Exergaming and Mediterranean Diet on Body Weight after Total Thyroidectomy

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KEYWORDS

Thyroidectomy, Exergaming exercises, Mediterranean diet, Body weight.

ABSTRACT

Objective: To investigate the effect of exergaming exercises and the Mediterranean diet on body weight in thyroid cancer patients following total thyroidectomy.
Design: Two-group pretest-posttest experimental design.
Setting: Damnhour Oncology Centre (Beheira governorate) and general surgery department, Kafr El-Sheikh University
Participants: Forty participants (18-55 years) with papillary thyroid carcinoma were randomly assigned to experimental group (A) and experimental group (B).
Intervention: Experimental group (A) received exergaming exercise and thyroid hormone replacement therapy, while experimental group (B) received the Mediterranean diet and thyroid hormone replacement therapy. All participants received three sessions per week for 12 weeks.
Main measures: Body weight and body mass index (BMI) were measured at baseline and after 12 weeks of intervention.
Results: There were statistically significant differences between exergaming and MedDiet groups post-treatment in body weight, with means equal to 73.8 and 80.15 kg, respectively. Also, in BMI, the means were 25.2 and 29.29 kg/cm², respectively, with more favor to the exergaming group ($P < 0.05$). At the end of three months of intervention, all the outcome measures were significantly improved in the exergaming and Mediterranean diet groups ($p < 0.001$).
Conclusion: Both exergaming exercises and the Mediterranean diet significantly improved body weight and BMI with more favor to exergaming group A ($P< 0.05$).
The findings of this study suggested that exergaming exercises might be considered an enjoyable alternative to routine exercises that improve body weight and BMI**.**

1. Introduction

Thyroid cancer (TC) is the most prevalent endocrine malignant tumor and represents 3–4% of all human tumors; its incidence has significantly increased in the past few years[1]. It is also considered the 5th most common tumor in females [2]. Estrogen may play a role in the pathogenesis of thyroid neoplasm [3]. In Egypt, thyroid cancer represents about 1.5% of all cancers and constitutes about 30% of endocrine malignancies. The rate among Egyptian females is 0.0027%, with the female-to-male ratio being less than three [4]. Several environmental factors may increase the incidence of thyroid cancer. These factors include modified iodine intake, lifestyle-associated risk factors, exposure to various toxic compounds, pollutants, xenobiotics, nutritional deficiencies, eating habits, and comorbidities [5]. Thyroid carcinoma has many types; the most common histological type is papillary thyroid carcinoma (PTC), which accounts for about 80% of TC patients [6].

Total thyroidectomy is the surgical procedure in which the whole thyroid is removed. Long-term thyroid-stimulating hormone (TSH) suppression therapy in differentiated thyroid cancer (DTC) patients after surgery can lead to drug-induced subclinical hyperthyroidism[7]. Eighty percent of patients with marked subclinical hyperthyroidism exhibit changes in body mass and bone mineral density and also experience weight gain, fatigue, neck pain, weakness, and tiredness, which compromise daily activities, contributing to a decrease in quality of life [8].

Physical inactivity is the fourth leading cause of global mortality. Lack of time to exercise is the main excuse for being physically inactive [9]. Finding exercises that are more motivational, encouraging,

and time-efficient has been a challenging task for researchers. Virtual reality exercises, or exergaming, for example, can combine exercise and gameplay into a virtual environment to promote greater physical activity among users. Some people get greater enjoyment and feel more positive toward exergaming than other forms of physical exercise[10]. Exergaming can boost energy expenditure during exercise and provide low to medium levels of exercise and positive social effects[11]. Exergaming is an acceptable method for exercising among older adults. It is also safe, easy to use, and enjoyable. Exergaming consoles are relatively inexpensive[12].

The Mediterranean diet (MedDiet) combines foods rich mainly in antioxidants and anti-inflammatory nutrients. The Mediterranean diet primarily consists of fruits and vegetables, which have a lower energy density. The Mediterranean diet is rich in fiber; thus, it enhances satiety, makes subjects feel full for a longer time, and can lead to weight loss. MedDiet improved long-term lifestyle changes [13]. For all of these reasons, it has been included among the most beneficial dietary approaches to prevent major noncommunicable diseases, such as cardiovascular diseases (CVDs), type 2 diabetes mellitus (T2DM), chronic kidney diseases (CKDs), and cancer[14].

The Mediterranean diet (MedDiet) has a beneficial effect in the prevention and management of various endocrine disorders, including thyroid disorders, gonadal disorders, and neuroendocrine tumors. The MedDiet has been associated with a decreased risk of nodular thyroid disease and thyroid cancer[5]. The Mediterranean-style dietary pattern has demonstrated its effectiveness in addressing the obesity epidemic and its associated consequences, such as cardiovascular diseases and cancer, globally [15].

Previous studies have demonstrated that exergaming exercises and the Mediterranean diet are effective in treating various disorders. Virtual reality exercise was proven to be effective on adolescents with overweight and obesity[16], neurocognitive disorders[17], paraplegia[18], type 2 diabetic men[19], and shoulder impingement syndrome[20]. The Mediterranean diet is associated with lower rates of incident diabetes[21], cancer[22], and children and adolescents with irritable bowel syndrome. Research on the impact of a Mediterranean diet on body weight and BMI in thyroid cancer patients following a total thyroidectomy remains limited. Therefore, this study aimed to investigate the effect of exergaming exercises versus the Mediterranean diet on body weight and BMI in thyroid cancer patients following total thyroidectomy.

Methods

- ***Settings***

All referred patients with total thyroidectomy were screened for eligibility to participate in this study according to inclusion criteria. Seventy nine participants were recruited from Damnhour Oncology Centre (Beheira governorate) (thirty participants) and the general surgery department of Kafr El-Shaikh University (49 participants). Thirty nine participants were excluded for different reasons, didn't meet the inclusion criteria, and declined to participate, as shown in the flow chart in Fig. 1. The study was conducted at private physiotherapy clinics between March 2022 and July 2023. Forty adult participants from both genders were selected based on the study's inclusive criteria: their ages ranged from 18 to 55 years, they had a history of papillary thyroid carcinoma diagnosed by an endocrinologist, and they received thyroid hormone medication after thyroidectomy. Lack of radioactive iodine treatment within the past 6 months, blood hemoglobin level >10 g/dL, lack of regular exercise, and dose of levotroxine drug should be controlled by the therapist. Exclusion criteria were abscess or inflammation suspected by preoperative tests, participants with stage IV cancer, history of head or neck malignancy, radiation therapy, patients with a history of Graves disease, patients with a history of thyroiditis, orthopedic and rheumatic conditions of the neck, and the patient's inability to cooperate.

- ***Sample size calculation***

Sample size calculation was done, as reported from the pilot study, with 95% power at $\alpha = 0.05$ level, number of measurements 2, for two groups, and effect size = 0.5 using F-test repeated measure MANOVA within and between interaction effects. The sample size was calculated using the G*Power software (version 3.0.10).

- ***Randomization***

Forty adult participants from both genders were randomly allocated equally into two groups randomized by the first author (M.M.E). Allocation was done by using separate envelopes.

- ***Outcome measures***

Outcome measures were measured at baseline and after 3 months of treatment.

Body weight: It was measured by the Doran DS5100 Physician's Scale. It is a digital scale that offers a variety of features that make it a convenient and accurate tool for measuring patient weight and height [23]. The device was calibrated by the author at the beginning of the study. The Doran DS5100 Physician's Scale is a valid, reliable, and accurate tool for measuring weight in medical settings [24, 25].

BMI: The BMI was calculated by dividing an adult's weight in kilograms by their height in meters squared [26].

- ***Intervention***

After the baseline measurements, the treating author proceeded with the intervention according to group allocation; all groups received hormonal replacement therapy.

The experimental group (A) received exergaming exercises and thyroid hormone replacement therapy. The treatment was administered 3 sessions a week for 12 weeks (36 sessions). The participants practiced 50 minutes per session, including the realization of the games and the rest between activities.

The experimental group (B) received MedDiet and thyroid hormone replacement therapy. All participants participated in the MedDiet intervention for 12 weeks. They received recommended dietary training from professional nutritionists at the baseline visit. Adherence to diet was measured 3 times through the 12 weeks of intervention by the Arabic adaptation of the MedDiet questionnaire[27] and the mean of the 12 weeks' measurements was taken for each participant [28].

The games chosen for the intervention sessions were as follows:

Wall breaker: The objectives of this game are to improve coordination, agility, and the velocity of breaking blocks with the upper limbs. Players are scored as a function of execution time: The faster the execution, the higher the score[29]. These skills are required to reach the cubes projected in front of the player, who performs alternating and crossed movements of the upper limbs, as shown in **Figure 2 (a,b).**

Stomp: The objective of Stomp is to improve the coordination and agility of the player to step on the lights that appear around him by performing anterior and lateral movements of the lower limbs, adjusting the position of the arms during these movements, and maintaining orthostatic postural balance [19], as illustrated in **Figure 2 (c,d)** [29] .

Run the World: the game Run the World, which simulates distance walking of 400 m, had its condition determined by the game, performing knee and hip flexion movements. This game was added to increase workload and minimize any possible disinterest of the participants[29]. The objective of this game is to promote the improvement of cardiovascular fitness and well-being through a walking simulation. The distance is determined by the game, and the player performs knee and hip flexion movements as shown in **Figure 2 (e,f).**

The three games are part of the Your Shape Fitness Evolved 2012 game. "Wall Breaker'' and "Stomp It'' were used in the first sessions to promote repetitive movements of the upper and lower limbs, as well as generate less reported fatigue. The first 18 intervention sessions were carried out with nine repetitions of the game Wall Breaker, which aims to improve coordination, agility, and speed. After the volunteers had a rest, nine repetitions of the game ''Stomp It'' were included.

In the last 18 sessions, the game "Run the World" was added. This game was added to the study to minimize the possible lack or loss of interest among the volunteers[18].

Statistical analysis

The measured variables were statistically analyzed and compared using SPSS for Windows version 23 (SPSS, Inc., Chicago, IL) with an alpha level set at 0.05. Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. The Shapiro-Wilk test for normality showed that the measured variables were normally distributed ($p > 0.5$). Data are expressed as mean and standard deviation for all outcomes except for gender (counts). Two-way mixed design MANOVA was used to compare the groups on the combined effect of all outcomes. When MANOVA shows statistically significant results, follow-up univariate ANOVAs with Bonferroni correction were performed for every outcome measure to protect against type I error.

Results:

The data in **Tables (1&2)** showed no difference between both groups in demographic and baseline characteristics of patients ($p >0.5$).

Mixed design multivariate analysis was conducted to assess the difference between participants in the two groups in the amount of change in their scores on the outcome measures. Statistically significant multivariate effects were found for the main effects of groups, Wilk's $A = 0.84$, $F(2,37) = 3.48$, $P=0.04$, $\eta^2 = 0.16$, for time, Wilk's $A = 0.24$, $F(2,37) = 59.79$, $p < 0.001$, $\eta^2 = 0.76$, as well as for the interaction between groups and time, Wilk's $A= 0.69$, $F(2,37) =8.49$, $p < 0.001$, $\eta^2 = 0.32$.

Follow-up univariate ANOVAs after 3 months of intervention revealed a statistically significant difference between both groups for the body weight outcome variable, $F(1,38) = 11.7$, $p = 0.002$, $\eta^2 = 0.24$, and for the BMI outcome variable, $F(1,38) = 15.73$, $p < 0.001$, $\eta^2 = 0.29$.

Between-groups comparison:

After 3 months of intervention:

There were statistically significant differences between exergaming and MedDiet groups post-treatment in body weight, with means equal to 73.8 and 80.15 kg, respectively. Also, in BMI, the means are equal to 25.2 and 29.29 kg/cm², respectively, with more favor to the exergaming group ($P < 0.05$) as in **Table 2.**

Within-group comparison:

At the end of three months of intervention compared with baseline, all the outcome measures were significantly improved in the exergaming and Mediterranean diet groups ($p < 0.001$).

Table 1: Demographic characteristics of subjects (N =40)

	Exergaming group	MedDiet group	t- value	p-value
	$\bar{X}$ ±SD	$\bar{X}$ ±SD		
Age (years)	34.55±5.85	35±6.66	-0.23	0.82 a
Height (cm)	166.2±8.94	166.5±8.08	-0.11	0.91 a
Gender, n (%)				
Female	5 (25%)	4 (20%)	χ^2=0.1	0.71
Male	15 (75%)	16 (80%)		

a: Not significant, SD: Standard deviation, P: probability, BMI: body mass index; X^2= Chi square

Table 2: Within and between group analysis for body weight and BMI

Variables	Exergaming group	Mediterranean group	MD (95% CI)	p-value (between groups)	η^2
Body weight (kg)					
Pre-treatment	84.85±6.11	85.1±5.17	-0.25(-3.87, 3.37)	0.89 a	
Post-treatment	73.8±6.3	80.15±5.4	-6.35(-10.11, -2.59)	0.002 b	0.24
MD (95% CI)	11.05(7.89,14.22)	4.95 (1.79, 8.12)			
p-value (within-group)	0.001 b	0.003 b			
BMI (kg/cm^2)					
Pre-treatment	31.51±3.14	32.16±3.75	-0.65 (-2.86, 1.56)	0.56 a	
Post-treatment	25.2±3.15	29.29±3.37	-4.1(-6.19, -2.01)	0.001 b	0.29
MD (95% CI)	6.31 (5.06, 7.56)	2.87 (1.61, 4.12)			
p-value (within-group)	0.001 b	0.001b			

BMI: body mass index; p-value: probability; a: non-significance difference; b: significance difference; CI: confidence interval; MD: mean difference; η^2: partial eta square.

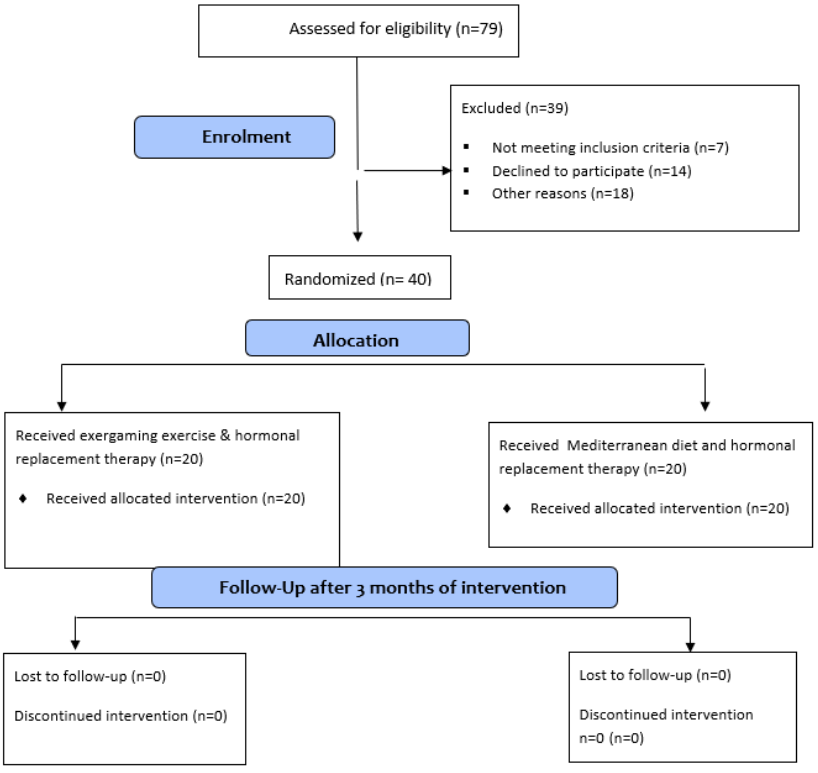

Figure 1. participant flow chart

Fig2: Exergaming exercises: (A&B) participant playing wall breaker, (C&D) participant playing stomp it, (E&F) participant playing Run the world

Discussion

The current study results showed that weight and BMI were significantly improved in the exergaming group, with means equal to 37.8 kg and 25.2 kg/cm², respectively. Results showed that weight and BMI were significantly improved in Mediterranean diet groups with means equal to 80.15 kg and 29.29 kg/cm² after 3 months of intervention in patients with total thyroidectomy ($p < 0.001$). The findings of this study showed that there were statistically significant differences between both groups in body weight and BMI with more favor to the exergaming group A ($P < 0.05$).

Both exergaming exercises and MedDiet improved body weight and BMI in patients with thyroidectomy ($p < 0.001$). It was attributed to participants completing 50 minutes of exercise. Due to the high level of engagement and enjoyment that video games can offer, they hold the potential to enhance exercise motivation, engagement, and even performance. The user may be so immersed and focused on the game that they may not even feel like exercising [30]. Exergaming can increase energy expenditure as it encourages the user to exert energy and physical effort to complete the game and achieve the desired outcome. It helps players to burn more calories and aids in weight loss [31].

The Mediterranean diet is high in fruits and vegetables, which are less dense in energy. Rich with fibers; thus, it enhances satiety, makes the subject feel full longer, and can lead to weight loss. 13 The MedDiet pattern provides a small amount of saturated fatty acids and a high quantity of antioxidants14. Food rich in antioxidants can lead to weight loss [32].

The results of this study agreed with Staiano et al.[33] who demonstrated that exergaming used as a tool to promote energy expenditure and to modestly reduce obesity. It can help to attenuate weight gain and reduce body mass index.

Also, the results of this study were in line with Cox et al.[34] who studied the impact of exercise on weight loss and weight maintenance. A study showed that performing exercise of a duration greater than the basic recommendations for health (150 min/week of moderate-intensity exercise) does appear to be more likely to contribute to weight loss and weight maintenance efforts.

The results of this study agreed with Estruch et al. [21], who studied the role of the Mediterranean diet on weight loss and obesity-related diseases. The result showed that this dietary pattern might also be used advantageously for weight loss and has been used in obesity.

The outcomes of this research were consistent with Esposito et al. [35], who evaluated the effect of Mediterranean diets on body weight. The results included that the Mediterranean diet associated with physical activity might be a useful tool to reduce body weight, especially when the Mediterranean diet is energy-restricted.

The results of this study agreed with Di Rosa et al.[36], who studied the effects of reaching 5% body weight loss on body composition in subjects with overweight and obesity. The study revealed that the Mediterranean diet (MD) and the Very Low-Calorie Ketogenic diet (VLCKD) might be effective at helping people lose body weight (BW) and fat mass (FM). The MedDiet significantly reduced waist circumference, body weight, and BMI compared to the baseline.

The results of this study were in contrast with Cox et al.[34], who studied the impact of exercise on weight loss and weight maintenance in individuals with type 2 diabetes. The study revealed that exercise alone does not contribute significantly to weight loss and weight maintenance. A small sample size (n=36) and different age groups (18-40) might be the cause of the contrast.

On the other hand, the results of this study were inconsistent with Christison et al.[37], who evaluated the effectiveness and sustainable impact of a multifaceted community-based weight intervention program for children, including an exergaming curriculum. The study revealed that using exergaming in community pediatric weight management did not improve weight status at the end of programming, and study implementation was limited by a small sample and missing data. Different age groups (8-18) also might cause the contrast. No patient complained of any signs or discomfort during the study.

This study has a few limitations; it measured the intermediate effect after 3 months of intervention. Therefore, future research should focus on exploring the long-term impact of the intervention and its follow-up. The absence of a control group taking only the medication also represents a limitation. So, future research should include a control group for generalization.

CLINICAL IMPLEMENTATION

The findings of this study may be implemented in the following ways:

The current study provides insights into how exergaming exercises and the Mediterranean diet, in the case of thyroidectomy, decrease body weight and BMI.

The present study suggested that exergaming exercises might be an enjoyable alternative to routine exercises for sedentary patients who experience weight gain.

RECOMMENDATIONS FOR FURTHER STUDIES

Further studies should be done with a larger population. Further studies are needed to determine the long-term effect after longer intervention. More studies are recommended to compare the impact on different age groups (pediatrics). Further studies should include a control group for generalization.

CONCLUSION

Exergaming exercises and the Mediterranean diet improved body weight and BMI with superiority to exergaming exercises. Exergaming exercises might be considered an enjoyable alternative to routine exercises for patients who experience weight gain. Exergaming exercises and a Mediterranean diet may be considered an important part of rehabilitation in patients after total thyroidectomy.

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Declaration of Competing Interest

The authors state there is no conflict of interest.

Availability of data and materials

By a mailed, justified request.

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