Big D

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Big D

> All I heard was the pumping of my heart. I breached barriers as if I was on a magic carpet ride.
>
> —Bob Beamon;
> *The Man Who Could Fly*, 1999

The annals of sport are replete with remarkable performances, but few if any have been as monumental as Bob Beamon's legendary leap into history at the 1968 Summer Olympics in Mexico City.[4] After 2 fouls put him on the verge of disqualification from the long jump, Beamon carefully remeasured his approach and accomplished a legal effort that advanced him into the finals against 3 Olympic medal holders, including the reigning gold medalist. The rest, as they say, is history. On his first jump of the finals, with a tailwind blowing at the permitted limit, Beamon hit the takeoff board and vaulted into space, finally returning to earth a full 8.9 meters (29 feet 2½ inches) from the launching pad. In a sport whose world record normally advanced in increments of 6 centimeters (2½ inches), Beamon had shattered the previous mark by 55 centimeters, or nearly 2 feet! His performance was so unexpected that it surpassed the range of the optical device installed to document the jump distances, which did not function beyond 28 feet. The officials had to send someone out to buy a measuring tape, delaying the rest of the competition by 20 minutes. No human, including Beamon, would exceed this accomplishment for more than 22 years.

Although this was the most famous performance of the 1968 games, world records also fell in the triple jump and most of the shorter running distances. These accomplishments are usually attributed to the diminished resistance offered by the rarefied atmosphere at Mexico City's altitude of 2240 meters. While not discounting the conventional explanation, some have suggested that another factor may have been at work: vitamin D.[8]

The rationale for this theory runs as follows: The primary natural source of vitamin D is not dietary, but production in the skin in response to solar ultraviolet B (UVB) radiation.[8,10] Because of this, vitamin D stores of individuals living at higher latitudes, including much of North America, Europe, and Asia, decline precipitously in the fall. The 1968 Olympics took place in October, when vitamin D levels in northern hemisphere athletes would normally be diminishing. However, the thin air of Mexico City not only offers less resistance to sprinters, but to UVB rays as well. The combined effects of the city's high altitude and tropical latitude may have synergistically acted to rapidly raise the vitamin D levels of any athlete practicing outdoors. Many competitors arrived early to acclimate themselves to the elevation, further increasing their solar exposure.[8]

This line of reasoning makes sense if you accept the premise that vitamin D can improve athletic performance. Such evidence is plentiful, but indirect and not incontestable.[3,8,14,17] Ultraviolet radiation has been found to increase physical fitness and exercise performance. Several studies have also shown fitness and performance to peak in the summer and decline in the winter. In addition to its well-known role in bone and calcium metabolism, vitamin D also acts on muscle tissue, increasing muscle mass and specifically type II fibers, at least in deficient or older individuals. Some, but not all, studies have shown that vitamin D enhances measures of physical performance, including reaction time, muscle strength, and balance.[8]

Is this research, mainly conducted in older populations, relevant to strapping young athletes? As it turns out, vitamin D deficiency is widespread, and athletes are not immune. Although the optimal serum level of 25-hydroxyvitamin D, the benchmark usually used to define vitamin D status, is in dispute, levels less than 20 ng/mL are often considered deficient, and between 20 and 30 ng/mL as insufficient.[10] Some authorities, however, feel that levels of about 50 ng/mL are preferable.[8] Even using the more conservative definitions, the world's vitamin D–deficient population was estimated to be 1 billion in 2007.[10] Among athletes, various studies have found a high prevalence of deficiency or insufficiency in dancers, gymnasts, runners, soccer players, and cyclists in localities ranging from the northern United States and Europe to the Middle East and Australia.[9,11,13]

The osseous consequences of more severe levels of vitamin D deficiency, rickets in children and osteomalacia in adults, are familiar in orthopaedic circles. A randomized study in female Navy recruits, whose serum D levels were not measured, found that modest doses of vitamin D and calcium reduced the incidence of stress fractures by 20% in comparison to placebo.[12] Nonskeletal effects of hypovitaminosis D are less well known: muscle weakness, reduced immunity, and increased susceptibility to a profusion of disorders including cancer, multiple sclerosis, arthritis, hypertension, cardiovascular disease, schizophrenia, and depression.[10] Given this background, it is not difficult to imagine that even merely suboptimal levels of the "sunshine vitamin" might hamper those striving to maximize their athletic performance.[3,8,13]

This information is thought provoking to those of us who serve as team physicians, but even readers who abnegate performance issues to other professionals will want to know its possible relevance to surgical outcomes. A 2010 study from the Hospital for Special Surgery in Manhattan revealed that hypovitaminosis D was common among patients scheduled for orthopaedic surgery.[7] In a general

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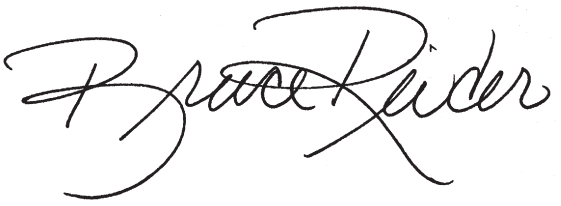
orthopaedic population of 723 patients, insufficient levels (≤32 ng/mL) were present in 43%, and 40% of these patients were deficient (<20 ng/mL). Of particular interest to *AJSM* readers was the finding that the greatest prevalence of abnormal vitamin D levels was found among trauma (66%) and sports medicine (52%) patients. Individuals between 18 and 50 years of age, men, and those with darker skin all were more likely to reveal abnormal levels of vitamin D.

If low levels of vitamin D are common in orthopaedic patients, it is natural to wonder whether remedying the situation might improve their healing response. In this month's issue of *The American Journal of Sports Medicine*, Angeline and colleagues,[1] from the same Manhattan institution, delved into that question using a small animal model. Several lines of investigation joined to direct their attention toward the healing of rotator cuff repairs. A 2009 clinical study that compared patients with rotator cuff tears to controls found that low serum levels of 25-hydroxyvitamin D correlated with higher degrees of fatty muscle infiltration and weaker isokinetic strength.[15] Furthermore, matrix metalloproteinases (MMPs) have been associated with poor healing of rotator cuff tears,[16] whereas the administration of MMP inhibitors seems to enhance healing.[5,6] When vitamin D–insufficient subjects were given supplementary vitamin D for a year, their elevated levels of circulating MMP-2 and MMP-9 decreased.[18] Finally, vitamin D has been shown to downregulate the production of MMP-9.[2]

In the current study, Angeline et al[1] induced vitamin D deficiency in 28 rats by restricting their diet and UVB exposure. They then detached and repaired the supraspinatus tendons of one shoulder in the deficient rats and a comparable control group, and compared them biomechanically at 2 weeks, then biomechanically, histologically, and with micro–computed tomography (micro-CT) at 4 weeks after repair. The biomechanical tests showed that the tendons of the D-deficient rats had substantially lower failure loads at 2 weeks after surgery, but this difference was not present at 4 weeks. The histological examinations revealed more normal characteristics of the tendon insertion in the control group, although there was no difference in bone formation on micro-CT analysis of the greater tuberosity.

While differences from the rodent model make direct extrapolation to human patients unwise, the study results are enticing enough to warrant further investigation of vitamin D as a possible adjunct to rotator cuff healing. Considering the high prevalence of hypovitaminosis D in the general and athletic populations and the wide-ranging activity of the vitamin, similar laboratory studies investigating possible benefits in other orthopaedic problem areas might also be worthwhile. Although the clinical utility of vitamin D for performance or healing enhancement is yet to be firmly established, perhaps someday those sports fans holding up "D-fence" signs will actually be calling for vitamin supplementation for their favorite team.



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