

# Effects of Aerobic Training Combined with Inspiratory Muscle Training on Cardiopulmonary and Skeletal Muscle Function, Dyspnea and Quality of Life in Patients with Chronic Heart Failure

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**Abstract - This randomized controlled study aims to determine the additive effects of combining Aerobic Interval Training (AIT) with Inspiratory Muscle Training (IMT) in subjects having chronic heart failure and inspiratory muscle weakness. 32 patients were enrolled, and underwent a 3 months training program each allocated to one of three different exercising groups comprised of IMT, AIT and a combination of both. IMT training involved a 15 minutes inspiratory training at 60% maximal inspiratory pressure, AIT involved a 30 minutes treadmill exercising at 60% to 90% of maximum heart rate, and the combined group performed both types of training separated by a rest period. Pulmonary function, respiratory and skeletal muscles function tests were performed as well as Quality of Life (QoL) and functional capacity before and after interventional periods. Our results showed the benefits of using the combination of the two training types on inspiratory muscle and skeletal muscle function. Also, additional improvements in functional capacity were observed using the 6 minutes' walk test and by evaluating the patients' QoL.**

**Keywords:** *Heart failure; Aerobic interval training; Inspiratory muscle training; Inspiratory muscle weakness; Cardiac rehabilitation; Quality of life.*

## I. INTRODUCTION

The main obstacle that heart failure patients face is exercise intolerance, usually manifested by fatigue and dyspnea during the daily living activities. Thus, these symptoms might contribute to physical impairment and reduce the autonomy of individuals. Exercise training has been shown to be safe and beneficial in heart failure patients. Thus, the non-pharmacologic strategy guidelines recommended exercise training to relieve symptoms, improve exercise tolerance, quality of life and reduce the rate of hospitalization.

## II. REVIEW

Exercise training is highly recommended in patients with Chronic Heart Failure (CHF) [1][2][3]. The significant improvements on patients Quality of Life (QoL) and functional capacity have been proven by many researchers after Aerobic Interval Training (AIT) [1] and Inspiratory Muscle Training (IMT) [4][5]. The combination of both modalities has been promising and proved to be more beneficial than each training modality taken alone. Two recent studies have confirmed the additional effects of combining IMT and AIT in CHF patients. Winkelmann et al. [6] reported additional improvements in cardiorespiratory response in the combined group when compared with aerobic training group. Adamopoulos et al. [7] reported additional benefits in serum biomarkers and dyspnea sensation in the combined group patients compared to the aerobic training group. Both studies did not measure the benefits at the level of skeletal muscle function, and did not compare their combined group patients to IMT group or to a control.

## III. AIM

The first aim of this study is to determine the effects of combined training on skeletal and respiratory muscle function, exercise capacity, left ventricular remodeling, dyspnea and quality of life in CHF. The second aim is to find the best training exercise that could have additional benefits on measured parameters.

## IV. METHODS

32 patients with stable CHF and inspiratory muscle weakness were randomly assigned to a training program for 12 weeks (3 times / week). The patients were divided, thereafter, into four different groups: controls (n=8), aerobic

interval training AIT (n=8), inspiratory muscle training IMT (n=8), and combined AIT+IMT (n=8). AIT consisted of treadmill exercise at 60% to 90% of Maximum Heart Rate (MHR). Interval training was chosen for its confirmed benefits over continuous training [8]. The treadmill exercise included 5 minutes warm-up period, followed by four bouts, each of 4 minutes at high intensity (60%-90% of MHR) interspaced by five low intensity bouts (50% of high intensity), each of 2 minutes, and ended by 5 minutes cool-down period. IMT was performed for 15 minutes using the PowerBreathe device [4]. It included 4 bouts, each of 3 minutes at high intensity (60% of maximal inspiratory pressure (MIP) with a warm-up and cool-down periods each of 1 minute at low intensity (50% of maximum intensity). The combined group training consisted of AIT followed by IMT session, with 5 minutes rest in between. The controls were instructed to maintain their habitual daily living activities. At baseline and after the training period, patients underwent pulmonary function test by Spirometry, respiratory muscle function assessment by electronic pressure transducer, echocardiography, stress test, skeletal muscle function test using hand-held dynamometer, and 6-min walk test. Dyspnea, according to Borg scale, and QoL, according to Minnesota living with heart failure questionnaire, were also assessed.

## V. RESULTS

Exclusively, skeletal muscle strength and endurance improved significantly in all three training groups. The combined group was shown to be the best group at the level of all improved parameters. Compared to the control, the combined group had 11% improvement in the maximal voluntary isometric force (kg) and a 30% improvement in the quadriceps muscle endurance capacity ( $p < 0.05$ ). Compared to the control, this training has shown a 96% improvement in inspiratory muscle strength ( $p < 0.01$ ) and 87% improvement in inspiratory muscle endurance ( $p < 0.001$ ). Quality of life score, functional capacity, exercise time and dyspnea sensation had been improved in all three groups with the combined training being the most beneficial. No significant differences were reported between groups on spirometric and cardiac structure variables, forced vital capacity, forced expiratory volume and left ventricle ejection fraction.

## VI. DISCUSSION

In this study, we have reported significant improvements in CHF patients after exercise training. We proved that combined exercise training has beneficial results on the respiratory muscle strength and endurance, as well as functional capacity and QoL. These results were previously shown by Winkelmann et al. in 2009 and Adamopoulos et al. in 2014. Skeletal muscle function that had not been

assessed by these two studies, have also been significantly improved in our patients. Such beneficial effects in skeletal muscle, strength and endurance, might be due to improved skeletal muscle intrinsic properties.

## VII. CONCLUSION

Combined AIT and IMT was safe and more effective in improving exercise capacity, skeletal muscle function, inspiratory muscle strength and endurance, pulmonary function, and QoL in CHF patients. Since no improvements have been detected in the cardiac function, we recommend that future studies must include a higher number of patients and assess for cardiac related improvements after combined training.

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## ETHICS

The study is approved by the ethics committee of Beirut cardiac institute, Beirut, Lebanon.

## REFERENCES

- [1] C. Brum, A. V. N. Bacurau, A. Medeiros, J. C. B. Ferreira, A. S. Vanzelli, and C. E. Negrão, "Aerobic exercise training in heart failure: Impact on sympathetic hyperactivity and cardiac and skeletal muscle function," *Brazilian J. Med. Biol. Res.*, vol. 44, no. 9, pp. 827–835, 2011.
- [2] P. Ponikowski *et al.*, "2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure," *Eur. Heart J.*, vol. 37, no. 27, p. 2129–2200m, 2016.
- [3] C. W. Yancy *et al.*, "2013 ACCF/AHA guideline for the management of heart failure: A report of the American college of cardiology foundation/american heart association task force on practice guidelines," *J. Am. Coll. Cardiol.*, vol. 62, no. 16, 2013.
- [4] I. D. Laoutaris *et al.*, "Immune response to inspiratory muscle training in patients with chronic heart failure," *Eur. J. Cardiovasc. Prev. Rehabil.*, vol. 14, no. 5, pp. 679–685, 2007.
- [5] M. Bosnak-Guclu *et al.*, "Effects of inspiratory muscle training in patients with heart failure," *Respir. Med.*, vol. 105, no. 11, pp. 1671–1681, 2011.
- [6] E. R. Winkelmann, G. R. Chiappa, C. O. C. Lima, P. R. N. Viecili, R. Stein, and J. P. Ribeiro, "Addition of inspiratory muscle training to aerobic training improves cardiorespiratory responses to exercise in patients with heart failure and inspiratory muscle weakness," *Am. Heart J.*, vol. 158, no. 5, p. 768.e1-768.e7, 2009.
- [7] S. Adamopoulos *et al.*, "Combined aerobic/inspiratory muscle training vs. aerobic training in patients with chronic heart failure: The Vent-HeFT trial: A European prospective multicentre randomized trial," *Eur. J. Heart Fail.*, vol. 16, no. 5, pp. 574–582, 2014. Electronic Publication: Digital Object Identifiers (DOIs):
- [8] U. Wisløff *et al.*, "Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: A randomized study," *Circulation*, vol. 115, no. 24, pp. 3086–3094, 2007.