

**Osteoporosis & Aquatic Exercise:
New Concepts, Updated Research, Novel Techniques
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Historically, aquatic exercise has been overlooked in the management of osteoporosis clients due to decreased weightbearing associated with immersion. This, coupled with the staunch belief that positive bone adaptations are due to mechanical loading accomplished exclusively with weight-bearing activities, has led therapists to ignore the benefits of aquatics for those individuals who might profoundly benefit from aquatic interventions. And while, the animal model demonstrates that gravitational loading does enhance bone growth¹, it is difficult to distinguish intrinsic—muscle-generating force that applies mechanical loads to bone—from extrinsic loading—gravity—in the human subject.² This mechanical interaction between muscle and bone which provides structural motion needs to be reviewed, as aquatic exercise can most assuredly provide sufficient load to move bone.

The ability for bone to detect and respond to mechanical loads is a sensitive process orchestrated by specific cells that respond to forces— stress, strain, shear, pressure, fluid flow, streaming potential and acceleration— that occur with loading.¹ It is this mechanical information that regulates the bone adaptation, maintenance and repair occurring as a consequence of this changing mechanical environment.¹⁻³ It is important to note, also, that bone does not require an extreme mechanical signal to elicit adaptive responses as both low-load magnitude with high frequency and very high magnitude strain can enhance bone strength.¹ As noted by Thompson et al,

“Mechanical loading of bone through normal daily activities or via ‘prescribed’ loading regimens, represents a means to protecting skeletal integrity... Delivering mechanical stimuli to improve or maintain bone health has numerous advantages such that mechanical signals are native to bone, safe at low intensities, involve the full range of the remodeling cycle, and result in production of lamellar bone.”¹

In addition to the mechanical interaction between muscle contraction that loads bone, there is increased metabolic activity related to contracting muscles that affects bone growth.⁴ Current research substantiates that contracting muscles actually act as an endocrine organ, making the relationship between muscle and bone far more intricate and not reliant on strictly weight-bearing exercise to accomplish positive effects on bone.³⁻⁴ Muscle contraction influences bone quality and quantity due to a series of highly regulated cellular interactions which are independent of weight-bearing stresses.¹⁻³ With this in mind, aquatic exercise can and does provide sufficient stimulus both intrinsically and via the crosstalk occurring with contraction, to be considered a viable option to address bone loss associated with osteoporosis.

The paucity of literature that exists regarding aquatic intervention and positive bone growth, is part of the reason for an under appreciation of water therapy to address osteoporosis. However, to understand why water is so powerful one must first recognize the unique capabilities that the physical properties of water bring to the table. In a population that is at high risk for fracture, the viscosity of water supports upright posture, exponentially decreasing the risk of a fall when attempting balance or other physical activity.⁵⁻⁶ Strength plus functional improvements coupled with positive effects on bone were noted in studies by Fernandes Moreira and Keiffer respectively, both incorporating high intensity aquatic exercise to accomplish these gains.⁶⁻⁷ It was noted that, “...the improvement in bone metabolism and bone mass observed in our study was not a result of impact exercises in the pool, but a consequence of resistive muscle training against water resistance”⁷ thereby substantiating the muscle’s impact on bone formation. Regarding posture, physical characteristic directly impacted by osteoporosis a study by Chaves Aveiro et al, demonstrated significant improvement in postural control for osteoporotic postmenopausal women after participating in a 12-wk water exercise program.⁸ The authors noted that the aquatic intervention was more effective than land-based therapy at improving postural control for the single-limb stance portion.⁹ It is notable that for a group of osteoporotic clients, practicing single leg stance is intrinsically safer in water than on land.

Studies that specifically addressed bone metabolism and mass predominantly stress high intensity activity, with small sample sizes and utilized DXA to establish bone mineral density. A 2018 study by Aboarrage Junior et al, using shallow

water and jump training, demonstrated improved bone mineral density for both the femur and the lumbar spine.⁹ An 8-month study by Pernambuco et al demonstrated that aquatic aerobic exercise while improving osteocalcin levels, did not improve lumbar and total femur BMD in the postmenopausal client. However, serum osteocalcin as a marker of bone metabolism, was positively affected by water exercise.¹¹ Additional studies conducted with of younger adult subjects likewise found significant effects on both bone mass and bone turnover.¹¹

Given the validated benefits aquatic exercise can offer patients with low bone density, it is a viable and possibly safer alternative to land exercise when weight bearing physical activity is not tolerated or safe due to comorbidities often seen in this population. Aquatic interventions are tailored to address balance deficits, ROM and strength deficiencies, postural concerns commonly seen in this population, as providing upgrades to one's aerobic status. It is the specificity of the intervention based on goals set at the onset which provides positive results. Therefore, consider a referral to an appropriate water based program to enhance overall health and function through physical activity which may exacerbate in weight bearing conditions, can still benefit bone health through the evidence described above.

Appropriate utilization of the unique properties of water, can elicit positive effects on bone. The safety, resistance and constant perturbing effects of the water make it a viable medium for balance, strength training, and functional upgrades, but, *if used appropriately*, can also provide significant improvement in bone adaptations. It, therefore, should not be discounted ---and in fact might be considered safer---to treat those diagnosed with osteoporosis since both bone and functional upgrades can be attained.

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