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# The effect of concurrent endurance and resistance training on selected physical fitness indices and quality of life in patients with beta thalassemia major

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## ABSTRACT

**Introduction:** The effect of concurrent endurance and resistance training on selected physical fitness indices and quality of life in patients with beta thalassemia major.

**Material & Methods:** In this semi-experimental, and field-based investigation design study, 40 eligible volunteer patients (aged 16–40 year; BMI < 25 kg/m2) randomly divided into 2 equal groups (control and exercise group). The exercise group (EG) performed 8 weeks of progressive concurrent endurance and resistance training three sessions per week. Resistance training exercises included squats, barbell chest presses, barbell overhead press, dumbbell lateral raises, and leg presses. Resistance was prescribed based on a percentage of each participant's one-repetition maximum (1RM), and the endurance training consisted of warm-up contain stretching exercises, and low-intensity treadmill running for 10-20 minutes. Before and after 8 weeks of training, Body weight, body fat percentage (%BF), Lean Body Mass (LBM), aerobic power (VO2max) and Quality of life (with questionnaire SF-36) were measured. Statistical information was obtained by Independent and paired t-tests was performed through SPSS software (version 24) and the significance level was considered as $p<0.05$.

**Results:** The results of the research revealed that the group of patients engaged in concurrent endurance and resistance training experienced significant changes in BMI, LBM, aerobic capacity, and quality of life after the post-test ($p<0.05$).

**Conclusion:** concurrent endurance and resistance training probably improves BF%, aerobic capacity, LBM and quality of life in patients with beta thalassemia major.

**Keywords:** Beta-Thalassemia Major, Quality of Life, Resistance Training, Concurrent Training.

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## 1. Introduction

Beta-thalassemia (BT) is described by the absence or reduction in the rate of production of the β-globin chain (1). Beta- thalassemia major is the most severe type of thalassemia which is known as Cooley's anemia that occurs either when individuals are homozygous or compounds heterozygous for more severe mutations in β chain (2). It usually induces between 6 months and 2 years and patients undergo severe anemia (heart failure, fatigue, and cachexia) (3). Beta-thalassemia has been reported to be around 1.5 per cent of the world's population (80-90 million people) carriers, with about 60,000 serving as symptoms born globally. The internationally estimated average annual frequency of symptomatic people is 1 in 100,000 (4). Iran, with a thalassemia gene prevalence rate of 4%, is among the countries located on the thalassemia belt. It is estimated that there are between two to three million BT carriers and 25,000 patients in Iran (5). Chelating therapy, besides blood transfusion, has improved the lifespan of thalassemia patients (6). Regular management with transfusions of blood or blood products might be overload the iron in various organs which result in diabetes, hypopituitarism complications in the liver and endocrine glands such as hypothyroidism, hypopituitarism, hyperparathyroidism, dark metallic pigmentation of the skin, cirrhosis, cardiac arrhythmia, and myopathy which can lead to 71% death of patients who have thalassemia major (7). Patients require regular blood transfusions for survival. Increased intestinal iron absorption finally leads to iron accumulation in the reticuloendothelial cells and in the parenchymal tissues. Iron overload and free iron causes the Fenton-type reaction and hemochromatosis (8). Myocardial siderosis is one of the important causes of mortality in patients with thalassemia major patients (9). Congestive heart failure, arrhythmias, and sudden deaths continue to occur (10). Adult patients suffering from thalassemia major have impaired body composition, especially in terms of whole-body lean mass and bone mineral density (11). Improvements in chelation therapy have been consistently reported to decrease the rate of new endocrine disorders, whereas patients who present poor compliance with chelation therapy are at an increased risk of developing endocrine disorders that affect body composition status (12). Most studies found a reduced exercise capacity in thalassemia patients and have attributed these findings to a combination of anemia and iron-mediated cardio toxicity, but the precise pathophysiological mechanisms have not yet been fully clarified (13). In addition, the need for continuous treatment throughout the course of one's life, the daily intake of chelators, and the need to constantly monitor the levels of iron in the blood are all expected to negatively impact the health-related quality of life (HRQoL) of patient with β thalassemia. HRQoL is a multidimensional construct related to the specific impact of the disease on quality of life (14). A factorial analysis of energy capacities found both the ability to recover from exercise and heart rate during exercise to have an aerobic basis (15). Thalassemia adults have been found to exhibit a marked decline in exercise capacity, most likely attributable to anemia, deconditioning, and an absence of exercise-induced hem concentration (16). Exercise significantly reduces ferritin and iron levels in the blood and, on the other hand, increases total iron binding capacity, hemoglobin, and hematocrit (17). Nevertheless research on the benefits of exercise for patients with beta thalassemia major is limited. The purpose of this study was to assess the effect of concurrent endurance and resistance training on selected physical fitness indices and quality of life in patients with beta thalassemia major.

## 2. Methodology

### 2.1. Materials and methods

The research was a semi-experimental, and field-based investigation design with 2 groups. 40 patients were selected from the Thalassemia Department of Amini Hospital in Langrud City for participation in this study, then randomly assigned to 2 equal groups of experimental and control group (n = 20). The experimental group participated in endurance-resistance training for 3 sessions per week for 2 months.

### 2.2. Participants

The statistical population of this study included all patients with thalassemia major referred to the thalassemia ward of Langrud city at the time of the study, which included 115 patients and 40 eligible volunteers (aged 16–40 years and body mass index < 25 kg/m2) were selected. The inclusion criteria were not having any acute or severe illness at that time. Also, the control group did not participate in the exercise program protocol. Initially, the sample size was 43 patients, one person was excluded from the study due to acute heart disease and two others due to not attending exercise training for more than 3 sessions. This study was conducted following the Declaration of Helsinki, and Ethical approval was obtained from the Rasht Branch, Islamic Azad University.

### 2.3. Measurements

**Body weight and Height:** To determine the participants' weight, they stood on a Sergio SWB-75 scale (Italy). Their height was also measured using a graduated tape measure. Both groups were fasting, wore sports shirts and pants, and were conducted in the thalassemia ward of Amini Hospital in Langrud.

**Body mass index:** BMI was calculated based on the ratio of weight (kilograms) to height (meters) squared (BMI=kg/m2).

**Body Fat Percent:** The percentage of body fat was measured using skinfold thickness with the Sahhan SH5020 caliper) South Korea), which has an accuracy of 1 millimeter. It was calculated using the three-site Jackson-Pollock. (Men: Chest, abdomen, and thigh; Women: Triceps, suprailiac, and thigh).

**Total body weight:** lean body mass (LBM) was determined using the following formula after obtaining total body weight (TBW) and body fat (BF%):

$$LBM=TBW-(TBW\times 100BF\%)$$

**Aerobic power:** To measure maximal aerobic power (VO2max), the Rockport test was used with the following formula:

$$VO2\ max\ (ml.kg-1.min-1)=132.853-(0.0769\times Weight)-(0.1565\times Heart\ Rate)-(3.2649\times Time)+(6.315\times Sex)-(0.3877\times Age)$$

**Quality of life:** Questionnaire SF-36 was used to assess the participants' quality of life. it has 8 components and 36 questions including: general health (5 questions), physical functioning (10 questions), role limitation due to physical reasons (4 questions), role limitation due to emotional reasons (3 questions), physical pain (2 questions), social functioning (2 questions), vitality (4 questions), and mental health (5 questions). The lowest score in this questionnaire is zero and the highest score is 100, with a score of 50 being suggested as a jumping-off point. IN Iran, the validity and reliability of this questionnaire for determining the quality of life of patients with thalassemia major have been investigated by various researchers such as Jafari et al. (2008) and Dehloui et al. (2009). Overall, internal consistency has been reported to be between 0.80 and 0.90 in Iran and between 0.77 and 0.90 in other countries. Recently, Cronbach's alpha of the SF-36 questionnaire was estimated to be 0.91 by Imani et al. (2013).

### 2.4. Intervention

**Exercise program:** One week before the start of the training program, three familiarization sessions were held for the subjects (including weight training, proper fluid intake during training, etc.). Then the experimental group participated in an 8-week intervention that included endurance and resistance training. The sessions were conducted three times per week, with each session lasting approximately one hour. The endurance training program, as shown in Table 1, included components such as stretching, warm-up activities, and light jogging on a zero-incline treadmill. Over the course of 8 weeks, the running time gradually increased from 10 to 20 minutes, while the running speed progressed from 3 km/h to 6 km/h.

***Table 1.*** *Endurance Training Program*

| Weeks | Warm-up Time (minutes) | Walking Time (minutes) | Velocity (km/h) |
|---|---|---|---|
| 1 | 5 | 10 | 3-4 |
| 2 | 5 | 12 | 3.5-4.5 |
| 3 | 8 | 15 | 3.5-4.5 |
| 4 | 8 | 15 | 4-5 |
| 5 | 10 | 15 | 4-5 |
| 6 | 10 | 20 | 4-5 |
| 7 | 12 | 20 | 5-6 |
| 8 | 12 | 20 | 5-6 |

Resistance training was performed using free weights, targeting major muscle groups at an intensity of 40–50% of one repetition maximum (1RM). The resistance training program, detailed in Table 2, consisted of weight training for one set of each exercise along with a cool-down period for the first four weeks. In the following four weeks, participants engaged in two training sessions per week, maintaining a similar structure but increasing the weight training to two sets. According to the protocol, the weights assigned to each subject were calibrated for 12–15 repetitions, a range that indirectly reflected their 1RM. During the first two weeks, training was conducted at 50% of this 1RM, with weights recalibrated every two weeks using the initial assessment method. If participants successfully lifted the newly assigned weight, the previous weight was maintained to ensure stability in training. 1RM of each participant for each exercise was obtained from the Brzeski formula:

$$1RM = Weight\div (1.0278-(0.0278\times Number\ of\ repetitions))$$

***Table 2.*** *Resistance Training Program*

| | Type of Exercise | Muscle Group | Intensity | Set | | Repetition Intensity | Number of Training Sessions / Week (days) | |
|---|---|---|---|---|---|---|---|---|
| | | | | first four weeks | second four weeks | | First four weeks | Second four weeks |
| 1 | Squat | Quadriceps femoris, Hamstrings ،Gluteus maximus | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |
| 2 | chest press | Nectorals (chest), deltoids (shoulders), and triceps (arms) | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |
| 3 | Forearm Barbell | Biceps brachia muscle | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |
| 4 | Lateral Raise | deltoid | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |
| 5 | Barbell Calf Raise | Gastrocnemius, soleus | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |
| 6 | Modified Sit-Up | Rectus abdominis | 50% 1RM | 1 | 2 | 12-15 | 3 | 2 |

### 2.5. Statistical Methods

This research utilized both descriptive and inferential statistics to analyze the data effectively. For inferential statistics, the Kolmogorov-Smirnov test was conducted to assess the normality of the data. Additionally, a covariance test and dependent t-test were performed to evaluate the hypotheses at a significance level of ($P<0.05$). All statistical analyses were conducted using SPSS software (IBM, SPSS Inc., Chicago, IL, USA).

## 3. Results

The Kolmogorov–Smirnov test indicated normal distribution for all of the variables. The results of descriptive analysis (n=20 for each group) and the changes observed in the control group post-test compared to the pre-test were presented in Table 3.

***Table 3.*** *Descriptive characteristics, selected physical fitness indices and quality of life data of the study participants*

| Variables | Exercise Group | Control Group | Sig |
|---|---|---|---|
| Male | 48.5 | 52.6 | 0.17 |
| Female | 51.5 | 47.4 | |
| Age (year) | 25.7±31 | 25.4±5.9 | 0.001 |
| Wight (kg) | 52.91±6.30 | 51.83±5.2 | |
| Pre Test | 53.27±4.2 | 51.93±6.4 | 0.05 |
| Post Test | | | 0.05 |
| BMI (kg/m$^2$) | 19.89±2.1 | 19.67±7.3 | 0.05 |
| Pre Test | 20.28±3.1 | 19.72±1.1 | 0.05 |
| Post Test | | | |
| BFP% | | | |
| Pre Test | 19.4±7.4 | 18.4±4.3 | 0.05 |
| Post Test | 19.2±6.2 | 18.7±8.1 | 0.05 |
| Average age of thalassemia | 16.28±11.07 | 14.42±13.34 | 0.102 |
| Diagnosis (month) | | | |
| Desferal history (year) | 22.22±2.4 | 21.36±1.6 | 0.001 |
| Aerobic power(ml/kg/min) | 39/8±6 | 38/63±3/3 | 0.001 |
| Pre Test | 42/6±8/2 | 37/18±9 | 0.001 |
| Post Test | | | |
| Muscular endurance (sit-up test | 14/48 | 13/63 | 0.001 |
| (Numbers per min)) | 19/9±2/3 | 13/31 | 0.001 |
| Pre Test | | | |
| Post Test | | | |
| Quality of life | | | |
| Physical performance | | | |
| Pre Test | 51/17±11/30 | 48/93±12/19 | 0/22 |
| Post Test | 57/02±14/62 | 47/01±9/1 | 0/001 |
| Role limitation due to physical | 52/28±24/36 | 49/88±14/7 | 0/37 |
| problems | 69/10±21/8 | 51/31±16/5 | 0/001 |
| Pre Test | | | |
| Post Test | | | |
| Physical pain | 34/21±21/11 | 38/48±18/21 | 0/25 |
| Pre Test | 53/19±17/5 | 36/27±9/11 | 0/005 |
| Post Test | | | |
| General health | 36/13±14/8 | 42/50±17/8 | 0/005 |
| Pre Test | 57/02±13/09 | 41/18±22/1 | 0/001 |
| Post Test | | | |
| Freshness and vitality | 48/13±2/18 | 41/53±3/1 | 0/32 |
| Pre Test | 61/19±1/75 | 43/03±1/17 | 0/001 |
| Post Test | | | |

| | | | |
|---|---|---|---|
| Social performance | 35/72±31/1 | 39/19±14/3 | 0/24 |
| Pre Test | 52/97±15/4 | 37/87±10/8 | 0/001 |
| Post Test | | | |
| Role limitation due to emotional | 55/28±12/1 | 51/63±13/2 | 0/17 |
| problems | 69/10±17/4 | 50/28±14/41 | 0/001 |
| Pre Test | | | |
| Post Test | | | |
| Mental health | 48/11±12/8 | 51/18±1/09 | 0/27 |
| Pre Test | 69/08±5/2 | 50/98±1/4 | 0/001 |
| Post Test | | | |

The results of the t-test comparing body mass index, lean body mass, aerobic capacity, and quality of life in the control group revealed no significant differences between the pre-test and post-test stages. However, as presented in Table 4, the t-test conducted to assess the effects of the simultaneous endurance and strength training program on fat mass, lean body mass, aerobic capacity, and quality of life in patients indicated that the $R^2$ values suggest a significant dependence of the changes in the dependent variables on the independent variable. The findings from the main group effect analysis demonstrated a significant impact of the intervention on the dependent variables. Consequently, our research confirms that the simultaneous endurance and strength training program has a substantial effect on fat and lean body mass, aerobic capacity, and quality of life in patients.

***Table 4.*** *The results of student t-test in interventions*

| **Factors** | **Exercise Group** | | **Control Group** | |
|---|---|---|---|---|
| | Means | Sig | Means | Sig |
| BMI | -0.394 | 0.016 | -0.150 | 0.413 |
| LBM | -13.21 | 0.001 | -1.60 | 0.349 |
| Aerobic power (VO2max) | -0.416 | 0.018 | -0.163 | 0.548 |
| Quality of life | -12.21 | 0.001 | -1.60 | 0.338 |
| Investigating the relationship of variables | | | | |
| | $R^2$ | | Sig | |
| BMI | 0.746 | | 0.003 | |
| LBM | 0.192 | | 0.002 | |
| Aerobic power (VO2max) | 0.498 | | 0.001 | |
| Quality of life | 0.613 | | 0.002 | |

## 4. Discussion

The results of our study indicated BMI of subjects in the experimental group showed a significant increase, while only a minor increase was observed in the control group. Additionally, the values for LBM were also notably higher in the experimental group, suggesting an increase in muscle mass. Beta-thalassemia major significantly impacts body composition, leading to alterations in nutritional status and increased health risks. Patients often exhibit low LBM and high BF%, contributing to conditions such as sarcopenic obesity (a decrease in muscle mass accompanied by an increase in fat) (18). In beta-thalassemia major, chronic anemia leads to an increased basal metabolism and heightened oxidative stress. Spleen removal due to hypersplenism plays a significant role in the development of pulmonary hypertension in affected patients. Following splenectomy, residual platelets are not removed from the bloodstream, resulting in elevated platelet counts. These factors act as coagulants and inhibit nitric oxide effects. Consequently nutritional disturbances and decreased levels of vitamins, particularly vitamin B12 and vitamin D, as well as reductions in selenium, zinc, copper, and carnitine. These deficiencies are implicated in the increase in body fat (19). According to the study by Razaqi et al., specific effects on body composition in the presented contexts were not precisely defined. However, we can infer some potential outcomes based on the nature of aerobic and resistance exercises. Aerobic exercises are recognized for their effectiveness in reducing body fat, while resistance training is effective for building muscle mass. The combination of both types of exercise may lead to a more optimal body composition by reducing BF% and increasing lean muscle mass. Further research is necessary to measure these effects specifically within the studied population (20). Our results showed a significant increase in aerobic capacity in the exercise group. Poor physical fitness is a prevalent issue among patients with thalassemia. Several studies have reported that individuals with thalassemia exhibit lower mean scores in quality of life (QoL) compared to healthy individuals (21), and chiefly the mean scores for physical activity among these patients are significantly lower compared to the scores for other dimensions (22). Several studies have reported reduced exercise capacity in patients with thalassemia major, attributing these findings primarily to a combination of anemia and iron-mediated cardiotoxicity (23, 24). But other research has

mostly linked poor physical performance to a limited response of peripheral muscles (25, 26). While anemia is a significant factor contributing to reduced exercise capacity, as it is closely related to blood hemoglobin levels, it does not fully account for this limitation. Correcting anemia through blood transfusions in patients with β-thalassemia has been associated with a substantial improvement in exercise performance. Benedetto et al. demonstrated that for each g/dL increase in hemoglobin, there was an increase of 82.5 mL/min in peak oxygen uptake (V'O2 peak) (27). Exercise trainings increases maximal oxygen uptake by enhancing mitochondrial and capillary density, improving cardiac output, and increasing hemoglobin levels (28). Also an exercise program can improve the quality of life by increasing exercise capacity (29, 30). The researches findings indicate that thalassemia significantly impacts the quality of life, resulting in a lower overall quality of life for most patients. Additionally, it adversely affects various aspects, including physical, psychological, social, and economic well-being, as well as the patients' self-perception (31). Sports rehabilitation has been shown to be effective in enhancing mental health among patients by increasing self-confidence, promoting well-being, fostering feelings of intimacy and happiness, and reducing symptoms of depression and anxiety. Overall, it significantly improves QoL for these individuals (32), our results align with this assertion; in this study, the group that participated in the exercise program demonstrated a significant increase in quality of life factors after eight weeks. This result is not consistent with Wagner et al. might be attributed to a low number of samples and the social and economic status of subjects and individual differences in spiritual beliefs, and the low number of exercise sessions (33). Participants were neither given a specific dietary regimen nor was their dietary intake monitored throughout the study. Additionally, activities outside of the prescribed exercise program were not controlled, and the timing of their blood transfusion was also not monitored. It is recommended that future studies be conducted with consideration of these limitations, focusing on variations in intensity, duration, and type of exercise over longer time periods for these patients.

## 5. Conclusion

The results of this study indicated that eight weeks of concurrent aerobic and resistance training led to an increase in BMI and lean body mass, improved quality of life, and enhanced aerobic capacity in patients with thalassemia major.

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