing 1000IU of Vitamin D3 plus 1200mg of calcium citrate. All members of the placebo group will receive a placebo capsule. The following will be assessed twice (pre and post five-month intervention): body composition (dual energy x-ray absorptiometry scan); dietary evaluation (food frequency questionnaire*);* psychological stress *(*POMS); physical performance (vertical jump, shuttle run); bone biomarkers (osteocalcin, collagen type 1 cross-linked C-telopeptide and Vitamin D binding protein); and serum 25 hydroxyvitamin D (active Vitamin D). Our **main outcome measures** will be changes in serum Vitamin D, bone mineral content and bone mineral density.

Vitamin D supplementation and bone turnover in NCAA D1 collegiate basketball players: a pilot study

Background and Significance:
Elite athletes are often assumed to be "superhuman", representing superior health, strength and endurance when compared to ordinary mortals. However, the rigors of attaining – *and sustaining* - peak physical performance remain tenuous; with athletes, trainers and coaches constantly striving for supplements which may provide an "edge" over the competition. Vitamin D supplementation has been recently touted in the scientific literature[1] and in the lay press[2] as an ergogenic aid, capable of enhancing athletic performance particularly in athletes known to be Vitamin D deficient[3]. And while the performance enhancing benefits of Vitamin D are widely debated, the consequences of Vitamin D (routinely measured as serum 25 hydroxyvitamin D or 25(OH)D for short) deficiency (<20ng/mL) and insufficiency (20-29ng/mL) have been well-described[4].

Athletes with Vitamin D deficiency have smaller hearts[5], decreased lean (muscle) mass[6], and at greater risk for bone fractures[7] as well as frequent illness[8] when compared to peers with higher serum Vitamin D. Basketball players[9] and African American athletes[7;10] appear to be at greatest risk for Vitamin D insufficiency/deficiency presumably due to differences in both diet and darkened skin color (which blocks the conversion of sunlight to Vitamin D within the epidermis). A recent study, however, suggests that African Americans have more Vitamin D binding protein, suggesting that a greater proportion of bioactive Vitamin is indeed available, despite the seemingly lower overall 25(OH)D levels documented in Black Americans[11].

Routine measurement of bone mineral content (BMC) and Vitamin D levels in basketball players has become increasingly common since Kevin Ware (University of Louisville) sustained a compound leg fracture during the 2013 Elite Eight NCAA Basketball Championship game (https://en.wikipedia.org/wiki/Kevin_Ware). Accordingly, cross-sectional studies document 94% of adolescent basketball players as Vitamin D insufficient[9] and 57% of Spanish professional basketball players as Vitamin D deficient[10]. Additionally, an investigation performed on eleven NCAA D1 basketball players demonstrated a 6.1% decrease in total BMC from pre-season to late summer, which was reversed the following year when a calcium citrate plus vitamin D supplement was introduced as an intervention to preserve bone mass[1].

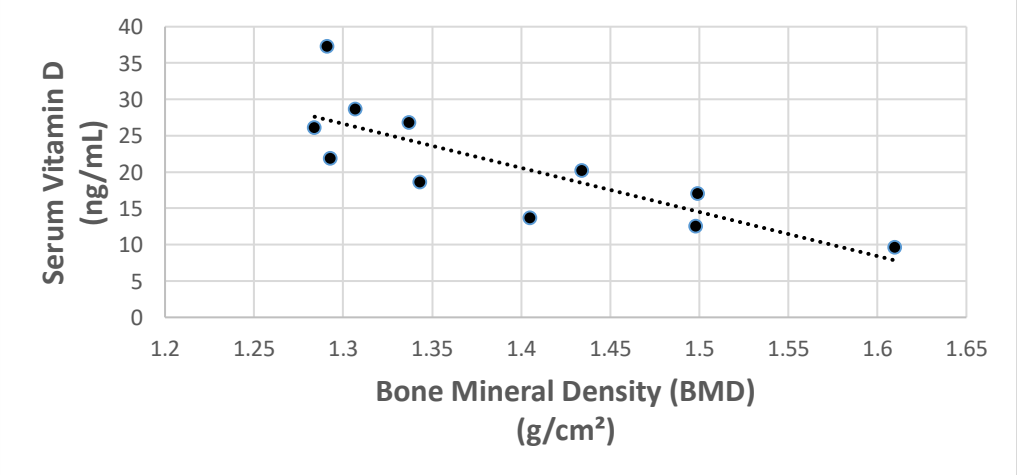
Preliminary data collected on Oakland University (OU) sports teams, both pre- and post-competitive season, identified the men's basketball team as having 25(OH)D concentrations that would, on average, classify them as Vitamin D insufficient pre-season (22ng/L) and Vitamin D deficient (15ng/mL) post-season (Table 1). These low Vitamin D values are even more concerning when the recommended threshold for serum 25(OH)D levels for athletes seeking "peak performance" is much higher (>50ng/mL)[3]. Given that: 1) Vitamin D is not a routine screening measure performed on OU athletes; 2) supplementation is neither provided nor recommended to OU athletes; and 3) the latitude (42°) of OU prohibits the synthesis of Vitamin D from November through February[12], the ***primary purpose of this study is to investigate the effects of Vitamin D plus calcium supplement on bone turnover in male and female collegiate basketball players during five months of off-season training.*** We hypothesize that a daily Vitamin D and calcium supplementation will facilitate bone formation and bone turnover, while raising serum 25(OH) D levels, in male and female basketball players (compared with athletes receiving a placebo capsule). Clinically, we wish to evaluate whether or not we can significantly elevate 25(OH)D levels via daily Vitamin D supplementation in basketball players before the competitive season begins.

Table 1: *Serum Vitamin D (25-hydroxy vitamin D; [25(OH)D]) status of collegiate sports teams tested pre and post competitive season (2015-2016). Vitamin D results in ng/mL, with a reported normal range of 30-100ng/mL*

Sports Team	Vitamin D Pre-season *(Mean±SD)*	Vitamin D Post-season *(Mean±SD)*	Vitamin D Post - Pre-season Δ *(Mean±SD)*
♀ Cross Country *(n=16)*	44.6 ± 15.6	39.1± 9.5	-5.4 ± 11.3
♂ Cross Country *(n=9)*	47.2 ± 4.5	38.2 ± 5.5	-9.0 ± 4.4
♀ Swimming *(n=13)*	44.9 ± 8.7	38.6± 7.4	-6.3± 4.4
♂ Swimming *(n=6)*	41.5 ± 12.7	32.1 ± 6.7	-9.4 ± 5.4
♀ Basketball *(n=10)*	41.4 ± 18.3	33.8 ± 24.0	-7.6 ± 10.5
♂ Basketball *(n=9)*	21.8 ± 7.9	14.5 ± 5.6	-7.2 ± 3.7

Oddly enough, a *negative* relationship was found between Vitamin D versus bone mass (both bone mineral content and bone mineral density) exclusively in male basketball players (Figure 1). This curious relationship suggested that those male basketball players with the lowest Vitamin D levels paradoxically had the strongest bones. Because this inverse linear relationship opposes our current paradigm (i.e. Vitamin D is expected to be associated with increased – not decreased - bone mass), we wish to explore this relationship further by assessing bone turnover markers plus Vitamin D binding protein. We speculate that African Americans possess a greater capacity to mobilize Vitamin D, which would artifactually lower (unbound) Vitamin D levels measured in blood. Therefore, it remains unclear whether or not increasing serum Vitamin D levels is physiologically or psychologically beneficial; particularly in male basketball players of African-American decent.

Figure 1: Relationship between Vitamin D (serum 25-hydroxyvitamin D) versus bone mineral density (BMD) in male basketball players, pre-competitive season (N=11; r=-0.80; p<0.01)



Methods:
All members of the 2017-2018 OU Men and Women's Basketball Team (N=30) will be invited to participate in this double-blind, randomized control trial. After informed consent is obtained, baseline testing will be performed at the end of the competitive season (May 2017). After baseline testing is completed, all male and female participants will be randomly split (using a random number generator) into two study groups: an intervention group and a control group. All members of the intervention group will receive a daily supplement containing 1000IU of Vitamin D3 plus 1200mg of calcium citrate. All members of the placebo group will receive a placebo capsule. A third party will prepare the capsules and perform the randomization, so that each participant will receive capsules identified only by subject number. The key which codes the randomization will be kept in a secure location by the third party and unlocked at the end of the study trial. A daily supplement log will be created to track supplement ingestion and monitor overall compliance with supplement regimen.

The following tests will be performed twice (pre and post five-month intervention, during off-season training) in the Prevention Research Center:

Anthropometric and Body Composition – after a height and weight measurement, lean, fat and bone mass will be quantified using a whole body dual energy x-ray absorptiometry (DXA) scan.

Dietary Evaluation – a food frequency questionnaire will be utilized to estimate macro and micronutrient intake.

Tests of Psychological Function– questionnaires will be administered to assess stress and burnout (POMS, PANAS, Mental Toughness Index, and Training Distress Scale).

Biochemical Measurements– Serum 25-hydroxy vitamin D will be measured, as a main outcome measure. Plasma osteocalcin (bone formation marker), serum collagen type 1 cross-linked C-telopeptide (CTx; bone resorption marker) and serum Vitamin D binding protein will also be assessed to elucidate bone turnover. Electrolytes (sodium and calcium concentrations) will also be measured in blood and urine.

The following physical tests will be performed in the Athletic Training facilities:

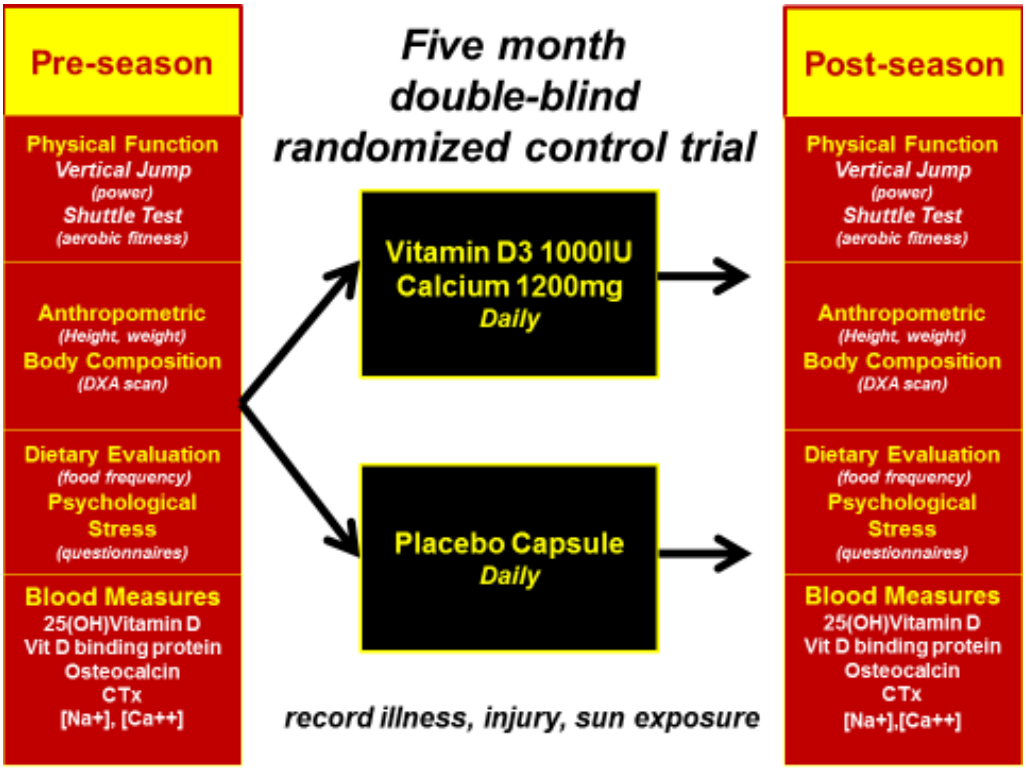
Tests of Physical Function – a vertical jump height will be conducted, using a vertec, and converted to Peak Power output using the following equation:
Peak Power (watts) = 60.7 x (jump height [cm]) + 45.3 x (body mass [kg]) – 2055.

A 20-m shuttle run will also be performed to estimate maximal aerobic capacity (VO_2 max).

Illness and Injury will be obtained from Athletic Trainer logs and sun exposure will be assessed using a Vitamin D phone app.

A diagram of the study design is shown on the next page (Figure 2)

Figure 2: *Herewith is a diagram of the overall study design for the athletes and summary of tests performed on basketball players:*



Expected Outcomes:
The practical outcomes from this investigation would be to clarify whether or not: 1) routine Vitamin D screening has a favorable cost/benefit ratio with regards to training improvements and 2) if daily Vitamin D plus calcium supplementation has a positive effect on bone mass and bone turnover, athlete health, and augmented (physical) improvements over the off-season training period. Thus, the main outcomes from this investigation would ***directly benefit athletes, coaches, trainers, and clinicians*** by providing evidence for (or against) inclusion of serum Vitamin D measurement within pre-participation exams while elucidating the beneficial (or detrimental) effects Vitamin D and calcium supplementation on athlete health and physical performance (in response to training) in basketball players.

The possible secondary outcomes of this study relate to elucidating the endocrine mechanisms underlying Vitamin D supplementation on changes in bone mass, overall body composition, psychological stress, and illness in collegiate basketball players during off-season training.

These data will be used as pilot data to procure external grant funding for both additional biochemical studies and to launch larger investigations. The NBA/GE Healthcare Sports Medicine and Orthopedics Collaboration website has indicated that future calls for proposals will target bone injuries in basketball players. Thus, our pilot results would make us highly competitive for this ($300,000 maximum) award (https://gex.brightidea.com/GENBACFP). As per usual, our study results will be submitted for conference presentation, manuscript submission and support graduate student theses and Capstone projects.

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