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Effect of ultraviolet on vitamin D and quality of life in postmenopausal women: a randomized controlled study

Type

Original paper

Keywords

quality of life, vitamin D, aerobic exercises, ultraviolet radiation

Abstract

Objective
To determine the influence of ultraviolet radiation on vitamin D plasma levels and quality of life in postmenopausal women with vitamin D deficiency

Subjects and Methods
In a single blinded randomized controlled trial design, thirty postmenopausal women were chosen suffering from a progressive, generalized muscle weakness, associated with decrease in physical function and poor quality of life. Subjects were aged between 45 and 65 years and were randomly assigned into group (A), treated by ultraviolet radiation in addition to regular aerobic exercises; and group (B), receiving solely aerobic exercises. All participants had 3 sessions per week for three months. Outcome measures measured before and after three months of intervention were vitamin D level and the SF-36, a specific quality-of-life questionnaire

Results
A significant increase in vitamin D was observed along with an improvement in quality of life in group A compared with group B after the treatment period.

Conclusions
twelve week program of ultraviolet radiation in addition to regular aerobic exercises yielded improvement in vitamin D and quality of life more than aerobic exercises alone in the management of postmenopausal chronic musculoskeletal disorders.

Explanation letter

all comment were considered and corrected with highlighted

Effect of ultraviolet on vitamin D and quality of life in postmenopausal women: a randomized controlled study

Abstract. [Purpose] To determine the influence of ultraviolet radiation on vitamin D plasma levels and quality of life in postmenopausal women with vitamin D deficiency. [Subjects and Methods] In a single blinded randomized controlled trial design, thirty postmenopausal women were chosen suffering from a progressive, generalized muscle weakness, associated with decrease in physical function and poor quality of life. Subjects were aged between 45 and 65 years and were randomly assigned into group (A), treated by ultraviolet radiation in addition to regular aerobic exercises; and group (B), receiving solely aerobic exercises. All participants had 3 sessions per week for three months. Outcome measures measured before and after three months of intervention were vitamin D level and the SF-36, a specific quality-of-life questionnaire. [Results] A significant increase in vitamin D was observed along with an improvement in quality of life in group A compared with group B after the treatment period. [Conclusion] twelve week program of ultraviolet radiation in addition to regular aerobic exercises yielded improvement in vitamin D and quality of life more than aerobic exercises alone in the management of postmenopausal chronic musculoskeletal disorders.

Key words: vitamin D, quality of life, ultraviolet radiation, Aerobic exercises

INTRODUCTION

Menopause is the interruption of menstruation for more than one year as a result of degenerative changes at the level of the ovaries and follicles, and is usually associated with changes in the ovarian hormone levels. The part of life after menopause is commonly termed postmenopausal period in female life [1]. The clinical picture associated with menopause is usually the presence of hot flushes, irregular menses, and excessive night sweats. While some women report no major signs other than the discontinuation of menses [2], many others tend to report many somatic and psychological symptoms often designated as postmenopausal syndrome. It is well documented that age is linked to a decline in physiological functions particularly the loss of bone mass density (BMD) in addition to a drop in muscle strength and mass termed sarcopenia. Such decline in muscle mass has been accused to induce functional impairment especially those related to activities of daily living, in addition to increased risk of falling and nonvertebral fractures [3]. Vitamin D deficiency is well documented in postmenopausal women at which parathyroid hormone is suppressed and is associated with increased intestinal calcium absorption, reduced BMD, increase bone loss, and increase fracture rate. Various risk factors were identified including age, decreased dietary intake, diminished sunlight exposure, wintertime, nursing home environment, reduced skin thickness, a decline in the ability of the skin to fabricate vitamin D, impaired intestinal uptake, and decreased hydroxylation in both kidneys and liver [4]. Vitamin D deficiency is usually asymptomatic, but research conclusions reported generalized muscle weakness, lengthened time to peak contraction in addition to augmented time to muscle relaxation, in post-menopausal women. Clinically, such associated changes are often described by affected women as heaviness in the legs, tiring easily, difficulty when performing some activities of daily living particularly rising from a seated or squat position, mounting stairs, or lifting objects [5]. Diagnosis of vitamin D deficiency is crucial since it may lead to impairment in quality of life (QoL) even if no specific symptoms are present [6]. Vitamin D supplementation is commonly used as a medical intervention but overdose may cause hypercalcemia, with associated anorexia, nausea, vomiting and diarrhea, polyuria, polydipsia, weakness, weight loss, insomnia, irritability, nervousness, severe depression, pruritus, proteinuria, and potential calcification in the kidneys, and ultimately renal failure [7]. Non-pharmaceutical treatment as ultraviolet radiation and exercises are used to address postmenopausal symptoms especially that chronic musculoskeletal disorders has been well correlated with diminished quality of life scores. Such modalities are regarded as natural and safe in managing postmenopausal syndrome and being less invasive than medications [8]. Ultraviolet is an electromagnetic energy, which falls between visible rays and X-rays and has a wavelength between 10 nm and 400 nm. It is divided into; UVA: Wavelength range between 315 and 400 nm., UVB: Wavelength range between 280 and 315 nm., and UVC: Wavelength below 280 nm [9]. The skin absorbs UVB radiation and uses it to convert skin sterols precursors, such as 7- dehydrocholesterol, to cholecaciferol (Vitamin D_3). In the liver and kidneys, this latter is converted to active metabolites form $1,25(OH)_2$ D_3. It has been agreed for many years that, exposure to artificial UV radiations or artificial sun light can be curative for vitamin D deficiencies [10]. In the same context, aerobic exercise has been claimed to be efficient in the management of a number of post-menopausal signs and symptoms including hot flushes, osteoarthritis, hyperlipidemia, fibromyalgia, depression, and diabetes mellitus

[11]. Regular aerobic activities were also reported to maintain and improve quality of life, decrease fatigue sensation, and lessen the rate of depressive disorders [12]. Researches trying to figure the relation between vitamin D deficiency and skeletal muscle strength concluded opposing results. Such conflicting results might be caused by research methodologies differences, genetic causes and research participant's characteristics. Additionally, vitamin D deficit has been found to be one of the correlated risk factors for osteoporosis, high fall risk and fractures, and was accused to affect negatively the patient's quality of life. Thus, the present study aimed to study the effect of ultraviolet radiation and aerobic exercise on muscle strength and consequently the quality of life in women in their postmenopausal life period.

SUBJECTS AND METHODS

This was a prospective, single-blinded, pre and post-test, randomized controlled trial. Thirty-six postmenopausal females were enrolled from the women's health outpatient clinic at faculty of physical therapy, Cairo University, outpatient clinic of obstetrics and gynaecology department. Eligible participant's age ranged between 45 and 56 years old, and their body mass index (BMI) ranged between 28 and 30 kg/m^2 and reporting a decrease in their physical function and quality of life. Exclusion criteria consisted of women reporting any inclusion in any physical activity, even in leisure time, for the last 12 months or suffering from any acute or chronic metabolic, hormonal, neurological, musculoskeletal, gastrointestinal, or urinary disorder or disease. In addition, subjects included in the study, were chosen not taking any vitamin D supplements, osteoporosis treatment, or current or previous intake of hormone replacement therapy. Prior to any evaluation, signed informed consent was collected from all participating women. The study was granted the approval from the institutional review board of the at Faculty of physical therapy, Cairo University with a reference number (P.T.REC/012/001543). The study abided to the guidelines of the declaration of Helsinki and was performed between September 2017 and October 2018.

Intervention

All participants were given a brief demonstration about the study and the tasks to be performed. An independent research assistant unwrapped closed casings containing a random cards generated automatically by a computer and divided the participants into two identical groups A and B. The study did not record dropouts after the randomization. Group A received ultraviolet radiation in addition to regular aerobic exercises. Ultraviolet sessions were performed three times per week for three months, and were achieved while the patient was lying down comfortably. The aerobic exercises were implemented 3 times per week for three months. Group (B) received solely aerobic exercises, three sessions per week for three months. For both groups, aerobic exercise session was performed as follows: 40 minutes of treadmill walking, as follows: warm up (10 minutes), followed by exercising (20 minutes) and ended by cooling down (10 minutes). Intensity of the exercise session was fixed at 60–70% of maximum heart rate (HR max) calculated as 220 – age [13].

Outcome measures

Vitamin D level was measured by blood analysis before and after 3 months of intervention in both groups. The plasma levels of Vitamin D were recorded before and after 3 months of intervention. Vitamin D concentrations were taken through high-performance liquid chromatography (HPLC) (Shimadzu, Japan). Kits used allowed the chromatographic determination of 25-OHD on a simple isocratic HPLC system with ultra violet detection. Interfering components were removed and analytes were concentrated through efficient protein precipitation and selective solid phase extraction. The limit of detection was 2.5 ng/ml and the coefficient of variation was <7 %. It has been found that serum 25-hydroxyvitamin D can be considered as one of the most valid markers of vitamin D status. It has been also agreed that vitamin D is considered deficient with levels less than 20 ng/ml (50 nmol/l) of 25-hydroxyvitamin D, while the range 21 to 29 ng/ml (52.5 to 72.5 nmol/l) is considered as vitamin D insufficiency, while the ideal level was set as 30 ng/ml (75 nmol/l). In this study, a level less than 20 ng/ml of 25-hydroxyvitamin D levels was considered as marker of vitamin D deficiency [14]. Additionally, the quality of life was judged by the SF-36 a tool considered generic and multidimensional, and evaluating a person's overall satisfaction with life and health. This tool has been translated and validated into many languages including Arabic [15]. The Arabic version of the questionnaire was self-administered and all subjects completed it at their routine clinical visit after they had accepted to participate in the study. SF-36 is a measure of physical and mental status for the last four weeks, and consists of three levels: first level containing 36 items, the second level comprising eight sub-scales that aggregate 2-10 items, and the third level involving two summary scales that aggregate sub-scales. These two latter, aggregate four sub-scales each: the first addressing the physical component, and the other addressing the mental component score. General health, vitality and social functioning have correlation with both of the summary scales. The higher score means better QoL, with score ranging between 0 and 100.

Data analyses

Using Statistical Package for Social science (SPSS) program version 23, the data recorded were analyzed. Before concluding analysis, data was evaluated for normality assumption, homogeneity, and occurrence of extreme scores. Such analysis was performed as preliminary measure before parametric calculations of the analysis of difference. We recorded a linear relationship between the dependent variables using scatterplot, and no proof of multicollinearity using Pearson correlation ($|r| < 0.9$). Additionally, no univariate outliers were observed in the data through boxplot, and no multivariate outliers, as evidenced by Mahalanobis distance. Vitamin D and quality of life were normally distributed, as demonstrated by Shapiro-Wilk's test ($p > .05$). Levene's test assured the homogeneity of variances ($p > .05$) for all dependent variables. Consequently, 2×2 MANOVA (mixed design) was considered to match the recorded variables for groups and at various periods. Alpha level was set at .05. The sample size (30 participants) was calculated to yield an 85% power and $\alpha=0.05$.

RESULTS

Thirty participants were involved in the final analysis after recording drops of six volunteers related to personal willingness of the participants (fig 1). They were previously allotted into two groups; 15 patients (group A) receiving ultraviolet radiation in addition to regular aerobic exercises, and the group B comprising 15 patients receiving aerobic exercises. The independent t-test showed no significant differences ($p>.05$) when comparing mean values of different personal characteristics in both groups (table 1).

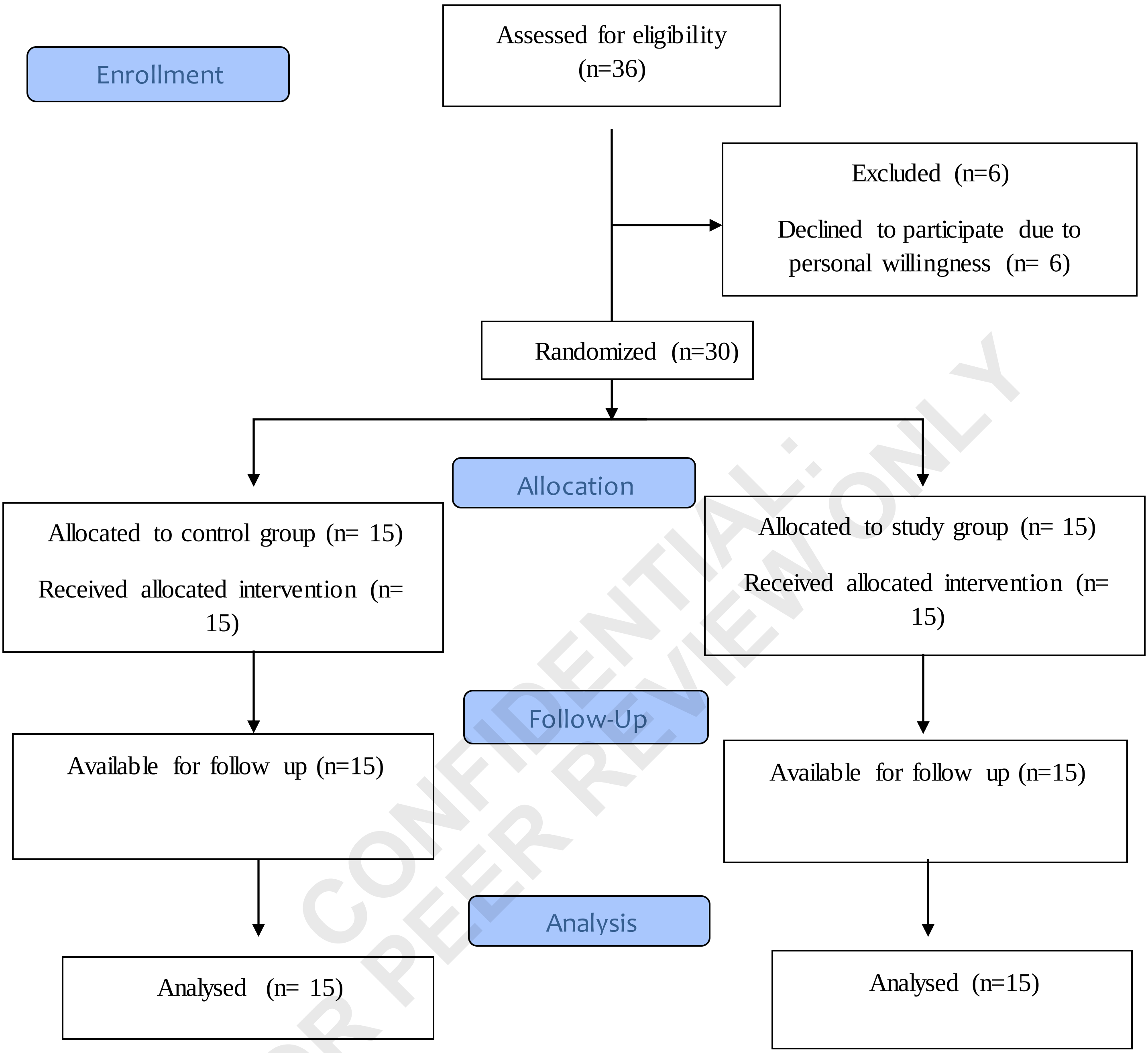

Fig (1): Flow chart of the study.

Table (1): Personal characteristics of patients in both groups

Items	Group A	Group B	Comparison		Significance
	x̄ ± SD	x̄ ± SD	t-value	P-value	
Age (years)	51.66±5.21	53.29±5.31	-0.915	0.367	**NS**
Body mass (kg)	84±14.9	84.05±11.28	-0.013	0.99	**NS**
Height (cm)	157.22±5.05	157.7±3.49	-0.327	0.746	**NS**

***x̄: Mean, SD: standard deviation, P: probability, S: significance, NS: non-significant.**

Mixed design MANOVA investigated thirty patients allocated into two identical groups in numbers. It showed a significant within-subject effect (F = 124.358, p = .0001) and treatment * time effect (F = 35.942, p = .0001); on the other hand, there was significance in the between-subject effect (F= 12.289, p = .0001). Table (2) present descriptive statistics (mean ± SD) and multiple pairwise comparison tests for the measured variables. Additionally, regarding the within-subject effect, the multiple pairwise comparison tests uncovered significant increase (p <.05) in vitamin D levels and quality of life scores after treatment in comparison with before treatment means for both groups. Calculations of the between-subject effects using multiple pairwise comparisons revealed significant increase (p <.05) in both vitamin D and quality of life more in group A than in group B.

Table (2): Descriptive statistics and multiple pairwise comparison tests for the all dependent variables for both groups at different measuring periods

	Group A		Group B	
Variables	**Pre**	**Post**	**Pre**	**Post**
Vitamin D	**20.5±1.91**	**32.77 ±5.34**	**19.22 ±1.88**	**22.08±2.55**
Quality of life	**44.35±4.28**	**57.05 ±5.44**	**41.68 ±3.99**	**46.25±5.02**
	Within groups (Pre Vs. post)			
p-value	**Vitamin D**		**Quality of life**	
Group A	.0001*		.0001*	
Group B	.001*		.0001*	
	Between groups (group A Vs. group B)			
	Vitamin D		**Quality of life**	
Pre treatment	.064		.075	
Post treatment	.0001*		.0001*	

***Significant at the alpha level (p < .05).**

DISCUSSION

It has been found that musculoskeletal disorders account for 14-30% of disorders affecting postmenopausal women resulting in functional deterioration, increase in the requirement for support in the achievement of routine activities, and poor quality of life [16]. The main cause of such limitations is the decline in estrogen levels leading to progressive drop in levels of growth hormone (GH) and insulin-like growth factor1 (IGF1). The associated decline in androgen production is accounted for the onset of sarcopenia [17]. The risk of sarcopenia in postmenopausal women has been reported to be doubled when concentrations of 25(OH)D drop lower than 10 ng/ml. Vitamin D deficiency is generally silent and usually women exhibit no clear symptoms , even though some amounts of muscle weakness and pain might be present and possibly lead to further reduction in the woman's quality of life [18]. In the present study, results revealed significant rise in vitamin D level and enhancement in the quality of life questionnaire scores in both post intervention groups when compared to pre intervention scores; however significant higher scores of vitamin D level and quality of life in subjects treated with UV radiation were recorded after treatment when compared to controls. Such observations agree with others [19], who reported that vitamin D deficiency is a frequently encountered clinically in post menopause and was linked to reduced intensity and duration of exposure to ultraviolet by 80-90% and other 10-20% by low dietary vitamin D intake. Each of these two sources was accused to provide sufficient supply, but if one of them is lost, the other source can easily become insufficient. In a multinational European study, occurrence of vitamin D deficiency reached 32.1% [20], while others published higher rates [14].

In this study, remarkable improvements were recorded in the ultraviolet radiation group. Such observation may be attributable to that the main source of vitamin D is the synthesis in the skin facilitated by the ultraviolet radiation effect on the 7-dehydrocholesterol, the vitamin D precursor. UVB has been accounted for the fabrication of vitamin D in the skin, and may reach 1,000 IUs for each minute of irradiation. In addition, any vitamin D deficiency can be caused by factors affecting the UVB photons to penetrate the skin. Dietary intake is a documented alternative source of vitamin D; on the other hand, contemporary diets lack sufficient amounts of vitamin D, even in fortified diets containing high levels of dairy and/or cereal products. Thus, the human body relies highly on skin production of vitamin D otherwise deficiency is inevitable [21]. The observed increase in vitamin D in this study is supported by other authors [22], who reported increase in vitamin D levels even 24 hours post UV light exposure.

In the same context, the conclusions of the present study are in agreement with others regarding improvement observed in the quality of life [16], who studied the added value of vitamin D on regular physical activity on 77 sarcopenic postmenopausal women. Adding Vitamin D supplements to gentle exercise was found useful in addressing catabolic mediators, inflammatory mediators such as C-reactive protein (CRP), and consequently refining some anabolic markers and thus increased the production of muscle proteins. These associated changes led to increase in fat-free mass and muscle strength, demonstrating effectiveness in management of sarcopenia with additional enhancements in functional markers and quality of life. The improvements recorded in the present study can be accounted for possible subsequent genomic and nongenomic actions leading to adequate muscle function. Genomic cascade are facilitated by nuclear vitamin D receptors that influence transport of calcium in the muscles and other related metabolisms [23]. Normal serum calcium level, enabled by suitable vitamin D levels, can be regarded as crucial for ordinary muscle functioning. Nongenomic actions were found to take place through vitamin D receptors existing on cell membranes. This binding triggers a series of pathways that were found to convey signals to the cytoplasm. Such mechanisms are also believed to regulate calcium inside the muscle cells [24]. Another possible explanation could be the initiation of mitogen-activated protein kinase signaling paths that were highly correlated with myogenesis regulation, cell proliferation, differentiation, and apoptosis. Taking these mechanisms altogether, it can be deduced that vitamin D can produce stimulation of muscle cell proliferation and growth. Additionally, potential protein synthesis observed can be the result of vitamin D binding protein that is linked to adenosine triphosphate (ATP) uptake in the skeletal muscle reticulum [25]. Four doses of vitamin D supplementation were found effective in enhancing physical and mental components of SF-36 [26]. In another study [27], community dwelling women were evaluated for physical performance according to vitamin D status and concluded that serum vitamin D was significantly associated with muscle strength and physical function scores recorded by SF-36 in postmenopausal women. These findings were confirmed in other studies performed in elderly women [28]. Aerobic exercises exhibited significant improvement in quality of life. This improvement is attributable to that regular physical activity is safe for postmenopausal women and the risks of developing major systemic or musculoskeletal disorders are reduced by regular physical activity with various identified modes and intensities [29]. The results agree with others [30], who recommended that postmenopausal women could benefit from the positive effects of physical activity through performing modest but regular physical activity. However, a combination of various modes of training, particularly resistance and endurance training has been claimed to be more beneficial than using one mode of exercising individually. Such variation in the training modes was claimed to contribute to improved quality of life among postmenopausal women with moderate deficits or frailty.

LIMITATIONS

Possible limitations in this study might be the psychological, physiological and potential cultural issues.

CONCLUSION

At the end, it can be concluded that, in postmenopausal women, 12-week program of ultraviolet radiation in addition to aerobic exercises yielded significant improvement in vitamin D, and improved the score of SF-36 quality of life score when matched to aerobic exercises only.

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CONFLICT OF INTEREST

Authors state no conflict of interest

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