Impact of Vitamin D Level on Sarcopenia in Elderly People: A Critical Review

Saniya Khan[1] Sunil Kumar[1] Sourya Acharya[1] Anil Wanjari[1]

[1] Department of Medicine, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (deemed to be university), Wardha, Maharashtra, India

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Address for correspondence Saniya Khan, Junior Resident, Department of Medicine, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (deemed to be university), Wardha 442001, Maharashtra, India (e-mail: Saniya.24@hotmail.com).

Abstract

Vitamin D insufficiency is a widespread health issue globally, particularly among the elderly. Vitamin D controls and affects the metabolism and functionality of several human systems, including muscle tissue. The action of vitamin D on muscles has been extensively studied, with evidence indicating that this vitamin can increase the osteogenic differentiation of muscle fibers, hence preserving and enhancing muscular strength and athletic performance. Low hormone levels are more common in older people as a result of poor food intake and decreased skin ultraviolet irradiation. As a result, elderly persons who are deficient in vitamin D may be at risk of developing sarcopenia, a geriatric condition defined by gradual loss of skeletal muscle mass and strength that is frequently accompanied by adverse events such as falls, incapacity hospitalization, and mortality. As a result, these activities are seen to be crucial in illuminating the underlying functional condition of the aged, and functional mobility is employed as a technique for assessing fall risk and frailty. Several randomized controlled studies have been done to explore the efficacy of oral treatment in elderly people to prevent or cure sarcopenia; however, the results are still debatable. We describe the biochemical, clinical, and epidemiological data supporting the idea of a causal relationship between vitamin D insufficiency and a higher likelihood of sarcopenia in elderly adults in this narrative review. The muscular system, the biggest organ in the body, contributing to around 40% of body composition, is vital in exercising and glycogen depletion. Sarcopenia, a steady deterioration in muscle mass and strength, and function in the aged can result in prolonged circumstances, wheelchair confinement, and a reduction in quality of life. Diagnosis and control of muscle wasting are vital for improving health and quality of life in industrialized nations with aging populations. Vitamin D, a fat-soluble vitamin, has gained popularity in recent years because of its relevance in sarcopenia. The role of vitamin D deficiency and fortification on muscle wasting will be the focus of this review.

Keywords
- vitamin D
- sarcopenia
- aging
- quality of life

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Introduction

Rosenberg coined the term "sarcopenia" in 1989, and it originated from the Greek words "sarx" (flesh) and "penia" (loss). Sarcopenia was initially defined as the decrease in muscle size as a result of aging. Sarcopenia was characterized in 2010 by the European Working Group on Sarcopenia in Older People as a syndrome characterized by a generalized and progressive loss of skeletal muscle mass and strength, with a risk of complications resulting such as physical impairment, poor quality of life (QOL), and death.[1] Activities of daily living (ADL) are widely employed as evaluation instruments in clinical methods and are vital in determining the health condition of older people.[2] Feeding, personal toileting, bathing, dressing and undressing, getting on and off a toilet, controlling bladder and bowel, moving from a wheelchair to bed and back, walking on a level surface (or pushing a wheelchair if unable to walk), and climbing and descending stairs are the 10 personal activities that are involved.[3,4] The Global Working Group on Sarcopenia defined sarcopenia as an age-related decrease in muscular strength and functioning. Frailty phenotype is represented by decreased physical and functional capacity, slow gait, memory impairment, falls, and weight loss. In a previous study, sarcopenia defined by appendicular skeletal mass (ASM)/Weight was more closely associated with metabolic parameters than was sarcopenia defined by ASM/height.[2,5]

Sarcopenia has been linked to an increased risk of falling in the elderly. It has been found that sarcopenic people aged 80 or older were more than significantly more likely to drop over a different observation period than non-sarcopenic people. Furthermore, data from nine prospective studies show that persons with a high muscle mass and a rapid walking pace live longer and they're less likely to develop sarcopenia. Vitamin D, a fat-soluble vitamin, is a substance produced by the skin in response to ultraviolet exposure (90%) and food consumption (10%).[6] The predecessor of vitamin D is 7-dehydrocholesterol (pro-vitamin D3), which is generated by the liver from cholesterol and then transformed in the skin by solar energy under the exposure to ultraviolet rays first through pre-vitamin D3, then to cholecalciferol (vitamin D3). Age, race, accessibility of the predecessor in the skin, skin color, seasonal change in solar brightness, regional latitude, daylight and length of sunlight exposure, epidermis area exposed, and usage of sunblock and clothing all influence endogenous vitamin D synthesis.[7]

The vitamin D receptor (VDR), a protein that successfully binds 1,25(OH)2 D3 at a sub-nanomolar concentration, mediates a significant portion of the biological activity of the active form of vitamin D3.[8,9] However, as people age, their blood levels of 25(OH)D3 and the expression of VDR in muscle cells both decrease, which can cause muscle wasting and the start of sarcopenia.[10]

Ergocalciferol (vitamin D2), found in plant foods (e.g., some forms of mushrooms called shitake), and cholecalciferol, found in naturally rich animal-based foods like egg whites, cod liver oil, fish fat, also including salmon, sardines, mackerel, and tuna, and some fortified foods like dairy, juices, and cereals, are the dietary sources.[11]

Sarcopenia is characterized as main or intermediate based on its cause. Sarcopenia is called "primary" when no other particular cause other than aging is visible, and "secondary" when additional causation variables other than aging are present. Sarcopenia can develop as a result of a systemic disease, particularly inflammatory diseases such as cancer or organ damage, and endocrine disorders such as diabetes. Sarcopenia can also be caused by a lack of physical exercise. Sarcopenia can also occur as a result of malnutrition or malabsorption.[12]

The incidence of sarcopenia among 1882 old Japanese people aged 65 to nearly two centuries was found to be 21.8% for males and 22.1% for women, using the clinical criteria.[13] Few studies have documented sarcopenia prevalence using criteria. Due to differences in diagnostic parameters for detecting sarcopenia, it is defined as cellular senescence incidence significantly lower than that described using the criteria. Vitamin D is a low-saturated vitamin that can function as a regulator via a nuclear receptor.[14] Vitamin D was found as an antirickets component in cod fish oil supplements in the 1930s. Since then, researchers have studied vitamin D metabolism in several animals, and the metabolic routes have been clarified.

The most essential role of vitamin D is to regulate the Ca^{2+} content in the bloodstream, a lack of which causes disorders including rickets in infants and osteomalacia in adults. Vitamin D deficiency or insufficiency has lately been linked with an increased risk of various disorders, including sarcopenia, heart disease, overweight, and malignancy. A lack of vitamin D lowers bone calcium and phosphorous assimilation from the intestine. This causes hypocalcemia and hypophosphatemia that can lead to rickets in infants and osteomalacia in adults. Decreased vitamin D production in the skin is the biggest reason for vitamin D insufficiency, which can be induced by insufficient ultraviolet rays exposure, extensive sunscreen usage, and restricted outdoor exercise. Insufficiency is also linked to a reduction in dietary vitamin D status, age, and liver or kidney diseases. The serum 25(OH) D content is used to assess vitamin D's nutritional status. A value of 30 ng/mL indicates vitamin D deficiency, whereas a concentration of 20 ng/mL or below indicates deficiency.[15]

Method

A literature search in English was conducted using the electronic databases PubMed, MEDLINE, Embase, and Google. The search terms were "sarcopenia" OR "CKD" OR "renal disease" OR "Vitamin D" OR "insufficient Vitamin D" OR "Quality of life." The archiving of relevant papers was supported by the writers' personal knowledge and experience in the field. Articles that match the following criteria are included in this review: studies in English are included, studies from the previous 10 years are included as well, and studies devoted entirely to CKD, vitamin D, and sarcopenia are included. Research methodology by Preferred

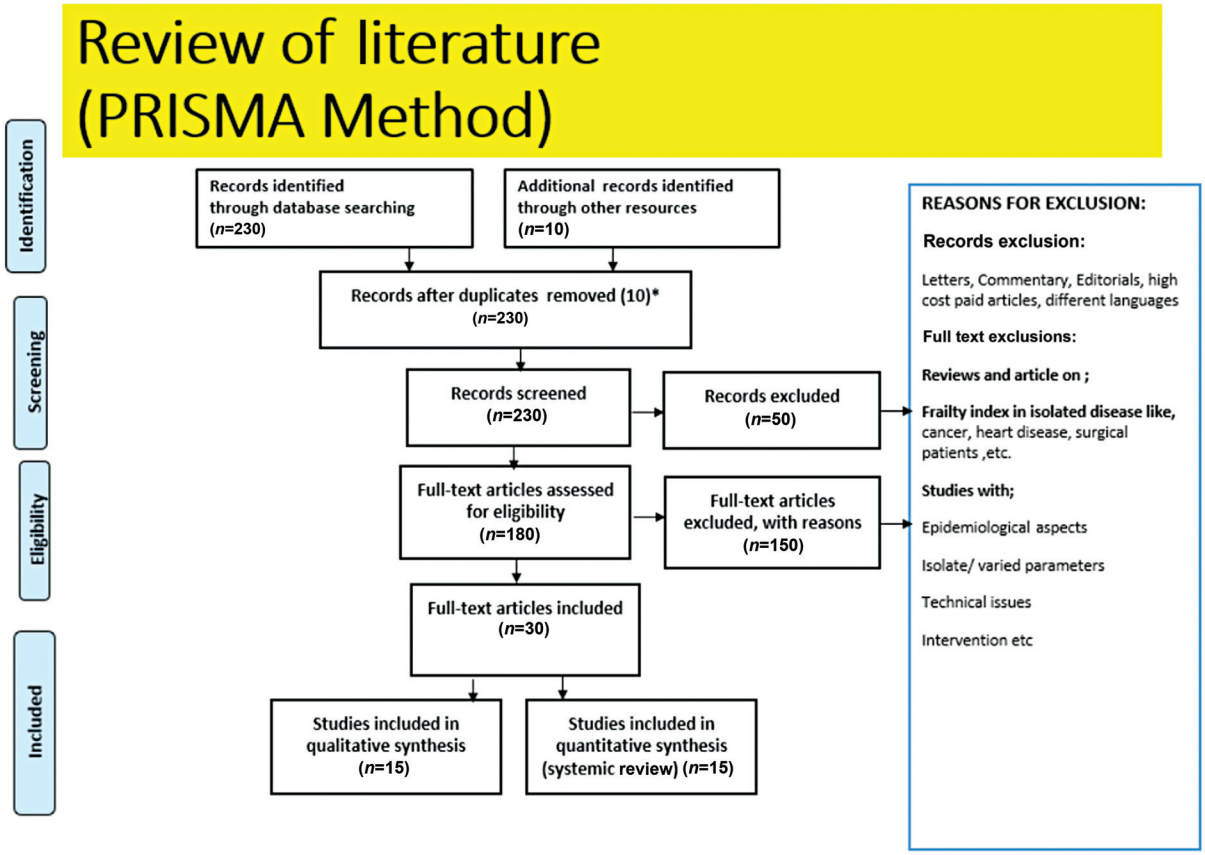

Fig. 1 Review of literature (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA method).

Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method is shown in ►**Fig. 1.**

Discussion

Several progressive studies have been conducted to investigate the function of vitamin D in muscular function and muscular performance in older persons, albeit the characteristics of the individuals and the technique of muscle strength evaluation vary. Multiple studies have proven that blood vitamin D levels are independently associated with muscle mass loss and muscular strength reduction in older persons, especially in men than in women, implying that older people having vitamin D deficiency are highly vulnerable to developing sarcopenia. A 2017 observational research indicated that abnormally low levels of vitamin D are related to an increased loss of muscular strength (determined as grip strength) in males aged 85 years; however, no significant variations in physical ability, as evaluated by time up and go test (TUG), were detected over time.[16] Aside from sarcopenia, observational studies show that older people who are vitamin D deficient are at a higher risk of other significant elderly outcomes, including weakness and falls.

Cross-sectional study conducted in Korea depicts a strong inverse association between 25(OH)D level and sarcopenia in the older population. This association was found to be independent of age, sex, body mass index, lifestyle factors (alcohol consumption, smoking, and regular exercise), and occupation.[17]

On the whole, epidemiological studies and mechanism of action experiments encourage a physiological link between both low vitamin D levels and maturity levels starting to decline throughout muscle mass and mass and strength quality, implying that supplements could be a method of preventing and treating sarcopenia, frailty, and their clinical comorbidities. Despite the information that the population having an age greater than 85 also known as “oldest-old” are now highly prone to vitamin D, cellular senescence, and hampered functionalities, just a small number of investigations have particularly concentrated upon this cohort. Additional research of the aforementioned age range is required to confirm vitamin D’s role in muscular health problems later in life.

Recent studies have suggested that 60% of the studied population was having the condition of sarcopenia. On the contrary, other studies differ from this point of view possibly due to the difference in evaluating methodologies that are employed to study this condition, and it has been concluded that critically ill patients who have sarcopenia have a higher tendency to become frail and have an increased risk of mortality; therefore, a routine assessment of sarcopenia is an important prognostic tool in patient outcomes.[18]

Vitamin D affects muscle tissue in both direct and indirect ways to dismiss the possibility of indirect impacts from

calcium along with phosphate; we doubled the amount of serum calcium along with phosphate in the vitamin D meal. The investigational outcomes revealed that there had been no noteworthy change in blood calcium or available phosphorus across units, ruling out the possibility of plasma calcium and phosphorus having an indirect influence.

Vitamin D deficiency hastens muscular atrophy caused by immobility, as seen by lower GA muscle mass, muscle fiber dispersion, and grip strength. Supplementing with 1,25D may prevent the loss of grip strength caused by immobility; curiously, vitamin D and exercise have an interactive impact on physical functioning.[19]

The continuous decrease in muscular strength is a characteristic of muscle wasting. Strength training is a better predictor of negative outcomes than muscle mass, including falls, poor physical performance, and death. The European Advisory Committee on Sarcopenia in Elderly People suggests using poor muscular strength as the major criteria to detect sarcopenia in their 2018 guidelines. The TUG is indicated by the fall prevention guidelines for diagnostic testing of older persons, so it can be used as an alternate indication of physical ability in the testing for sarcopenia. The TUG is an essential indication for measuring physical performance since it is used to acquire balance, walking speed, and groups in the organization information from older persons.[20]

There has been a minimal study on elderly people who get a single vitamin D pill in addition to a fitness routine. According to Uusi-Rasi et al's research of 70- to 80-year-old women, fitness training alone can increase lower limb muscular strength and physical functioning, while vitamin D does not affect physical features.[21] The foundation serum levels of 25(OH)D3 in the subjects were higher, and the initial mean (standard deviation) of the vitamin D group was 25.1 (6.9) ng/mL, which rose to 37.0 (7.4) ng/mL after 24 months. Changh et al discovered combining vitamin D supplementation with protein supplementation and exercise can significantly increase grip strength and also show a trend toward increasing muscle mass.[22]

Since the data are inadequate, the International Therapeutic Guidelines for Muscle wasting do not suggest treatment in elderly adults with sarcopenia. According to the findings of this review research, older persons should be urged to enhance their physical activity.[23] It is suggested that older persons with vitamin D deficit supplement with adequate levels of vitamin D and endeavor to minimize both muscular dormancy and vitamin D paucity. Since these variables may aggravate the reduction in muscular potency and bodily ability, the underlying life process may entail a synergistic impact of vitamin D and exercise in increasing enzymatic activity and breakdown of muscle tissue protein.[24]

A link has been discovered between serum 25(OH) D levels and muscular operation. Serum 25(OH) D values of 30 ng/mL (75 nM) and 20 ng/mL (50 nM), respectively, indicate vitamin D deficiency . Okuno et al found that over 90% of 80 elderly Japanese women over the age of 65 had insufficient vitamin D and 28% had a deficit.[25] Throughout a 3-month monitoring period, 56.3% of individuals with deficient vitamin D levels suffered drops. A meta-analysis of five randomized controlled studies on the results of vitamin D supplementation (20 g/day, 800 IU/day) on accidents and bone fractures in the aged indicated that treatment reduced the risk of tripping by 22% compared with calcium alone or a placebo.[26] Moreover, 20 g/day vitamin D supplementation resulted in a considerably decreased frequency of bone fracture compared with 10 g/day (400 IU/day) treatment. It has been determined that older people with low blood 25 (OH) D levels are predisposed to sarcopenia.

Research on vitamin D supplementation had demonstrated that it increases muscular strength. A literature review of 29 research on the influence of vitamin D supplementation on muscle mass discovered that dietary supplementation dramatically improved muscular endurance so in persons with serum 25(OH) D concentrations less than 30 ng/mL versus others with concentrations exceeding 30 ng/mL.[27] This indicates that supplements are more beneficial in instances when serum 25(OH) D levels are reduced, such as in the elderly. Separate research found that consuming vitamin D orally at a rate of 100 g/day (4,000 IU/day) for 4 months raised muscle nuclear VDR by 30% and muscle strength fiber size by 10% in senior ladies (mean age of 78 years).[28] A meta-analysis of seven clinical experiments using vitamin D supplementation, on the other hand, revealed an enhancement in top and bottom limb muscle endurance in healthy 18 to 40-year-old volunteers.[29] This demonstrates that the advantages of plasma Levels are not restricted to the old and the feeble. Vitamin D supplementation may enhance muscular strength and mass and may be beneficial in the preclusion and treatment of sarcopenia.

Nevertheless, a meta-analysis of 16 random, observational trials exploring the impact of treatment on muscle strength in postmenopausal women found that it does not always increase muscle performance.[30] Supplements did not affect grip strength or back muscular strength, both of which are indications of overall muscle strength. These discrepancies in vitamin D supplements' effects might be attributed to a variety of factors, including the amount and kind of vitamin D utilized, the period of the treatment, and the participants' vitamin D sufficiency. More study is highly required (►**Table 1**).

Conclusion

Treatment of sarcopenia and control of its development are key challenges in industrialized nations with a high number of senior inhabitants in terms of lowering health-care expenditures and improving QOL. Several studies provide evidence for the usefulness of vitamin D as a treatment in instances of muscle wasting in the aged people. Nevertheless, whether vitamin D administration in sarcopenia sufferers has favorable benefits such as inhibition of muscular atrophy and improved muscle force is debatable, due in part to the intricate processes behind vitamin D's action on muscle

Table 1 The different studies reviewed in this article

Author and year	Title	Conclusion
Bischoff-Ferrari et al[26] May 2005	Fracture prevention with vitamin D supplementation: a meta-analysis of randomized controlled trials	Oral vitamin D supplementation between 700 to 800 IU/d appears to reduce the risk of hip and any nonvertebral fractures in ambulatory or institutionalized elderly persons
Kim et al[17]	Vitamin D deficiency is associated with sarcopenia in older Koreans, regardless of obesity: the Fourth Korea National Health and Nutrition Examination Surveys (KNHANES IV) 2009	Strong inverse association between 25(OH)D level and sarcopenia in the older population and was independent of age, sex, BMI, lifestyle factors
Okuno et al[25] March-April 2010	Effects of serum 25-hydroxyvitamin D_3 levels on physical fitness in community-dwelling frail women	Serum 25(OH)D3 levels at baseline are associated with functional capacity and improvements in physical fitness with regard to walking ability, balance, and lower extremity strength, and at least 47.5 nmol/L may be necessary to maintain walking ability and balance, and greater than 67.5 nmol/L is preferable for lower extremity strength and a functional capacity in Japanese "Specified elderly women"
Uusi-Rasi K et al[21] May 2015	Exercise and vitamin D in fall prevention among older women: a randomized clinical trial	The rate of injurious falls and injured fallers more than halved with strength and balance training in home-dwelling older women, while neither exercise nor vitamin D affected the rate of falls
Granic A et al[16] April 2017	Vitamin D status, muscle strength and physical performance decline in very old adults: a prospective study	lowest 25(OH)D season-specific quartile was associated with a faster rate of muscle strength (GS) decline in men (aged≥85), and acceleration of the decline over 5 years in all participants
Zhang et al[29] April 2019	Effect of vitamin D supplementation on upper and lower limb muscle strength and muscle power in athletes: a meta-analysis	Vitamin D supplementation positively affected lower limb muscle strength in athletes, but not upper limb muscle strength or muscle power. Different muscle groups and functions may respond differently to vitamin D supplementation
Cheng et al[22] October 2021	The optimal strategy of vitamin D for sarcopenia: a network meta-analysis of randomized controlled trials	Combining vitamin D with protein supplementation and exercise can significantly increase grip strength and showed a trend toward increasing muscle mass
Bhurchandi et al[18] October 2021	Correlation of sarcopenia with modified frailty index as a predictor of outcome in critically Ill elderly patients: a cross-sectional study	Critically ill patients with sarcopenia had more tendency to become frail, thereby increased risk of mortality

tissue. More research on vitamin D and cellular senescence will be beneficial in shining additional light on the subject.

Conflict of Interest
None declared.

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