

Effect of Resisted Exercise on Vitamin D Levels in Obese Insulin Resistant Patients

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Abstract

Background: Vitamin D is crucial in regulating calcium and phosphorus absorption, skeletal metabolism, and immune system function. This study aimed to investigate the impact of resisted muscle exercise on vitamin D levels in obese insulin-resistant patients, assessed through blood level vitamin D tests and HOMA-IR.

Patients and Methods: Fifty-two female patients aged between 30 and 40 years, with a BMI between 30 and 39.9 kg/m², participated in the study. They were randomly assigned to two groups: Group A received vitamin D supplements, resisted exercise, and a balanced diet, while Group B received vitamin D supplements and followed a balanced diet. Both groups were evaluated using the same methods.

Results: Both groups demonstrated significant improvements in all outcome measures compared to baseline ($p < 0.05$). However, Group A showed greater improvements in insulin resistance (mean difference -0.96; $p = 0.001$) and vitamin D levels (mean difference 7.79 ng/ml, $p = 0.001$) compared to Group B after the intervention.

Conclusion: Resisted exercise effectively improves insulin resistance and vitamin D levels in middle-aged women with vitamin D deficiency. The combination of exercise and vitamin D supplementation may offer greater benefits than either intervention alone.

Keywords: Vit D level; Obesity; Insulin Resistant; Resisted Exercise

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Introduction

Obesity has become a global health concern, characterized by the excessive accumulation of fat, which not only reduces life expectancy but also poses significant health risks. According to data from the World Health Organization (WHO), in 2020, more than 1.9 billion individuals have a body mass index (BMI) exceeding 25 kg/m², with over one-third of them classified as obese with a BMI of over 30 kg/m²[1]. This epidemic of obesity is closely linked with an increased risk of various chronic conditions, including Type 2 diabetes, cancer, metabolic syndrome, hypertension, and hyperlipidemia, all of which entail substantial direct and indirect financial costs [2]. Adipose tissue, a vital carbohydrate and lipid metabolism organ, exhibits heightened responsiveness to insulin. Obesity significantly elevates the risk of insulin resistance and subsequent development of Type 2 diabetes (T2D) [3]. Insulin resistance refers to a condition where insulin's effectiveness in promoting glucose utilization is diminished, leading to compensatory hyperinsulinemia, where pancreatic cells

produce and secrete more insulin while maintaining normal glucose tolerance [4]. A clear and important relationship between insulin resistance and vitamin D levels indicates that vitamin D plays a crucial role in promoting optimal insulin secretion. The presence of vitamin D receptors on pancreatic beta-cells provides evidence for this claim [5]. Vitamin D is a liposoluble vitamin that is primarily found in two forms: D2 (ergocalciferol), which is received through diet, and D3 (cholecalciferol, commonly known as 25(OH)D), which is formed in the skin when exposed to UV light [6].

Appropriate vitamin D (vit D) levels are necessary for healthy growth and development. It is crucial for regulating the metabolism of bones and calcium levels. Moreover, recent studies indicate that hypo vitamin D's non-calcitropic effects—the immune system, endocrine pancreas, liver, skeletal muscle, and adipocyte regulation—harm long-term health. As it happens, low vitamin D levels are associated with a number of chronic conditions and diseases, including obesity and some types of cancer [7].

The presence of vitamin D3 in body fat compartments hampers its absorption from both dietary and cutaneous sources, which is believed to be a contributing factor to vitamin D insufficiency associated with obesity [8]. Studies have demonstrated that exercise treatments not only increase muscle growth, function, and mobility but also boost the anabolic effects of leucine and promote better functional results when combined with vitamin D supplementation [9]. Resistance exercise triggers physiological stimuli and molecular signaling cascades that lead to certain physiological changes, such as enhanced glucose storage, increased skeletal muscle mass, and decreased risk of diabetic complications [10].

The objective of this study is to investigate the therapeutic benefits of resistance exercise combined with vitamin D supplementation in improving vitamin D levels and insulin resistance, thereby reducing the risk of chronic diseases, enhancing musculoskeletal health, and improving overall quality of life.

Materials and Methods

Study design

This randomized experiment used a 1:1 allocation ratio to ensure equal representation in each research group. From April to December 2023, the study enrolled obese women with insulin resistance who were patients at Qena General Hospital and had insufficient levels of vitamin D. Throughout the research treatments, strict adherence to local protocols for managing insulin resistance and vitamin D insufficiency was upheld.

Sample size calculation

G*power software and a previous, similar study were used to establish the sample size based on power analysis [11]. The significance threshold (0.05) and power (0.80) were established. After accounting for possible dropouts, the

sample size was raised by 20% from the 26 participants that the calculation produced; 52 people participated.

Randomization

Every participant in the study was randomly assigned to one of the two groups using a random generator, which ensured an unbiased and equitable allocation procedure. After confirming enrollment, patients were immediately informed of their allocated therapy group to provide transparency and enable informed participation.

Study Subjects

The study included 52 individuals who were obese and between the ages of 40 and 50. Their BMI varied between 30 and 39.9 kg/m². Twenty-six obese female volunteers were chosen from the outpatient clinic at Qena General Hospital to be divided into two groups, Group A and Group B.

Group Allocation

Group A comprised female volunteers who were obese and had been referred due to signs of insulin resistance and vitamin D insufficiency. The group undertook a thorough intervention program, which included the administration of vitamin D supplements, engaging in resistance exercise training, and maintaining adherence to a well-balanced diet.

Group B consisted of obese female participants who were given a vitamin D supplement in addition to adhering to a balanced eating plan. This group served as the control group for comparison with Group A.

Inclusion Criteria

Volunteers meeting the following criteria were eligible for participation in the study:

- Age between 30 and 40 years.
- Body mass index (BMI) ranging from 30 to 39.9 kg/m².
- Female sex.
- Vitamin D levels below 20 ng/ml, as per established guidelines [12], and Presence of insulin resistance, indicated by HOMA-IR levels between 1.82 and 3.63 [13].

Exclusion Criteria:

Patients meeting any of the following conditions were excluded from the study:

- Diabetes diagnosis.
- Osteoporosis diagnosis.
- Acute infections or deep vein thrombosis (DVT).
- Neurological or orthopedic conditions that impede participation in exercise.
- Acute ulcers or arterial wounds present on the lower limb.

Ethical considerations

Before participation, each patient will be provided with a comprehensive description of the treatment plan's methods and the instruments utilized for measurements, ensuring informed consent. Furthermore, every patient will receive detailed information on the goals and aims of the treatment. Before their enrollment in the study, all participants will be required to provide written informed permission.

Ethical Approval

The study's procedure has received ethical approval from the Faculty of Physical Therapy's Ethical Committee for Scientific Research, protocol number P.T.RTC/012/004559. This guarantees that the study adheres to ethical standards and protects the rights and welfare of the participants.

Evaluations

Clinical examination and medical history

Initially, each patient in the two groups had a thorough history obtained. To calculate the BMI, each volunteer in groups A and B had their height, weight, and BMI measured while wearing light clothing and bare feet.

Clinical outcome measure

The blood sample was taken from participants to evaluate vitamin D levels and insulin resistance (homa IR) before and after treatment.

Interventions

Pharmacological treatment

All participants received a prescription from a physician following the pharmacological protocol, calling for a daily vitamin D dosage of 2000 IU [14].

Resisted exercise

On the first day, participants were required to warm up with a set of conventional stretches for 15 min. Instruction on appropriate lifting techniques up to an estimated 1RM was given to the participants. We will begin with low-intensity resistance exercises (40–50% of 1RM, or working until fatigued): leg curls, leg extension, chest press, chest fly, seated row, lateral pull-down, biceps curls, triceps overhead extension, and triceps pushdown. The program should advance to moderate (60%–70% of 1RM) if the person has more experience exercising or when their discomfort and weakness improve. Then, it should progress to high intensity (80% of 1RM). For 12 weeks, these workouts should be done three times/week, with 10 to 15 repetitions; the main muscle it is important to work on the hip and core muscle areas. Then end the exercise by 15 min as a cooling down (**Figure 1**) [15].



Figure 1. Leg extension exercise/leg curls exercise/ Lateral Pull-Down Exercise.

Analytical statistics

The unpaired t-test was used to compare subject characteristics between groups, while the Shapiro-Wilk test was used to check the normality of the data distribution. Levene's test was used to assess the homogeneity of variances among the groups. A two-way mixed MANOVA was used to examine the impact of vitamin D and HOMA-IR on both within-group and between-group effects. Several comparisons were conducted after applying Bonferroni adjustments. The statistical tests were performed with a significance level of $p < 0.05$. The statistical analyses were conducted using IBM SPSS version 25 of the Statistical Program for Social Sciences (SPSS), which is situated in Chicago, IL, USA.

Results

This study examined the impact of resistive exercise on vitamin D levels in obese individuals with insulin resistance. Before and after the treatment program, data on vitamin D and the Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) were gathered from both groups.

General characteristics of the subjects

The group A average was 35.76 ± 3.29 years, 160.57 ± 2.36 cm, and 99.03 ± 4.07 kg for age, height, and weight, respectively (**Figure 1, Table 1**).

The group B average was 36.53 ± 2.92 years, 160.65 ± 2.26 cm, and 100.73 ± 4.91 kg for age, height, and weight, respectively (**Figure 2, Table 1**).

Table 1 shows the topic characteristics of groups A and B. There were no significant differences in age, weight, height, or BMI between the groups ($p > 0.05$).

Table 1. The average age, height, and weight of groups A and B compared to one another.

	Group A	Group B	MD	t-value	p-value	Sig
	X ± SD	X ± SD				
Age (years)	35.76 ± 3.29	36.53 ± 2.92	-0.76	-0.89	0.37	NS
Height (cm)	160.57 ± 2.36	160.65 ± 2.26	-0.07	-0.12	0.90	NS
Weight (kg)	99.03 ± 4.07	100.73 ± 4.91	-1.69	-1.35	0.18	NS

X ± SD: Mean and standard deviation; MD: Mean difference; NS: non-significant; t-value: Un-paired t-test value; p-value: Probability value

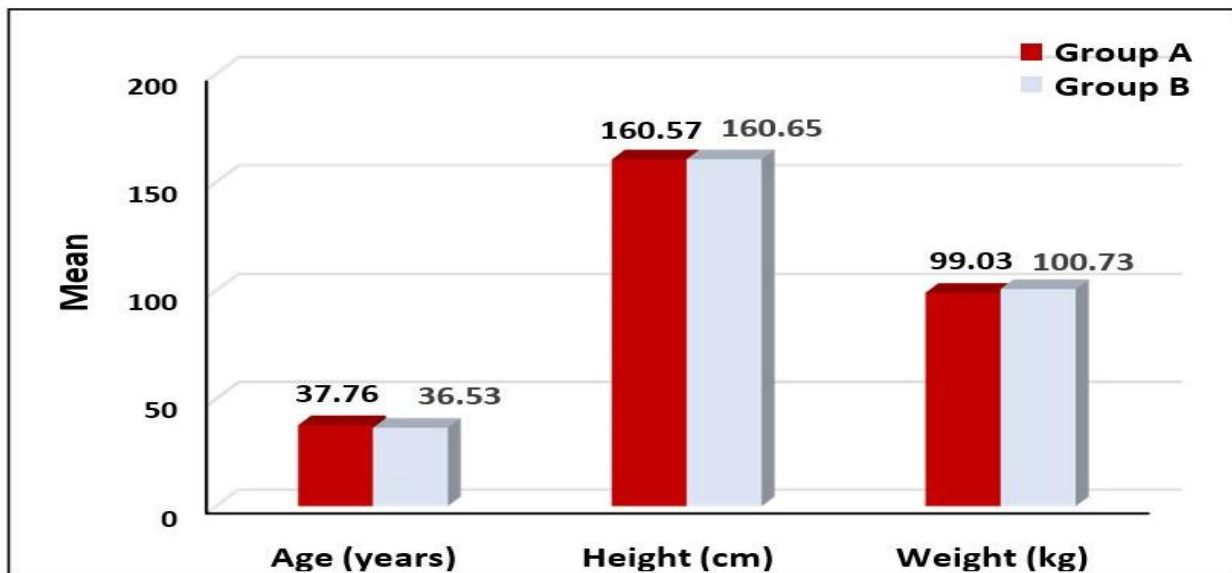


Figure 2. Mean age, height, and weight between group A and group B. Comparing groups within Group A

Group A had a mean ± SD of 11.72 ± 2.32 ng/ml of vitamin D pre-therapy and 33.65 ± 4.48 ng/ml post-treatment. The percent of change was 187.11%, and the mean difference was -21.93 ng/ml. Vitamin D levels significantly increased (p = 0.001) between pre- and post-therapy (**Figure 2, Table 2**). Pre-therapy, mean ± SD HOMA-IR was 2.97 ± 0.11 and was 0.72 ± 0.11 post-treatment. The percent of change was 75.75%, and the mean difference was 2.25. When comparing HOMA-IR post-treatment to pre-treatment, there was a substantial drop (p = 0.001) (**Table 3, Figure 3**).

Group B

Group B had a mean ± SD of 11.78 ± 2.03 ng/ml of vitamin D pre-treatment and 25.86 ± 5.10 ng/ml post-treatment. The percent of change was 119.52%, and the mean difference was -14.08 ng/ml. Vitamin D levels showed a statistically significant increase (p = 0.001) between pre- and post-therapy (**Figure 2, Table 2**). Before and after therapy, the mean ± SD HOMA-IR was

2.92 ± 0.16 and 1.68 ± 0.17, respectively. With a percentage of change of 42.46%, the mean difference was 1.24. When comparing HOMA-IR after treatment to its baseline level, there was a substantial drop (p = 0.001) (**Table 3, Figure 3**).

Table 2. Mean vitamin D levels before and after therapy for groups A and B.

Vitamin D (ng/ml)	Pre-treatment X ±SD	Post-treatment X ±SD	Mean difference (MD)	% of change	P-value	Sig
Group A	11.72 ± 2.32	33.65 ± 4.48	-21.93	87.11	0.001	S
Group B	11.78 ± 2.03	25.86 ± 5.10	-14.08	19.52	0.001	S
MD	-0.06	7.79				
P-value	0.92	0.001				
Sig	NS	S				

X ± SD: Mean and standard deviation; S: Significant; NS: Non significant; p-value: Probability value.

Table 3. Mean HOMA-IR pre and post-treatment of group A and group B.

HOMA-IR	Pre-treatment X ±SD	Post-treatment X ±SD	Mean difference (MD)	% of change	P-value	Sig
Group A	2.97 ± 0.11	0.72 ± 0.11	2.25	75.75	0.001	S
Group B	2.92 ± 0.16	1.68 ± 0.17	1.24	42.46	0.001	S
MD	0.05	-0.96				
P-value	0.20	0.001				
Sig	NS	S				

X ± SD: Mean and standard deviation; S: Significant; NS: Non significant; p-value: Probability value.

An analysis comparing the two groups (A and B)

Pre-treatment

The mean vitamin D differential between groups A and B before therapy was -0.06 ng/ml. There was no significant difference in vitamin D levels between the groups before therapy (p = 0.92) (**Figure 4**). Before therapy, groups A and B's HOMA-IR mean differences were 0.05. There was no significant difference in HOMA-IR between the groups before therapy (p = 0.20) (**Figure 5**).

Post-treatment

Following treatment, there was a 7.79 ng/ml mean difference in vitamin D levels between groups A and B. Following treatment, group A's vitamin D levels were substantially higher than those of group B (p = 0.001) (**Figure 4**). Following treatment, group A and group B had a mean HOMA-IR difference of -0.96. Following treatment, group A's HOMA-IR dropped considerably less than group B's (p = 0.001) (**Figure 5**).

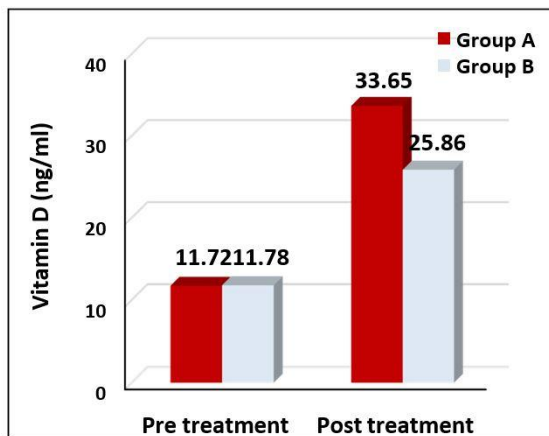


Figure 4. Mean Vitamin D pre and post-treatment of both groups

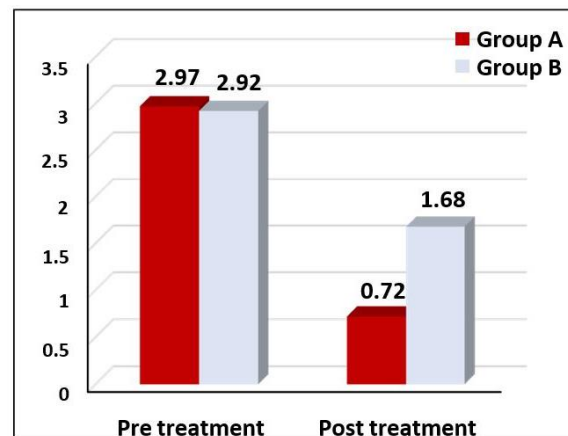


Figure 5. Mean HOMA-IR pre and post-treatment of both groups.

Discussion

Our study explores the possible therapeutic benefits of combining resistance exercise with vitamin D supplementation for obese adults with insulin resistance in order to improve their metabolic health. The widespread influence of obesity on worldwide health emphasizes the need for therapies focused on reducing its related problems, such as insulin resistance. Our study aims to add to the continuing discussion on effective treatment options by examining the combined effects of resistance exercise and vitamin D supplementation on several metabolic markers. Expanding on previous research that has explained the separate advantages of exercise and vitamin D, our study aims to discover new information on how the combined strategy might effectively improve metabolic health and decrease the likelihood of chronic illnesses. Our study aims to use a careful examination of metabolic indicators to understand the specific ways in which these therapies work together to produce positive outcomes. This research has the potential to provide insights into individualized therapy approaches for obese persons with insulin resistance.

We conducted a study to explore the therapeutic benefits of resistance exercise in combination with vitamin D supplementation for improving vitamin D levels in obese persons who are struggling with insulin resistance. The results of our study revealed a significant improvement in several metabolic parameters, such as vitamin D levels, HOMA-IR, fasting blood glucose, fasting insulin, HbA1c, BMI, and fat mass in Group A. Group A underwent both resistance exercise and vitamin D supplementation. At the same time, Group B only received vitamin D supplementation. The difference between the two groups was statistically significant ($p < 0.05$). These results align closely with previous studies, emphasizing the combined effect of exercise and vitamin D supplementation on metabolic health.

Artaza-Artabe et al. [16] conducted a thorough investigation exploring the

complex relationship between physical exercise and vitamin D supplementation. Their results closely correspond with ours, indicating that the combination strategy of physical activity and vitamin D supplementation has great potential for improving musculoskeletal health and general metabolic performance. Their investigation corroborates our findings, offering more evidence of the advantageous impacts of this combined intervention approach. Furthermore, Farag et al. [17] discovered convincing data suggesting that vitamin D supplementation, especially when combined with physical exercise, can increase life expectancy. Their randomized controlled experiment highlights the significant health advantages provided by the combination of vitamin D administration and exercise, stressing the crucial role of this dual strategy in improving overall well-being. This study strengthens the importance of our discoveries, emphasizing the many advantages of physical activity and vitamin D supplementation for general health.

Insights obtained from Zhang and Cao. [18] provide a better understanding of the intricate connection between resistance training and blood 25(OH)D levels in persons with a shortage of vitamin D. Their findings emphasize the need for more studies to clarify the fundamental processes that drive this association. Nevertheless, our work provides vital insights into the combined impacts of exercise and vitamin D supplementation on metabolic health, contributing to the expanding body of knowledge in this area.

Moreover, the research conducted by Bird and Hawley [19] demonstrated significant enhancements in insulin sensitivity and resistance as a result of resistance training, highlighting its beneficial influence on total insulin sensitivity.

In a meta-analysis done by Li et al. [20], it was shown that resistance training led to significant improvements in HOMA-IR, especially in older groups. The results emphasize the capacity of resistance training to improve insulin sensitivity and metabolic health, especially in people who are prone to insulin resistance. Although the findings vary, our study provides significant insights into the existing data that supports the positive benefits of resistance exercise and vitamin D supplementation on metabolic health.

In contrast to these findings, Lee. [21] observed that overweight and obese teens did not show any noticeable enhancement in insulin sensitivity or fasting insulin levels after engaging in resistance exercise. This emphasizes the intricate nature of metabolic reactions to exercise treatments, and it also emphasizes the necessity for customized strategies that are specifically designed to meet individual requirements and attributes. Although there are differing outcomes, our research adds to the increasing amount of evidence that supports the therapeutic effectiveness of resistance exercise combined with vitamin D supplementation in enhancing metabolic health and lowering the likelihood of chronic diseases in obese individuals with insulin resistance.

Our work provides useful insights into the therapeutic potential of combining

resistance exercise with vitamin D supplementation to improve metabolic health in obese adults with insulin resistance. Additional investigation is necessary to clarify the fundamental processes and enhance intervention approaches to maximize the combined advantages of exercise and vitamin D supplementation in this group.

Conclusion

The study's findings indicated that while using a vitamin D supplement in conjunction with resisted exercise is more effective than using a vitamin D supplement alone, using a vitamin D supplement in patients who have a vitamin D deficiency, insulin resistance, and obesity appears to have clinically meaningful therapeutic outcomes on vitamin D level and insulin resistance.

Recommendations

The present study's findings propose many suggestions for future investigation. Firstly, further research is required to examine the precise effects of resistive exercise on vitamin D levels in diabetic obese people. This research has the potential to provide useful knowledge on the therapeutic advantages of exercise therapies designed specifically for this particular group of people. Furthermore, further research is necessary to investigate the impact of resistance training on vitamin D levels in obese, diabetic adolescents. Further investigation with diverse outcomes might enhance our comprehension of the intricate relationship between physical activity, vitamin D, and metabolic well-being in this specific group, considering their distinct physiological traits and health concerns.

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Authors' contributions

Odetta Ashraf Morris, Mona Ahmed Abdelwahab, Akram Abd Elaziz, Fatma Abd Elkader Atta, and Mona Abdelraouf Ghallab contributed to the manuscript's conceptualization, methodology, investigation, and drafting. Mona Ahmed Abdelwahab, Akram Abd Elaziz, Fatma Abd Elkader Atta, and Mona Abdelraouf Ghallab contributed to supervising and reviewing the manuscript. All authors read and approved the final manuscript.

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Availability of data and material

The data are available upon request.

Consent for publication

Not applicable.

Conflict of interest

No conflicts of interest.

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