

Narrative Review

Impact of Supervised Exercise Program and High-Dose Cholecalciferol Supplementation on Health and Function of the Musculoskeletal System among Older Persons: A Narrative Review

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Abstract

Background

Cholecalciferol intake and exercise can improve musculoskeletal function and strength among older persons who has a higher risk of fractures, falls, and impaired lower limb function. Appropriate vitamin D supplementation can lessen the severity of disabilities and fall rates. This study aimed to explore the impact of extended physiotherapy and high-dose cholecalciferol supplementation on health and function of the musculoskeletal system among older persons. With a PEDro score ranging from 6 to 8, randomized controlled trial was used. Studies combined with Cholecalciferol or vitamin D supple-

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mentation along with resistance exercise, aerobic training, strength training, power training is beneficial for older persons with risk of fall prevention, enhancing musculoskeletal functioning and maintaining optimal functional performance. Based on the review, there is no evidence to support the impression that vitamin D3 supplementation on its own provides any benefits. But the existing literature revealed a limited quantity of studies, suggesting that further research is required before any definitive conclusions or recommendations can be drawn regarding the advantages of vitamin D3 supplementation for the musculoskeletal health and function of older individuals.

Keywords: Cholecalciferol; Muscle strength; Physiotherapy

Introduction

Vitamin D is a fat-soluble vitamin that is now recognized to play a significant role in a number of biologic functions, including immune regulation, proliferation, differentiation, apoptosis, and angiogenesis [1]. Due to the subtle or vague nature of its signs and symptoms, vitamin D insufficiency is a widespread health issue across the world [2]. Many studies concur that vitamin D deficiency is defined as a 25-hydroxyvitamin D3 (25(OH)D3) concentration less than 20 ng/mL (50 nmol/L); whereas, vitamin D insufficiency is defined as a 25(OH)D3 concentration between 21 and 29 ng/mL (50-74 nmol/L) [3].

Losses in muscle strength are linked to declines in functional ability, independence, and an increase in frailty, falls, and disability in older adults [4]; as a result, a combination of interventions to improve older muscle's receptivity to resistance training and combat anabolic resistance training may be beneficial. Supplemental cholecalciferol (700–1000 IU/d) lowers the risk of falls and nonvertebral fractures [5] in elderly people who live independently and those who are hospitalized. As a result, older individuals may benefit from cholecalciferol supplementation, but they may require a greater dosage to treat their severe vitamin D insufficiency [6]. Additionally, cholecalciferol lowers morbidity through a number of ways [7]. Physiotherapy (PT) administered as an informed unsupervised home program has been found in various trials of older people to reduce the risk of falling [8,9]. However, the value of such a program following an acute hip fracture has not been assessed. Increases in the relative number and cross-sectional area (CSA) of muscle fibers (type II in particular) have been observed, and studies in humans have shown that vitamin supplementation has a positive impact on musculoskeletal health in older adults [10]. Additionally, studies have shown that after receiving supplement and exercise treatment, muscle strength increased and fall rates decreased and D3 supplementation dramatically enhanced vitamin D receptor concentration [10].

On the other hand, D3 supplementations had no positive effects on balance, strength, or [11] functioning. Furthermore, a systematic review examining the effects of vitamin D3 supplementation in vitamin D-sufficient adults over the age of 18 years discovered no appreciable effect on grip or proximal lower limb muscle strength;

however, pooled data involving vitamin D-deficient participants (serum 25(OH)D 25 nmol/L) showed a significant effect on hip muscle strength [12,13]. As a result, the purpose of this study was to evaluate the combined impact of physiotherapy and cholecalciferol (vitamin D3) supplementation on older individuals' health and musculoskeletal system.

Materials and Methods

This narrative review was done following the methodology described.

A comprehensive search was done using the Medical Subject Headings (MeSH) phrases "Cholecalciferol," "Physiotherapy," "Supplements Vitamin D3," "Muscle Function," "Aging Population," and "Exercises" on PEDro, Pubmed, and Google Scholar. Randomized controlled trial with a PEDro score of >5 was required for inclusion criteria.

Result and Discussion

A study conducted by Drey et al, 2011 [14] where the goal of the study was to contrast the effects of Strength Training (ST) and Power Training (PT) on prefrail older adults' functional performance. A 12-week exercise program was given to 69 older persons (165 years old) who were living in the community and were prefrail by Fried's criteria. The participants were randomly assigned to the ST, PT, and control groups. Before beginning the intervention phase, vitamin D3 supplements were given orally to all individuals. After intervention PT is not better to ST in prefrail community-dwelling adults, despite the fact that both training approaches significantly increased physical performance. ST seems to be superior over PT when it comes to dropout rates. The high rate of vitamin D3 insufficiency and small increase in physical performance among research participants who took vitamin D3 supplements highlight the value of this strategy for physical exercise treatments.

Another study conducted by Gianoudis et al, 2014 [15] where in This 12-month community-based randomized controlled trial, called exercise: Strong Bones for Life, had the goal of determining the viability and efficacy of a multimodal exercise program incorporating High-Velocity (HV) PRT, along with an osteoporosis education and behavioral change program, on Bone Mineral Density (BMD), body composition, muscle strength, and functional muscle performance in older adults. 162 older individuals with risk factors for falls and/or poor BMD (mean SD; 67 6 years) were randomly assigned to the exercise program (n = 81) or a control group (n = 81). Exercise included weight-bearing impact, difficult balance/mobility drills, and HVPRT conducted in a fitness center three times per week. In comparison to controls, the exercise program produced modest but significant net improvements in Bone Mineral Density (BMD) in the femoral neck and lumbar spine (1.0% to 1.1%, p 0.05), muscle strength (10% to 13%, p 0.05), functional muscle power (Timed Stair Climb, 5%, p 0.05), and dynamic balance (Four Square Step Test, 6%, p 0.01; Sit-to-Stand). In older persons with risk factors for falls and/or low BMD, a multimodal exercise program following intervention is an efficient way to enhance several musculoskeletal and functional performance markers.

Study conducted by Agergaard et al, 2015 [16] where they investigated in healthy young and old adults, they looked at whether vitamin D consumption may enhance the muscle response to resistance exercise. During a time and at a latitude of low sunlight (December-April, 56°N), healthy untrained young (n = 20, age 20-30) and old (n = 20, age 60-75) men were randomized to 16 weeks of daily supplemental intake of either 48 g of vitamin-D + 800 mg calcium (Vitamin-D-group) or 800 mg calcium (Placebo-group). The individuals did progressively harder quadriceps muscle strength exercise for the final 12 weeks of the supplementation. The quadriceps' isometric strength and muscle hypertrophy, as defined by increases in Cross Sectional Area (CSA), were calculated. The mRNA expression of the Vitamin-D Receptor (VDR), cytochrome p450 27B1 (CYP27B1), and myostatin were examined in muscle samples. Both young men (71.6 vs. 50.4 nmol/L, respectively) and senior men (111.2 vs. 66.7 nmol/L, respectively) in the vitamin-D groups saw a substantial rise in serum 25(OH)D concentration and were statistically different from placebo at week 12. Resistance training for 12 weeks boosted young people's quadriceps CSA and isometric strength relative to baseline.

Yet another study by Uusi-Rasi et al, 2015 [17] where they investigated to ascertain if focused exercise training and vitamin D supplements are beneficial in lowering falls and harmful falls in older women. It was a two-year randomized, double-blind, placebo-controlled experiment of vitamin D and open exercise that was carried out in Tampere, Finland, between April 2010 and March 2013. 409 home-based women in their 70s to 80s participated. The major requirements for participation were at least one fall the year before, no use of vitamin D supplements, and no medical conditions that would prevent activity. S There were four experimental groups: placebo without exercise, vitamin D without exercise (800 IU/d), placebo with exercise, and vitamin D with exercise. After intervention Exercise and vitamin D did not reduce falls, according to analyses using an intent-to-treat population. In the placebo without exercise, vitamin D without exercise, placebo and exercise, and vitamin D and exercise research groups, the fall rates per 100 person-years were 118.2, 132.1, 120.7, and 113.1, respectively; however, the fall rates that were harmful were 13.2, 12.9, 6.5, and 5.0, respectively. Strength and balance training significantly reduced the incidence of harmful falls and wounded fallers among older women who lived at home, but neither exercise nor vitamin D had an impact on the rate of falls. Exercise enhanced physical performance.

In this review study, a total of 680 participants were involved, and the intervention group's main therapy choices were vitamin D supplements. A long-term physiotherapy program may also include multimodal exercises, muscular strength training, power training, and balance training. (Table 1) describes the treatment preferences of the patients.

From a comprehensive analysis, it was shown that serum 25 [OH] D, also known as vitamin D or cholecalciferol, plays a significant role in patients with older individuals who are at high risk of falling or developing osteoporosis on their bones. Supplementing with vitamins and undergoing intensive physiotherapy together can increase muscular strength and function, lower the risk of falling, and enhance balance. (Table 2) summarizes the article.

Author	Participants	Mean age	Interventions		Duration
Drey et al, 2011 [14]	69	77	Experimental	>20 ng/mL=1000 IU D3/day <20 ng/mL=2000 IU D3/day and RET 2.60 min per week	12 weeks
			Control	>20 ng/mL=1000 IU D3/day <20 ng/mL=2000 IU D3/day and Sedentary	
Gianoudis et al, 2014 [15]	162	67	Experimental	1000 IU D3+700 mg Ca/day and HV-PRT 3x per week	12 months
			Control	1000 IU D3+700 mg Ca/day and Sedentary	
Agergaard et al, 2015 [16]	40	70	Experimental	1920 IU D3+800 mg Ca/day and RET 3x per week	16 weeks
			Control	800 mg Ca/day and RET 3x per week	
Uusi-Rasi et al, 2015 [17]	409	74	Experimental	800 IU D3/day and RET 2x/week for 12 months, 1x/week for next 12 months or sedentary	2 years
			Control	Placebo/day and RET 2x/week for 12 months, 1x/week for next 12 months or sedentary	

Table 1: Patient preference for treatment.

Author	Title	Design	Outcome measure	Results	PEDro score (0-10)
Drey et al, 2011 [14]	Effects of Strength Training versus Power Training on Physical Performance in Pre-frail Community-Dwelling Older Adults	Randomized Controlled Trial	SPPB, SF-LLFDI aLM (DXA)	Muscle power: increased with vitamin D intake (p=0.017) Muscle function: SPPB increased with exercise (p=0.009), SF-LLFDI was N/S Body composition: aLM was N/S	06
Gianoudis et al, 2014 [15]	Effects of a Targeted Multimodal Exercise Program Incorporating High-Speed Power Training on Falls and Fracture Risk Factors in Older Adults: A Community-Based Randomized Controlled Trial	Randomized Controlled Trial	Timed stair climb test 30 s sit-to-stand test, TUG Femoral neck and spine (DXA) Four square step tests Total body lean and fat mass (DXA)	Muscle strength: intervention increased strength relative to controls (p<0.001) Muscle power: Intervention increased power relative to controls (p<0.05) TUG: no between-group difference BMD: intervention increased femoral neck relative to controls (p<0.05) Body composition: lean and fat mass: N/S	06
Agergaard et al, 2015 [16]	Does vitamin-D intake during resistance training improve the skeletal muscle hypertrophic and strength response in young and elderly men? – a randomized controlled trial	Randomized controlled trial	Isometric knee extensor (strain gauge) MRI of quadriceps muscle (6 mm thick) Muscle strength/CSA	Muscle strength: no between-group difference Muscle CSA: no between-group difference Muscle quality: N/S	07
Uusi-Rasi et al, 2015 [17]	Exercise and Vitamin D in Fall Prevention Among Older Women: A Randomized Clinical Trial	Randomized Clinical Trial	knee angle of 110° SPPB, TUG Femoral neck and spine (BMD) Backwards walking	Muscle strength: increased with exercise (p<0.001) Vitamin D supplementation N/S Muscle function: SPPB=N/S TUG: vitamin D without exercise increased relative to placebo without exercise (p=0.01) BMD: femoral neck Dynamic balance: improved with exercise (placebo: p=0.001, vitamin D: p=0.03). No additive effect of vitamin D	08

Table 2: Article summary.

Vitamin D is considered to be essential for healthy bone metabolism. Serum 25-hydroxyvitamin D (25(OH)D) levels that are insufficient are linked to higher fall rates, greater bone loss, and a higher risk of fractures. Low 25(OH)D levels have also been linked to decreased physical performance and faster reductions in bodily functions, according to some research [13-25]. Systematic reviews and meta-analyses of clinical studies investigating the effect of vitamin D on preventing fractures and falls in older adults living in the community as well as on increasing physical functioning, however, have shown conflicting results [14-26].

Several studies on vitamin D without concurrent calcium supplementation showed no increase in muscle strength [15-16], indicating that calcium is necessary for the vitamin-D effect on skeletal muscle. Studies have shown improvements in muscle function when vitamin-D and calcium intake are combined [17,18]. Additionally, studies of control groups getting calcium supplements only failed to detect any improvement in muscular strength. As a result, calcium was supplied to both groups in the current investigation. The absorption of calcium is reliant on vitamin D. Therefore, coupled with the suggested impact of vitamin-D, it cannot be ruled out that calcium plays a role in the result of the skeletal muscles.

The optimum blood 25(OH)D concentrations and vitamin-D supplementation dosages are subjects of discussion. Recommendations for vitamin-D consumption range from 10 µg /day for babies to 250 µg /day for individuals with severe insufficiency, depending on age and grade of sufficiency [19]. Nevertheless, it is obvious that there is a dose-response connection between the daily dosage and increases in blood 25(OH)D concentrations [20]. Lower than 50 nmol/L serum 25(OH)D concentrations are considered vita.

Additionally, there is conflicting research regarding how vitamin D could affect how the body functions [21,22]. A greater 25(OH)D level was linked to superior neuromuscular function in a population-based study of men and women 60 years of age or older 23. Surprisingly, the chair stand test's performance seemed to worsen at the highest 25(OH)D concentrations over 120 nmol/L (>48 ng/mL), maybe as a result of the low number of observations in the highest group [23]. This discovery requires verification. High 25(OH)D levels have been linked in studies utilizing high vitamin D doses to an increased incidence of fractures and falls, indicating detrimental effects on balance and mobility [24-27].

Conclusions and Call for Action

In conclusion we believe that exercise program such as strength training, power training and multimodal exercise represents an effective approach for fall prevention, improve musculoskeletal functions and maintain functional performance in an optimum level for older adults. This review found no evidence that vitamin D3 supplementation alone is beneficial, but the literature search turned up only a small number of studies, indicating that more research is needed before any firm conclusions or recommendations can be made about the benefits of vitamin D3 supplementation for older persons musculoskeletal health and function. Micro and macronutrients are essential for elderly people since they are more likely to fall and have less mobility. Acute respiratory tract infections are less likely with daily vitamin D intake. Most older adults have reduced levels of endogenous synthesis and dietary intake so suggested Intake of 2000 IU/d (50 µg/d) Tolerable upper levels of intakes (Men: 100 µg/d Women: 100 µg/d) is required for them.

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