Impact of home-based physical exercises and diet management on functional performance and depression among Vitamin D deficient females

Impacto de los ejercicios físicos en el hogar y el manejo de la dieta sobre el rendimiento funcional y la depresión en mujeres con deficiencia de Vitamina D

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Abstract

Background: This study investigated the impact of different interventions on depression and functional performance in females with vitamin D3 deficiency, a condition found to be two to three times more prevalent in women and associated with various symptoms.
Methods: A total of 120 women were randomly assigned to four equal groups; Group A had a home exercise regimen, sun exposure, and vitamin D3 supplement; Group B had a diet, sun exposure, and vitamin D3 supplement; Group C received sun exposure and a vitamin D3 supplement; and Group D received only their vitamin D3 supplementation for 6 weeks
Results: Over the study period, significant improvements were observed in Groups A, B, and C compared to Group D. These included increases in vitamin D3 levels and improved physical function, measured by a vitamin D3 blood test (25-hydroxyvitamin D test), the 6-minute walk test ($p < 0.05$), and reductions in depression and dyspnea, measured by the Hamilton Depression Rating Scale (HAMD) and Dyspnea Borg Scale respectively ($p < 0.001$). Further analysis revealed that Group A showed greater improvement in vitamin D3 levels and 6MWD compared to Groups B and C ($p < 0.01$). Groups A and B also showed a significantly greater improvement in HAMD compared to Group C. Group A also showed a significantly greater improvement in dyspnea scores compared to Groups B and C ($p < 0.01$), while there was no difference between Groups B and C in this regard ($p > 0.05$).
Conclusion: Therapeutic methods affected depression and functional performance in females with vitamin D3 deficiency, but exercise combined with a Vitamin D3 supplement was more effective.

Keywords

Exercise, diet therapy, functional performance, depression, Vitamin D3.

Resumen

Antecedentes: Este estudio investigó el impacto de diferentes intervenciones sobre la depresión y el desempeño funcional en mujeres con deficiencia de vitamina D3, una condición que se encontró que era de dos a tres veces más prevalente en las mujeres y asociada con varios síntomas.
Métodos: Un total de 120 mujeres fueron asignadas al azar a cuatro grupos iguales; El grupo A tuvo un régimen de ejercicio en el hogar, exposición al sol y suplemento de vitamina D3; El Grupo B tuvo una dieta, exposición al sol y suplemento de vitamina D3; El Grupo C recibió exposición al sol y un suplemento de vitamina D3; y el Grupo D recibió solo su suplementación con vitamina D3 durante 6 semanas.
Resultados: Durante el período de estudio, se observaron mejoras significativas en los Grupos A, B y C en comparación con el Grupo D. Estos incluyeron aumentos en los niveles de vitamina D3 y mejora de la función física, medida mediante un análisis de sangre de vitamina D3 (prueba de 25-hidroxivitamina D), la prueba de caminata de 6 minutos ($p < 0.05$) y reducciones en depresión y disnea, medidas mediante la Escala de Calificación de Depresión de Hamilton (HAMD) y la Escala de Disnea de Borg, respectivamente ($p < 0.001$). Un análisis adicional reveló que el Grupo A mostró una mayor mejoría en los niveles de vitamina D3 y 6 MWD en comparación con los Grupos B y C ($p < 0,01$). Los grupos A y B también mostraron una mejora significativamente mayor en HAMD en comparación con el Grupo C. El Grupo A también mostró una mejora significativamente mayor en las puntuaciones de disnea en comparación con los Grupos B y C ($p < 0,01$), mientras que no hubo diferencias entre los Grupos B y C a este respecto ($p > 0,05$).
Conclusión: Los métodos terapéuticos afectaron la depresión y el rendimiento funcional en mujeres con deficiencia de vitamina D3, pero el ejercicio combinado con un suplemento de vitamina D3 fue más efectivo.

Palabras clave

Ejercicio, dietoterapia, rendimiento funcional, depresión y Vitamina D3.

Introduction

Vitamin D3 (cholecalciferol) is an essential secosteroid hormone that supports musculoskeletal integrity and plays a regulatory role across several physiological systems, including immune, endocrine, and cardiovascular processes. In addition to its established contribution to calcium and bone metabolism, accumulating evidence links vitamin D3 deficiency to a wide range of chronic health conditions such as cardiovascular disorders, certain malignancies, and immune dysfunctions (Bouillon et al., 2007; Holick, 2007; Martineau et al., 2017; Jolliffe et al., 2021).

Vitamin D3 is primarily obtained through two sources: endogenous synthesis in the skin following ultraviolet-B (UVB) exposure and dietary intake. Nevertheless, vitamin D deficiency continues to be recognized as a major global health issue. Epidemiological research conducted across Europe, Asia, Africa, and the Americas consistently reports high prevalence rates of vitamin D insufficiency among diverse populations and age groups (Mithal et al., 2009; Autier et al., 2014; Palacios & Gonzalez, 2014; Spiro & Buttriss, 2014; Cashman et al., 2016; Bouillon et al., 2019; Manson et al., 2020).

Paradoxically, this deficiency is also prevalent in regions characterized by abundant sunlight, such as Saudi Arabia. Studies by Almulhim et al. (2015) and Al-Faris (2016) revealed that between 30% and 80% of Saudi women are vitamin D deficient, with particularly high rates observed among women. These findings highlight the influence of limited sun exposure, cultural clothing practices, and lifestyle habits on vitamin D status, despite the availability of intense sunlight throughout the year (Al-Daghri, 2018; Lips et al., 2019).

In recent years, attention has shifted toward the potential role of exercise training in modulating vitamin D3 status. Regular physical activity, especially outdoors, can enhance endogenous synthesis through greater UVB exposure and may improve calcium metabolism and musculoskeletal health (Almulhim et al., 2015; Al-Faris, 2016). Furthermore, several studies have demonstrated positive correlations between optimal vitamin D3 levels and improved athletic performance, muscle strength, endurance, and recovery capacity (Laird et al., 2010; Crescioli, 2020; Bigman, 2022; Bischoff-Ferrari et al., 2022; Malczewska-Lenczowska et al., 2024).

Dietary factors also play an important role in maintaining sufficient vitamin D3 levels. Limited consumption of vitamin D-rich foods such as fatty fish, eggs, and fortified products contributes to deficiency. Laird et al. (2010) emphasized the need for nutritional strategies that not only increase vitamin D intake but also address factors influencing its absorption, such as dietary fats and micronutrient balance.

Additionally, vitamin D3 has been implicated in the regulation of brain function and mental health. Evidence suggests that low vitamin D3 levels may be associated with mood disturbances and depressive symptoms, potentially through mechanisms involving neurotransmitter synthesis and neuroendocrine modulation. Anglin et al. demonstrated a significant relationship between reduced vitamin D concentrations and a higher incidence of depression (Anglin et al., 2013).

Therefore, this randomized controlled trial was designed to evaluate the effects of a home-based physical training program compared with dietary therapy, sunlight exposure, and vitamin D3 supplementation on functional performance and depression among women with vitamin D3 insufficiency.

Methods

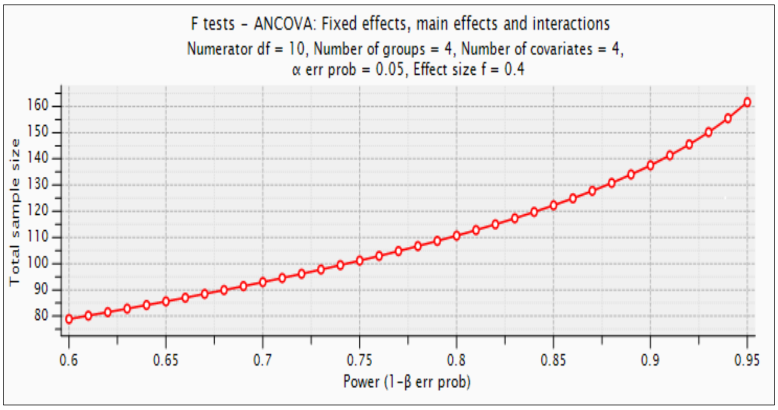
Ethics Statement

This research work was officially permitted by the Badr University in Cairo (BUC)-Institutional Ethical Committee (No: BUC-IACUC-231015-42). Respect for the principles outlined in the Helsinki Declaration was required of all researchers. Before the study began, participants were given a verbal explanation of the experiment and were asked to sign a written consent form, which included the option to withdraw from the study at any time for any reason.

Sample Size

The sample size for this study was calculated using the G*Power program version 3.1.9 (Heinrich-Heine-University, Düsseldorf, Germany) for a one-tailed test. The calculation was based on F tests (ANOVA: Special effects and interactions) Alpha level (α) = 0.05, Power = 0.85, and Effect size f = 0.40. This calculation considered a comparison of four independent groups for four major dependent variable outcomes. The study required at least participants (30 in each group) to achieve accurate results as shown in Figure (1).

Figure 1. Sample size calculation.



Study Design and Subjects

The experiment was set as a randomized controlled trial study which was carried out from November 2023 to June 2024. The females were mostly recruited by announcements and media coverage to potentially eligible females recognized and, females who had shown interest in our research (n= 235). The study sample consisted of 120 females following inclusion criteria: (aged 19-25 years). All participants were invited for vitamin D3 screening with a vitamin D3 deficit of less than 25 nmol/L and persisted for 6 months. 120 females were engaged in the experiment (Figure 2) following the exclusion of everyone who met any of the following requirements: Liver, renal endocrine, autoimmune disease, or chronic sickness, Pregnant and married females, Patients with illnesses of the heart and lungs, Past fractures or neuro-musculoskeletal conditions. A basic random sample technique was used to distribute the 120 females into 4 equal groups (n=30). Every person was given the task of choosing an envelope at random from a hidden box. The letters from groups A, B, C, and D were inside the envelope, ready to assign each subject to the target group. Randomization was performed using a computer-generated sequence prepared by an independent researcher. Group assignment was concealed using sealed envelopes (simple randomization) to prevent selection bias.

Home-Based Physical Exercise (Experimental Group A): This group of thirty individuals underwent full-body physical exercise six days a week, plus sun exposure and vitamin D supplementation for six weeks.

Dietary management (Experimental group B): For six weeks, the thirty participants in this group were given dietary management, sun exposure, and a vitamin D supplement.

Sun Exposure and Supplements (Experimental group C): For six weeks, the thirty participants in this group got solely sun exposure and their vitamin D supplement.

No Intervention (Control Group D): Thirty individuals in this group received only their vitamin D3 supplementation for 6 weeks.

Interventions

Personal data, including age, height, weight, BMI, and VIT D history, were taken, and recorded in a recording data sheet, the primary outcome of the study was a vitamin D3 blood test (Vitamin D3 Level detection in Blood by Lab Test). The Secondary Outcomes were: the Hamilton Depression Rating Scale (HAMD), 6MWD (6 Minutes' Walk Test), and the Dyspnea Borg scale. The patients were brought separately before performing the 6MWT and described the way of the survey, and then they responded to all 17 questions, and the results for each patient were calculated and written down. Comfortable clothing and appropriate shoes should be worn for walking. It is recommended to stick to the patient's regular medical schedule. Before an exam, a light supper is acceptable. Before starting the test, patients shouldn't have engaged in strenuous exercise within two hours.

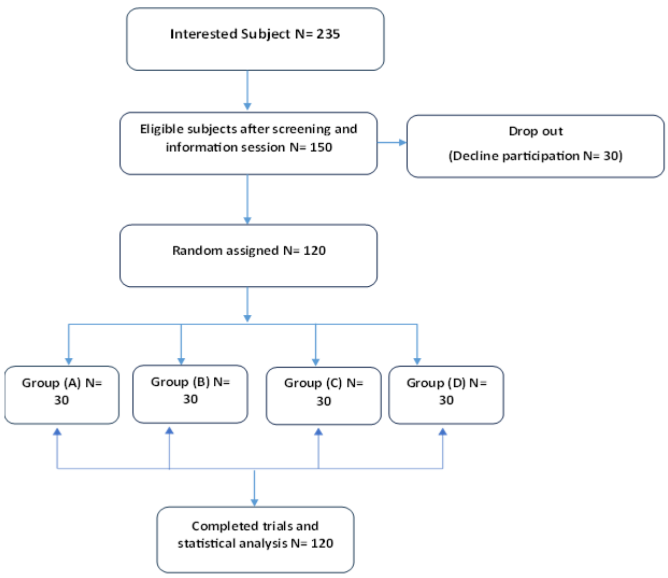
30-meter corridors and three cones (which were one at the start, one in the middle, and one at the end of the corridor) were used. The participants were ready & relaxed for 10 minutes, as well as each one stood and rated their baseline Blood pressure, pulse rate, saturation (SpO2), dyspnea, and general fatigue using the Borg scale before and after the 6MWT. The timer was set to six minutes, and the lap counter to zero. All essential equipment was assembled (lap counter, timer, clipboard, Borg Scale, worksheet) and proceeded to the beginning point. The participants were instructed about the method of applying the test and the instructions.

Thirty individuals who were randomized to the experimental group (A) were asked to regularly expose themselves to the sun for 30 minutes every day, between 8:30 AM to 10:00 AM, an early morning exposure arm: participants will expose arms and legs (≈ 20-30% body surface area) to direct sunlight (Ibrahim et al., 2015) and to take 400 IU (the suggested daily intake of vitamin D3 for an adult) (Pearce & Cheetham, 2010) of vitamin D3 supplements once daily for six weeks. Without sunscreen, exposure to the face, arms, hands, and legs. Add full body physical exercises 6 days per week (Home Based Exercise) for 6 weeks. A one-hour session of home-based exercise consists of a three-minute warm-up, nine minutes of full-body (lower, abdomen, back, and upper limbs) aerobic and strengthening activity, and three minutes of cool-down. This routine is done four times a day for a total of fifteen minutes every session. Six days with one day off for recovery, plus daily check-ins with each patient to make sure they completed all the exercises and received instructions. Aerobic training: Brisk walking, marching in place, or stepping exercises. Strengthening exercises (2–3 sets of 8–12 repetitions each): Squats or sit-to-stand from a chair. Wall push-ups. Step-ups on stairs. Resistance band rows or biceps curls (if bands available) (Cegielski et al., 2017).

An additional thirty women were assigned to diet management (Experimental group B): and received vitamin D3 supplements, dietary guidance, and sun exposure for six weeks. Milk, tuna, and yolk eggs are among the food sources of vitamin D3 that are part of the weekly diet program for females. The subjects' diet was composed of 15% proteins, 30% fat, and 55% carbs overall (Dominguez et al., 2021).

Additional 30 females allocated to sun exposure and supplements (Experimental group C): received only exposure to the sunlight as well as their vitamin D3 supplementation for 6 weeks. The last 30 females were allocated to (Control Group D): females assessed at the first and the end of the study without intervention. received only their vitamin D3 supplementation for 6 weeks.

Figure 2. Flow chart



Measurement of outcomes

Primary outcome

The serum concentration of 25-hydroxyvitamin D [25(OH)D], which is considered the most reliable biomarker of vitamin D status. Venous blood samples were obtained from participants at the start and the end of the intervention. Samples were centrifuged, aliquoted, and stored at −80°C until analysis. Serum 25(OH)D was measured using a chemiluminescent immunoassay, which has been widely validated in clinical research. Vitamin D status was defined according to Endocrine Society guidelines: deficiency (<20 ng/mL), insufficiency (21–29 ng/mL), and sufficiency (≥30 ng/mL) (Holick, 2017).

Secondary outcomes

6MWT

It determines the distance that the subject can swiftly walk on a level, firm surface in six minutes (6MWD). This test checks how the exerciser's response affects the entire system, including the systematic and peripheral circulation, respiratory and cardiovascular systems, neuromuscular elements, and muscle metabolism. Contrast cardiopulmonary exercise testing, which can deliver information regarding the different functions of all organs and systems that are included in the exercise, in addition to the mechanism of exercise restraint, the 6MWT does not deliver this information. Subjects do not reach their full capacity of exercise during the self-paced 6MWT; as an alternative, they select the exercise intensity and can stop at any instant to rest. However, the 6MWD may more accurately represent the degree of activity needed for daily life because the majority of activities of daily living are achieved at submaximal levels of effort. The important equipment includes a machine-driven lap counter, a timer (or stopwatch), three little cones to designate the locations, a chair that is portable along the walkway, worksheets on a clipboard, a sphygmomanometer, and a phone (Torres-Castro et al., 2022).

Borg scale

A modified Borg scale dyspnea score. This scale consists of 10 verbal (10 descriptions) and 12 numerical (12 descriptions) descriptions for dyspnea assessment. Patients were asked to check the boxes that best describe their dyspnea perception. The modified Borg scale is a valid and reliable assessment tool for dyspnea. (Kendrick et al., 2000).

The Hamilton Depression Rating Scale (HAMD)

There are 17 questions in this questionnaire, and each of them can be graded from 0 to 4. A rating of 0 means there is nothing wrong, and a score of 4 means the patient has serious signs of depression. In the sum of all answers, depression is classified according to intensity (0-7) there is no depression, (8-13) there is mild depression, (14-18) there is moderate depression (19-22) there is severe depression, (above 23) there is very severe depression. Satisfactory reliability and validity were detected for the Hamilton Depression Rating Scale (HAMD) (Müller & Dragicevic, 2003).

Data analysis

Initial Shapiro-Wilk tested data normality, also Levene's tested variances` homogeneity, and ensured for both. MANOVA test was compared demographic features. Mixed MANOVA had investigated therapeutic benefits on VD3, HAMD, 6MWD, also Dyspnea Borg scale measures. Post-hoc test via Bonferroni correction had checked multiple subsequent compares. Significant level was sated at <0.05 using statistical package for social studies (SPSS- windows/25), (IBM SPSS, Chicago, IL, USA).

Results

Subjects' characteristics

Table (1) represented non-statistical differences in BMI and age, also baseline clinical features of study population (>0.05).

Effect of treatment on Vitamin D3, 6MWD, HAMD and Dyspnea Borg scale:

Mixed MANOVA ensured objective benefits of time and therapeutic responses (72.27, 0.001, η^2 0.69). Remarkable time gains (986.45, 0.001, η^2 0.97). Therapeutic remarkable gains (26.41, 0.001, η^2 0.47).

Within group comparison:

By protocol end, a remarkable elevated VD3, 6MWD, obvious reduced HAMD, also Dyspnea Borg scale correlated with baseline in experimental groups (> 0.001), while nonstatistical change for group D (> 0.05). (Tables 2- 3).

Between groups comparison:

Nonstatistical differs at initial evaluation in-between groups (> 0.05). An obvious VD3 increase for experimental groups in relation to control one (< 0.05), remarkable VD3 increase of group A in favor to B and C (< 0.001), while no obvious difference between group B & C (> 0.05). There was remarkable 6MWD raised for experimental groups compared with control D (< 0.001), and obviously improved in A in favour to others B& C (< 0.001), also 6MWD remarkably improved of B in favor to C (< 0.001).

A remarkable reduced HAMD in experimental groups in compare with control D (< 0.001), with a significant reduced HAMD in both experimental A& B in favour to C (< 0.01), unless no differs in-between experimental A& B (> 0.05). An obvious Dyspnea Borg scale reduction in experimental groups, respectively in favour to D (< 0.001), and experimental A has favour reduction in Dyspnea Borg scale to experiment B& C (< 0.01), with no statistical differs between both experimental B& C (> 0.05), (Table 4).

Table 1. Demographic and clinical baseline features (120) *

	Experimental A	Experimental B	Experimental C	Group D
Age (years)	21.53 ± 1.17	21.23 ± 1.10	21.27 ± 1.11	21.37 ± 1.22
BMI (kg/m^2)	21.90 ± 1.37	21.77 ± 1.33	21.37 ± 1.22	21.27 ± 1.23
VD3 (ng/mL)	12.83 ± 4.09	13.27 ± 4.71	13.73 ± 4.93	14.07 ± 4.25
6MWD (m)	308.77 ± 6.44	307.97 ± 5.09	310.63 ± 5.92	309.47 ± 6.98
HAMD	11.93 ± 1.87	12.10 ± 1.77	12.33 ± 1.71	11.87 ± 1.57
DBS	1.63 ± 0.62	1.43 ± 0.50	1.53 ± 0.63	1.47 ± 0.57

BMI: Body mass Index; 6MWD: 6 minutes-walk distance; HAMD: Hamilton Depression Rating Scale

Table 2. Clinical features post protocol (120) *

Variable	Experimental A	Experimental B	Experimental C	Group D	F-value	p value	η^2
VD3 (ng/mL)	29.67 ± 5.89	24.23 ± 5.77	23.97 ± 5.07	14.30 ± 3.98	44.66	0.001	0.54
6MWD (m)	371.60 ± 8.80	339.93 ± 8.28	324.93 ± 6.38	311.13 ± 8.69	307.95	0.001	0.88
HAMD	5.83 ± 1.49	6.30 ± 1.26	7.60 ± 1.22	11.57 ± 1.72	98.72	0.001	0.72
DBS	0.38 ± 0.22	0.65 ± 0.37	0.73 ± 0.25	1.33 ± 0.48	40.12	0.001	0.51

BMI: Body mass Index; 6MWD: 6 minutes-walk distance; HAMD, Hamilton Depression Rating Scale; p < 0.05 significance; η^2, Partial Eta Square.

Table 3. Within groups improvements baseline vs 6 weeks of intervention.

Variable	Experimental A		Experimental B		Experimental C		Group D	
	MD (95% CI)	p value	MD (95% CI)	p value	MD (95% CI)	p value	MD (95% CI)	p value
VD3 (ng/mL)	-16.84 (-18.43, -15.24)	0.001	-10.96 (-12.56, -9.37)	0.001	-10.24 (-11.83, -8.63)	0.001	-0.23 (-1.83, 1.37)	0.77
6MWD (m)	-62.83 (-65.51, -60.16)	0.001	-31.96 (-34.64, -29.29)	0.001	-14.3 (-16.98, -11.62)	0.001	-1.66 (-3.34, 1.01)	0.22
HAMD	6.1 (5.44, 6.75)	0.001	5.8 (5.14, 6.46)	0.001	4.73 (4.07, 5.39)	0.001	0.3 (-0.35, 0.96)	0.36
DBS	1.25 (1.06, 1.43)	0.001	0.78 (0.59, 0.96)	0.001	0.8 (0.62, 0.98)	0.001	0.14 (-0.05, 0.32)	0.15

MD: Mean difference; CI: Confidence interval; p < 0.05 significance.

Table 4. Comparing post treatment mean values of VD3, 6MWD, HAMD and Dyspnea Borg scale between groups.

	Vitamin D3 (ng/mL)		6MWD (m)		HAMD		DBS	
	MD (95% CI)	P value	MD (95% CI)	P value	MD (95% CI)	P value	MD (95% CI)	P value
Group A vs B	5.44 (1.80,9.06)	0.001	31.67 (26.05, 37.28)	0.001	-0.47 (-1.46, 0.52)	0.59	-0.27 (-0.51, -0.03)	0.01
Group A vs C	5.7 (2.06, 9.33)	0.001	46.67 (41.05. 52.28)	0.001	-1.77 (-2.76, -0.77)	0.001	-0.35 (-0.58, -0.12)	0.001
Group A vs D	15.37 (11.75, 18.99)	0.001	60.47 (54.85, 66.08)	0.001	-5.74 (-6.72, -4.73)	0.001	-0.95 (-1.19, -0.72)	0.001
Group B vs C	0.26 (-3.36, 3.89)	0.99	15 (9.38, 20.61)	0.001	-1.3 (-2.29, -0.31)	0.004	-0.08 (-0.32, 0.15)	0.78
Group B vs D	9.93 (6.30, 13.56)	0.001	28.80 (23.18, 34.41)	0.001	-5.27 (-6.26, -4.27)	0.001	-0.68 (-0.92, -0.45)	0.001
Group C vs D	9.67 (6.03, 13.29)	0.02	13.8 (8.18, 19.41)	0.001	-3.97 (-4.96, -32.97)	0.001	-0.6 (-0.84, -0.36)	0.001

MD: Mean difference; CI: Confidence interval; p < 0.05 significance

Discussion

This study was conducted to determine the efficiency of home-based exercise, diet management, and sun exposure as well as their vitamin D supplement on vitamin D deficiency among female university students. The results found that there was a statistically significant increase in vitamin D3 in groups A, B, and C in comparison to Group D, while group A showed a statistically significant increase in vitamin D3 compared to groups B and C and there was no statistically significant difference between groups B and C. Furthermore, the statistically significant increase in 6MWD was obvious in the three experimental groups in comparison to group D with a statistically significance increase in group A in comparison to groups B and C while group B showed a statistically significant increase than group C. Moreover, there was a statistically significant decrease in HAMD in the three experimental groups in comparison to group D and there was a statistically significant decrease in HAMD of group A and group B in comparison to that of group C while there was no statistically significant change between group A and group B. In addition, there was a statistically significant decrease in the Dyspnea Borg scale of the three experimental groups in comparison to the control group and a statistically significant reduction in group A compared with that of group B and group C but there was no statistically significant difference between groups B and C.

As vitamin D3 is censoriously important for the skeleton integrity among other body tissues and functions, geography and recognized risk factors should be taken into consideration when evaluating screening recommendations and supplementation suggestions for adolescents (Alharthi, 2020). Vitamin D3 deficiency is very high among females, possibly due to a sedentary lifestyle and low milk consumption. So recommended for vitamin D3 deficiency studies (Elshafie et al., 2012).

Agreement with previous randomized trials demonstrated that Vitamin D3 supplement was better than advised exposure to sunlight for treating vitamin D3 shortage. More doses may be required in subjects with high BMI. However, there was no significant effect on physical performance and functional limitations between women (Wicherts et al., 2011). The results of our current study, which found that home-based exercise was superior in improving vitamin D3 and functional performance level, were consistent with Hoseini et al. (2020) suggestion that exercise and vitamin D3 supplements had an advantage in controlling weight gain in elderly women with vitamin D3 deficiency and improving the functional performance. In addition, several studies found that vitamin D3 therapy should be given to women with inadequacy or shortage to improve muscle strength, gait speed, body sway, and mobility (Zhu et al., 2010; Bunout et al., 2006).

Consistent with our findings, Al-Othman et al. (2012) reported that vitamin D3 deficit is common among children and teenagers and is affected by both exposure to sunlight and physical activity. The epidemic of vitamin D3 deficiency may be prevented if children are encouraged to lead active outdoor lifestyles in both their homes and schools. So, they recommended that all groups, especially the most physically active and sun-exposed, take vitamin D3 supplements. Deal with a previous study that concluded that the most significant indicators of vitamin D3 deficiency in Vietnamese people were low dairy intake and no physical activity.

Increased physical activity and dairy intake play a role because these women might not get enough exposure to the sun because of get-dressed uses or cultural norms that promote fair (untanned) skin (von Berens et al., 2018; Fischer et al., 2023). These previous studies explained the importance of a combination of physical activity and sun exposure with vitamin D3 supplements in improving functional performance as proved by the results of our study.

A study conducted by Zhang and Cao (2022) showed that exercise type and intensity, sex, and vitamin D3 nutritional status were just a few of the elements that may affect how exercise affects blood levels of 25(OH)D. Another study recommended that moderate-intensity exercise was enough to reduce depressive symptoms as proved by the results of our study (Xie et al., 2021).

Previous reviews mentioned that Vitamin D3 shortage has been related to chronic physical problems, lesser mental health, depression, as well as psychotic disorders. Even though there is some indication that a developmental deficiency in VD may be related to the risk of psychosis, there is little factual support for the theory that VD is a potential cause of depression rather than its outcome. So, they recommended that researchers also need to consider studying the critical role of VD in depression, in designing any future research to treat depression (Boulkrane et al., 2020).

The results of our study demonstrated that the physical exercise combined with vitamin D supplements and sun exposure had the same result as the dietary control with vitamin D supplements and sun exposure in improving the depression score, but it was better than the vitamin D supplements and sun exposure. Agreement with a previous study found that vitamin D supplementation and exercise (especially outdoors) have positive effects on depressed women with vitamin D deficiency (Irandoust, K., & Taheri, 2017).

According to a study that inspected the impact of exercise on vitamin D3 levels in female participants, group A, who consumed a healthy diet, did not experience a statistically significant change in their vitamin D3 levels. However, the vitamin D3 level rose to 70% of the baseline value in group B, which received a vitamin D3 supplement added to a balanced diet. In the second group, C, the level of vitamin D3 climbed three times the first reading and 50% of the participants reached the normal range when activity was coupled with vitamin D3 tablets and nutritious meals. For women, exercise has a significant impact on vitamin D3 levels (Lips et al., 2014).

In line with the findings of our study, which showed that diet control and sunlight exposure had a greater impact on vitamin D3 status than did sun exposure and supplementation alone, Lips et al.. (2014) discovered that a mixture of exposure to sunlight, good nutrition, food protection, and vitamin D3 supplements is necessary to obtain adequate vitamin D3 status in the people of most countries through the year.

Also, Pasco et al. (2001) recommended dietary intake (RDI) for vitamin D may be needed in adult women. A previous study demonstrated that increased ingestion of marine food substances that provide vitamin D3 should be encouraged among middle-aged females in northern.

Carswell et al. (2018) stated that almost all participants in a randomized, placebo-controlled trial were able to achieve clinically significant vitamin D3 adequacy in either safe, simulated summer sunshine or oral vitamin D3. Nevertheless, supplementation with vitamin D3 did not enhance exercise performance, indicating that vitamin D3 has no direct impact on exercise performance. It is advised that more research be done to determine how nutrition management and at-home exercise regimens can improve vitamin D3 deficiency in teenage girls.

Limitations

Despite these encouraging findings, some limitations should be acknowledged. The sample size was limited to a narrow age group, gender, and the short study duration precluded long-term outcome evaluation. Future research should involve larger, more diverse samples and examine molecular mechanisms linking vitamin D3 to psychological and physical health.

Conclusions

The current study examined the effects of vitamin D3 supplements, sun exposure, and physical activity at home versus diet control, to manage vitamin D3 efficiency among female university students. The results showed that the combination of physical activity, sun exposure, and vitamin D3 supplements was more effective than diet control in enhancing participants' functional performance, and vitamin D3 levels. But there was no statistically significant change between group A and group B in HAMD.

fully comprehend the many therapeutic effects in demonstrating vitamin D 3 shortage and its impact on functional and psychological performance, more research is required.

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Informed Consent Statement

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